

Papers and Posters Presented at the 40th Annual Meeting of the Psychonomic Society  
Century Plaza Hotel, Los Angeles, California  
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POSTER SESSION I

California Showroom, Thursday Evening, 7:00–8:30

• PERCEPTION •

(1)

**Deficits of Complex Form Perception and Attention in a Patient With Partial Achromatopsia.** RACHEL E. SHOUP, *University of California, Davis*, & JAMIE A. MAZER & JACK L. GALLANT, *University of California, Berkeley*—Physiological studies in non-human primates suggest that cortical area V4 is important for the perception of both color and form. Cells in V4 are also modulated by attention. Because humans with V4 lesions typically exhibit severe achromatopsia, most studies of these patients have focused on color vision. We assessed form vision and attention in a patient, A.R., with upper left quadrant achromatopsia due to a small right occipito-temporal (V4) infarct. Data were acquired in a series of threshold discrimination tasks performed concurrently in the four visual quadrants. Despite normal performance on motion and simple form stimuli, A.R. showed marked deficits in the discrimination of non-Cartesian (curvature) stimuli in his impaired quadrant. He also had difficulty judging relative position and localizing low salience stimuli in this quadrant, suggesting an impairment in attention. These data suggest that human area V4 is functionally homologous to V4 in nonhuman primates.

(2)

**Time, Space, and Shape Distortions in Aperture Viewing.** CAROL YIN, *California Institute of Technology*—As an object moves behind multiple occluders, portions of the object are revealed while other portions become occluded. To see the object we must be integrating shape information across time and space, but how? The mechanisms of this spatiotemporal shape integration may be revealed by examining perceptual distortions that occur during aperture viewing. Moving objects anorthoscopically viewed through a slit often appear compressed (skinnier), but this compression is not homogeneous across the surface of the object. We showed observers ovals and quadrilaterals with different degrees of distortion and asked observers to judge whether the left or right half of the shape appeared more elongated. Preliminary results suggest that the amount of perceived distortion depends on the contour curvature. However, another experiment using four circles marking the vertices of an imaginary quadrilateral found that part of the distortion may be accounted for by a misperception of time.

(3)

**Visual Analysis of Human and Animal Biological Motion Displays.** JEANNINE PINTO & MARGARET SHIFFRAR, *Rutgers University*—Adults can effortlessly perceive a human form in a display of discrete elements (“point-lights”) moving as if attached to the major joints of an invisible person (Johansson, 1976). Given our great sensitivity to these complex forms and the clear ecological value of such sensitivity, some investigators suggest that the perception of these figures involves mechanisms specifically attuned to biological motion. Does this sensitivity extend to nonhuman animal forms? In a series of studies, we investigated the breadth of observers’ sensitivity to biological motion. Previous findings suggest that the visual system can perform global analyses in the extraction of human structure from motion-carried information. We will report findings that suggest that such analyses can also be deployed in the perception of

other animal forms (e.g., birds, cats, horses). We will also report variations across these displays in the orientation specificity of sensitivity, discussing possible implications for accounts of biological motion perception.

(4)

**Representing the “What” and the “Where” of Undetected Change.** IAN M. THORNTON, *Nissan Cambridge Basic Research*, & DIEGO FERNANDEZ-DUQUE, *University of Oregon*—Studies of change blindness demonstrate that we are seldom aware of everything that is before our eyes. However, these studies may be telling us more about the limits of visual awareness than about the limits of visual representation. Specifically, we have suggested that the explicit reports used for most change blindness tasks underestimate the visual system’s ability to represent change. In the current series of experiments we use a simple change detection task coupled with a speeded orientation discrimination task to show that even when observers are subjectively unaware of a change in orientation, such changes still affect their subsequent orientation responses. These results provide new evidence that visual representation of change can exist outside of awareness and furthermore that these representations provide information about “what” has changed as well as information about “where” a change has taken place.

(5)

**On the Inadequacies of Cognitive Explanation of Gamma Motion Phenomena.** WILLIAM C. SCHMIDT, *SUNY, Buffalo*—Several candidate cognitive accounts have been put forward to explain the expansion motion that is experienced when a probe item accompanies a previously visible prime (i.e., illusory line motion). Object level accounts posit that the motion experienced is the result of processes that transform one object view (the prime) into another later view (the probe). However, this account fails to explain the data. For instance, they do not explain why motion can be experienced within the single presentation of an item (gamma motion), why multiple motion experiences can occur within probe items, why the direction of motion experienced depends on spatial separation, why the effect breaks down for identifiable objects, and several other empirical results. Low-level mechanistic approaches on the other hand fare better at explaining these results. A framework is presented that coordinates such findings.

(6)

**A New, Object-Based Visual Illusion.** ADAM C. G. COOPER & GLYN W. HUMPHREYS, *University of Birmingham* (sponsored by Jane Riddoch)—In six experiments, normal participants were required to compare the distance between features that grouped with the distance between features that did not group, and then to choose the wider or narrower distance. For all experiments, a strong response bias was found indicating that the distance across the grouped features was perceived as the wider by approximately 0.1° of visual angle, regardless of item shape or of presentation type. We suggest that differences in perceived distance reflects the use of distinct forms of spatial coding: “within object” and “between object,” in the terms introduced by Humphreys and Riddoch (1994, 1995). In addition, the direction of the illusion may be due to multiple factors: possibly higher neural resolution for within- versus between-object coding, or greater neural activation during selection of single, large objects versus during selection across multiple, smaller objects, where activation level is related to size of area selected.

(7)

**The Effect of Lateral Feature Displacement on Perceived Facial Attractiveness.** JAY FRIEDENBERG & NICHOLAS FRIEDMANN, *Manhattan College*—We investigated the influence of lateral displacement of facial features on perceived attractiveness. In Experiment 1, the eyes, nose, and mouth of normal photographic facial images were displaced to the left and right in various combinations. The features were displaced by three pixels, corresponding to approximately 1% of average facial width. Faces with two features moved to the left and one to the right were rated significantly less attractive than those with two features moved to the right and one to the left. Experiment 2 sought to replicate this effect by performing the same displacements on symmetrical faces to control for amount of deviation from the vertical midline. The results showed that conditions with any featural displacements were now rated lower. This suggests that sensitivity to featural deviation of this sort is more sensitive in symmetrical faces.

## • PATTERN PERCEPTION •

(8)

**Response Categories and Interlevel Interference in Local–Global Processing.** STEPHEN D. CHRISTMAN, *University of Toledo*, & FREDERICK L. KITZERLE, *Northern Illinois University*—Subjects identified targets at local versus global levels of hierarchical stimuli presented to the left, central, and right visual fields. Target sets consisted of two letters (H vs. S) for one group of subjects, a letter and a number (H vs. 3) for a second, and a letter and a shape (H vs. square) for a third. Global precedence was unaffected by target identity: Global targets were processed more quickly in all three conditions. However, interlevel interference (slowed RTs when stimulus identity at nontarget level is incongruent with stimulus identity at target level) was affected by target identity, with subjects discriminating between two letters exhibiting more interference than the groups discriminating letters from nonletters. Results support the hypothesis that precedence and interference reflect distinct mechanisms, with interference arising in part from Stroop-like response conflict. Left–right visual field asymmetries in both precedence and interference were small and unaffected by target identity.

## • INFORMATION PROCESSING •

(9)

**Effect of Speed–Accuracy Tradeoff on Motoric and Premotoric Components of Reaction Time.** ROLF ULRICH, STEFAN MATTES, & HILTRAUT MÜLLER-GETHMANN, *University of Tübingen*, ALLEN M. OSMAN, *University of Pennsylvania*, & GERHARD RINKENAUER, *University of Tübingen*—Most reaction time (RT) models assume that subjects spend less time for stimulus processing when they are encouraged to respond faster at the expense of accuracy. Consequently, these models assume that at least part of the speedup occurs during premotoric components of the reaction process. To test this prediction, we used movement-related brain potentials to divide RT into two intervals. Specifically, we separately examined the effects of speed–accuracy tradeoffs on the portions of RT before and after the initial development of the motor potentials associated with a signaled hand response. The results of two experiments showed that speed instructions not only shortened the interval before the development of the motor potential, but also the interval immediately preceding the overt movement. In summary, these results do not support the common notion that speed–accuracy tradeoff effects reside completely within the premotoric part of the RT process.

(10)

**Investigating Information Processing Using a Psychological Refractory Period Paradigm.** MARK A. GUADAGNOLI, *University of Nevada, Las Vegas*, ROBERT MICHAEL KOHL, *College of William and Mary*, & CRAIG A. LANE, *Auburn University*—The cur-

rent study examined information processing (IP) with a psychological refractory period (PRP) paradigm. Typically, PRP paradigms utilize the second reaction time (RT<sup>2</sup>) of two closely spaced S–R pairs. The current study investigated the effects of the second S–R pair on the RT<sup>1</sup>. Logically, if the second S–R pair affected RT<sup>1</sup>, IP is not wholly serial. Subjects ( $n=24$ ) were required to provide RTs under a series of conditions, each manipulating a stage of IP. Results of the repeated measure ANOVA revealed a significant effect of the second S–R pair on the first RT. The results support a model that consists of parallel processing until information demands require serial processing.

(11)

**Cognitive Demands of a Straight-Line Curve Tracing Task.** MARK VAN SELST, *San Jose State University*, TONY RODRIGUEZ, *University of California, Irvine*, & STACY GRANADA, *San Jose State University*—Ullman (1980) suggests that late perceptual processing of a visual scene takes place through an assembly of basic visual operations that include mental rotation, curve tracing, and spatial indexing operators. Previous dual-task studies using the psychological refractory period (PRP) paradigm have investigated the cognitive demands of mental rotation. These earlier studies have demonstrated that mental processes required to compensate for stimulus misorientation are largely subject to the same dual-task processing bottleneck that delays response selection and some forms of stimulus categorization in the PRP paradigm (Ruthruff & Miller, 1995; Van Selst & Jolicoeur, 1994). The current work examines the stability of the interdot distance effect in curve tracing (Jolicoeur, Ullman, Mackay, 1991) across the stimulus onset asynchrony (SOA) manipulation in the PRP paradigm. Distance effects in curve tracing, like misorientation effects in mental rotation, remain largely additive across SOA. Curve tracing requires central processing.

(12)

**Motor Cortex Activation During Overt, Inhibited, and Imagined Movements.** ALLEN M. OSMAN, *University of Pennsylvania*, ROBERT ALBERT, *University of Utah*, & MARTIN HEIL, *Philipps University*—Is imagining a simple speeded movement similar to initiating the movement and then inhibiting it before it becomes overt? Movement-related brain potentials were used to monitor sensorimotor cortex (SMC) activation during real and imagined movements that were either executed or inhibited. Subjects performed real and imagined movements in a choice-RT task where the signal contained two features. An easily discriminable feature indicated which hand to move or imagine moving, and a less discriminable feature indicated whether to execute or withhold the response. SMC activation began at the same time for executed and inhibited real movements but vanished quickly for the latter. SMC activation also occurred for imagined movements, was greater when they were supposed to be executed than inhibited, and lasted for some time. Thus, the imagined movements were not merely aborted real movements or automatic reactions to the signal, but involved controlled and extended activation of the motor system.

(13)

**What Maintains the Integrity of Concepts in Conceptual Combinations?** PETER M. MOERTL & FRANCIS T. DURSO, *University of Oklahoma*—Recent research has shown that emergent information in conceptual combinations can be activated faster than prestored information. Springer and Murphy (1992) showed that “peeled apple–white” is verified faster than “peeled apple–round.” These findings fit into a growing body of research in psychological concepts that show the unstable character of concepts. If the meaning of concepts changes freely with context, what of the concept is there to give it identity? We show that if a feature normally unrelated to a concept was true of a conceptual combination, it was responded to quickly only if that feature came from a salient dimension of the concept. A feature from an emerging dimension not salient to the concept

showed no verification advantage. This suggests that the ultimate integrity of concepts depends on the configuration of dimensions. Conceptual combinations and metaphors that take advantage of those dimensions will be understood quickly.

(14)

**A Multilayer Connectionist Model That Predicts General Properties of Speeded Performance.** DAVID R. ADAMS & JOEL MYERSON, *Washington University*—A connectionist model is proposed in which processing is represented as the probabilistic flow of activation through a multilayer network. Task difficulty is represented by the number of layers of processing required by the task. The model correctly describes the shape of reaction time distributions, the trade-off between speed and accuracy, and the relation between correct and error reaction times. The model additionally describes the effects of age and individual differences in processing efficiency on the preceding phenomena. Unlike other more abstract reaction time models (e.g., the diffusion model), our model describes the content of the representations being processed. Therefore, it can predict effects that depend on the content of these representations. For example, the model predicts that errors are more likely when items that are similar require different responses. This model can serve as a framework for building connectionist models of specific tasks that incorporate properties of speeded performance.

(15)

**The Task-Dependence of Staged Versus Cascaded Processing in Speech Production.** CHRISTOPHER T. KELLO, DAVID C. PLAUT, & BRIAN MACWHINNEY, *Carnegie Mellon University*—We investigated the on-line relationship between overt articulation and the central processes of speech production. In two experiments manipulating the timing of Stroop interference in color naming, we found that naming behavior can shift between exhibiting a staged or cascaded mode of processing, depending on task demands: An effect of Stroop interference on naming durations arose only when there was increased pressure for speeded responding. In a simple connectionist model of information processing applied to color naming, we accounted for the current results by manipulating a single parameter, gain, modulating the rate of information accrual within the network. We discuss the implications of our results for how chronometric data are used to infer the architecture and representations of cognitive processes.

• ATTENTION •

(16)

**Masking in the Attentional Blink: Failure of the Object Substitution Hypothesis.** BARRY GIESBRECHT, *Duke University*, WALTER F. BISCHOF, *University of Alberta*, & ALAN KINGSTONE, *University of British Columbia* (sponsored by Walter F. Bischof)—Identification of the second of two targets in a rapid stream of visual stimuli is impaired if the first is identified correctly. To obtain this *attentional blink* (AB), the second target must be masked by a temporally trailing, spatially superimposed pattern (Giesbrecht & Di Lollo, 1998). The mechanisms involved were thought to be the same as those involved in masking by object substitution, a form of masking that can be observed by using 4 dots that surround but do not overlap the target (Enns & Di Lollo, 1997). The present experiments tested this hypothesis: a 4-dot mask was used and variables known to modulate object substitution were manipulated. Despite observing strong object substitution masking, no AB was observed. The results force the rejection of the object substitution hypothesis and constrain recent models of the AB.

(17)

**Serial Attention as Strategic Memory.** ERIK M. ALTMANN & WAYNE D. GRAY, *George Mason University*—Serial attention is the process of focusing mentally on one item at a time. This process has two phases: attention switching and attention maintenance. Attention

switching involves rapidly building up the activation of a new item to dominate old items. Attention maintenance involves letting the current item decay while in use to prevent it from intruding on the next item later on. SASM, a model based on this analysis, suggests that this balance of high initial activation followed by gradual decay reflects a strategic adaptation to task demands on one hand and principles of memory on the other. The model makes novel and accurate predictions about response times and error rates, integrates past use and current context as memory activation sources, and integrates attention switching and attention maintenance into one unified account.

(18)

**Automatic Processing of Valence.** DIEGO FERNANDEZ-DUQUE, *University of Oregon*—Three experiments explored the automatic processing of object valence using a modified continuous performance task. Subjects pressed a single key to frequent nontargets but withheld their motor response when an occasional target occurred. RTs decreased before commission errors and increased afterward, revealing a shift in response criterion due to error detection. Sometimes, a valenced cue was displayed between trials, such as a happy face accompanied by the word “good” auditorily, or a sad face with the word “oops.” Subjects knew that cue valence was unrelated to past performance and should be ignored. The negative valence of the uninformative cue slowed reaction times, even when it was congruent with the subject’s internal feedback (i.e., after an error). Furthermore, negative valence reduced commission errors whereas it increased omission errors. These results are consistent with an involuntary shift toward a more conservative response criterion following a negative, albeit uninformative, cue.

(19)

**An Animal Model of Task Switching.** GIJSBERT STOET & LAWRENCE H. SNYDER, *Washington University*—Task switching paradigms have been used to study executive control in humans. Response times and error rates increase immediately after a change in task. We hypothesized that animals would also show switch costs. A rhesus monkey performed two 2-choice reaction time tasks. In each trial, a colored, patterned stimulus was presented. In one task, the monkey pressed one of two buttons, depending on stimulus color. In the other task, the monkey reacted according to stimulus pattern. The screen background color identified which task to perform. Response times and error rates were increased immediately following a change in task (by 6.2 msec and 1.6%, respectively). Increases also occurred for stimuli that instructed different movements in the two tasks, compared with stimuli that instructed similar movements (congruency effect). We conclude that task switching in humans and monkeys is similar, and that animal studies are potentially informative about the nature of executive control.

(20)

**Oculomotor Capture by Sudden Onsets During Visual Search.** MATTHEW S. PETERSON, ARTHUR F. KRAMER, & DAVID E. IRWIN, *University of Illinois, Urbana-Champaign*, & SOWON HAHN, *University of California, Riverside*—Earlier studies of the effects of onsets on eye movements during visual search used color singletons as targets. A series of experiments was conducted to explore the effects of onsets, set size, and onset validity on eye movements during nonsingleton visual search. Observers’ eye movements were monitored while searching displays for the presence of a predefined target. The results show that the probability that the eyes made initial saccades toward an onset was a function of display complexity and onset validity. Unlike previous studies using singleton search (Theeuwes, Kramer, Hahn, & Irwin, 1998), observers were able to inhibit eye movements to irrelevant onsets, and this effect lasted past the initial saccade. Onsets with chance validity that were not targeted by the initial saccade were likely to be the target of the second saccade, suggesting that saliency prioritizes the order of attentional allocation (Theeuwes, 1994) and is influenced by top-down control.

(21)

**Task-Set Inhibition in Set Switching.** KATHERINE ARBUTHNOTT, *University of Regina*—Flexible switching between goals is common in human cognition. Set switching paradigms, in which participants switch between tasks across consecutive trials, show significant cost for switching relative to consecutive trials of a single task even with ample preparation time before a switch. This study tested the hypothesis that inhibition associated with a recently abandoned task accounts for residual switch cost (Mayr & Keele, in press), by comparing switch cost for alternating (ABA) and non-alternating (ABC) tasks. Results indicated significant switch costs only for alternating tasks, supporting the hypothesis. More wrong-task errors were made in the alternating condition, but decision errors (the wrong choice within the correct task) were not associated with switch cost. Alternating task cost correlated with performance on the Trail Making Test, part B, especially with the TMT-B to TMT-A ratio. The results suggest that task-set inhibition is an important executive process underlying flexible switching between goals.

(22)

**Contingent Capture for Onsets and Offsets: Attentional Set for Perceptual Transients.** PAUL ATCHLEY, *University of Kansas*, ARTHUR F. KRAMER, *University of Illinois, Urbana-Champaign*, & ANNE P. HILLSTROM, *University of Texas, Arlington*—Four experiments were conducted to examine if attentional set affects the ability of visual transients (onsets and offsets) to capture attention. In the experiments, visual search for an identity-defined target was conducted. In the first three experiments, the target display either onset entirely or was revealed by offsetting camouflaging line segments to reveal letters. Prior to the target display, there was a noninformative cue, either an onset or an offset, at one of the potential target locations. Cues that shared the same transient feature as the target display captured attention. The lack of predictable target transients led to attentional capture by all forms of transients. The final experiments with luminance changes without offsets or onsets showed attentional capture when the luminance changes were large. The results suggest that attentional set can be broadly or narrowly tuned to detect changes in luminance.

(23)

**Asymmetries of Hand-Centered Attention and Motor Programming in Neglect.** LAUREL J. BUXBAUM & PERDITA PERMAUL, *Moss Rehabilitation Research Institute* (sponsored by H. Branch Coslett)—Normal subjects reaching to targets show greatest interference from distractors close to the hand (hand-centered attention). In neglect, attention is abnormally distributed in egocentric or allocentric coordinates, as evident—for example, in RT facilitation (spatial summation) from distractors to the left of targets. Within which coordinate frames does neglect arise in reaching tasks? Eight neglect patients and 12 control subjects reached to a central target from right start (RS) or left start (LS) positions, in the presence or absence of distractors. Patients were slower to reach in the no-distractor condition from RS, indicating deficits in leftward movement programming. In this context, distractors caused facilitation when they were left of the hand (RS) and interference when they were right of the hand (LS). The attentional asymmetry in neglect may thus be hand-centered. We propose a unified account of the motor and attentional findings implicating impaired coding of movement vectors for leftward locations.

(24)

**Shifting Attention to Different Levels Within Global–Local Stimuli.** FRANCES J. FRIEDRICH & J. V. FILOTEO, *University of Utah*, & J. L. STRICKER, *University of California, San Diego*—Several experiments investigated how attention is shifted to different perceptual levels within a stimulus. Global–local stimuli were presented in sequential couplets; the target was either at the same global–local level

or the target changed levels within each couplet. Previous studies have found that the response to the second target within a couplet is faster if the levels remain the same than if they change. The present experiments replicated this *level-shifting effect* and demonstrated that this effect cannot be accounted for by changes in the size of the targets or by repetition or identity priming. These results suggest that the shifting effect is related to the parsing of different spatial frequencies in the global–local stimuli, a finding consistent with the attentional weighting model proposed by Robertson (1996). In addition, level-shifting within a stimulus and shifting attention between spatial locations seem to be subserved by separate mechanisms.

(25)

**Attentional Selection Produces an Inhibitory Surround.** JEFFREY R. W. MOUNTS & ROBIN TOMASELLI, *SUNY, Geneseo*—Subjects made speeded form discriminations to target objects embedded in an array of distractors. If the target was an attentionally salient object that captured attention (i.e., an abrupt onset or a feature singleton), form discrimination RTs were enhanced. However, if the target appeared adjacent to one of these attentionally salient objects, form discrimination RTs were slowed, relative to a control condition. As the spatial separation between the attentionally salient distractor and the target increased, RT performance improved. When task demands were altered so that the feature singletons did not capture attention, the inhibitory region was no longer observed. The data suggest that attending to an object creates an inhibitory surround that suppresses the processing of neighboring objects.

(26)

**Interactive Effects of Flanker Type and Perceptual Load on Attentional Selectivity.** DOUGLAS N. JOHNSON, *Colgate University*—Two experiments were performed using a visual search task with the target letter appearing in a circular array among five homogeneous (“easy” search) or heterogeneous (“hard” search) distractors. In Experiment 1, either a neutral or incompatible flanking letter was presented peripheral to the main stimulus array. An ANOVA (on RTs) revealed an interaction between flanker type and search type, suggesting that selective attention was possible under hard search conditions but not easy search conditions (consistent with previous findings). Experiment 2 was a direct replication of Experiment 1, except that on some of the trials the flanking stimulus was an English word. An analysis of trials involving a letter flanker revealed that, although there was a main effect of flanker type, there was no interaction between search type and flanker type. These data show that events external to a given trial affect the role of perceptual load on attention selectivity.

• COGNITION •

(27)

**Memory Seeding: Representations Underlying Quantitative Estimation.** NOELLE LAVOIE, LYLE E. BOURNE, JR., & ALICE F. HEALY, *University of Colorado*—Brown and Siegler (1996) found that training participants on a subset of country populations improved estimations for country populations in general and that this effect remained intact over time. Their results provided evidence that information abstracted during learning formed a general metric framework for estimating populations (abstraction) and that estimations were not dependent on specific country information (anchoring). In an extension, we found that training on seed populations improved performance on other populations, but we did not find conclusive evidence for an abstraction explanation. Subsequent experiments manipulated the amount and type of information that participants could inspect while completing the estimation task. Any kind of information led to improved performance on an immediate test, relative to a control condition. After a retention interval, more accurate performance was evident for participants who were given 3 populations (vs. 1) and were given the names of the countries as well (vs. no names).

(28)

**The Role of Inhibition in Sequential Action Control.** KAREN Z. H. LI & ULMAN LINDENBERGER, *Max Planck Institute for Human Development, Berlin*, & DENNIS RÜNGER & PETER A. FRENCH, *Humboldt University*—We investigated sequential action control using a visual “go–no-go” task in which individuals monitored instances of seven categories (e.g., numbers, letters, shapes). The sequence of categories was first memorized. On each test trial, participants waited for an instance of Category 1, keypressed, waited for an instance of Category 2, keypressed, and so on for all seven categories. Foil (“no-go”) items were instances of all categories other than the currently relevant one, allowing the classification of intrusions as a function of ordinal distance from the current sequential position. The resulting pattern of intrusions is consistent with the notion of greater lateral inhibition of proximal goals (lower error rates at Lags  $-1$  &  $+1$ ) than of distal goals. Consistently across the seven “go” items, accuracy was high and RTs were fast. Findings are discussed in relation to current models of inhibition and sequential action control (e.g., Houghton & Tipper, 1994) and aging.

(29)

**When Memory Overload Contributes to Making a Correct Probabilistic Choice.** TALIA BEN-ZEEV & JEFFREY M. STIBEL, *Brown University*, MARTY DENNIS, *Yale University*, & STEVEN A. SLOMAN, *Brown University*—Increasing memory load may contribute to making a correct probabilistic choice on a hard probability problem, known as the Monty Hall dilemma. According to mental-models theory, people create different and equiprobable models for each of the three choices in this problem. We increased the number of choices (from 3 to 10 and then to 100) to create increasing degrees of memory demands based on the assumption that more choices require more models. Results yielded an S-shaped function, showing that correct performance increased gradually with number of choices and then reached an asymptote. Increasing memory load may have induced people to create only two representations: One for their initial choice (attached to a smaller probability) and one for the remaining options (attached to a larger probability). Even when choices were correct, however, probability judgments were generally not, implying a dissociation between uncertain choice and probability judgment.

(30)

**Sex Differences in Spatial Cognition and Arithmetical Reasoning.** DAVID C. GEARY, SCOTT J. SAULTS, FAN LIU, & MARY K. HOARD, *University of Missouri, Columbia*—The study was designed to test the hypothesis that the male advantage in arithmetical reasoning, as measured by the ability to solve complex word problems, is mediated by a male advantage in spatial cognition. To this end, groups of male ( $n = 113$ ) and female ( $n = 123$ ) undergraduates were administered arithmetical computations and arithmetical reasoning tests, along with an IQ test and a test of spatial cognition. There was no sex difference on the IQ test, but males showed significantly higher mean scores on the arithmetical computations, arithmetical reasoning, and spatial cognition measures. A series of structural equation models indicated that individual differences in arithmetical reasoning were related to individual differences in IQ, spatial abilities, and computational fluency. Moreover, the results suggested that the sex difference, favoring males, in arithmetical reasoning is mediated by the male advantage in computational fluency and spatial cognition.

(31)

**Warning! Warnings May Not Be Hazardous to Your False Memories.** MICHAEL P. TOGLIA, *SUNY, Cortland*, JEFFREY S. NEUSCHATZ & DAVID G. PAYNE, *SUNY, Binghamton*, JAMES M. LAMPINEN, *University of Arkansas*, & JONATHAN M. GRASSO, *SUNY, Cortland*—We report three experiments employing Deese/Roediger–McDermott lists. The first study identified phenomenological characteristics that distinguished true from false memories. Hypothesizing that these features could be used diagnostically

to reduce false memories, one group of subjects in Experiment 2 (recognition) and Experiment 3 (recall) was given a strong warning that included a sample list and information on how to use features to improve memorial accuracy. Other groups received either a weaker warning (sample list only) or no warning. Both warnings were ineffective in reducing illusory recollections. Interpretations are offered in terms of source monitoring theory.

• HUMAN LEARNING/MEMORY •

(32)

**Of Mice and Men: A Comparison Using Virtual Hebb–Williams Mazes.** DAVID I. SHORE, *University of Toronto, Rotman Research Institute and Baycrest Center for Geriatric Care*, LIANNE STANFORD, *Dalhousie University*, JOSEPH W. MACINNES, *DalTech*, & RAYMOND M. KLEIN & RICHARD E. BROWN, *Dalhousie University*—The Hebb–Williams mazes consist of a standardized set of graded problems that have been instrumental in exploring the impact of various brain states on the behavior of over a dozen mammals, with the notable exception of humans. To address this gap in the literature we developed a computer-generated virtual environment to test human performance. The learning curves across species were strikingly similar, lending support to rodent models of human memory. An additional similarity concerned a robust gender effect: Females of both species were less efficient in solving this set of problems than males. Finally, humans learned faster than rodents in both the acquisition and test portions of the protocol. These results represent the first modern comparison of human and rodent learning using the same test of spatial intelligence.

(33)

**Schematic Knowledge About Sources Is Used in Source Monitoring.** UTE J. BAYEN & JULIA SPANIOL, *University of North Carolina, Chapel Hill*, GLENN V. NAKAMURA, *University of Memphis*, CHIN-LUNG YANG, *University of North Carolina, Chapel Hill*, & SUSAN E. DUPUIS, *University of Memphis*—Source monitoring refers to mental processes leading to attributions regarding the origin of information. We tested Johnson, Hashtroudi, and Lindsay’s (1993) assumption that prior source-relevant knowledge is used in some source-monitoring tasks. In several experiments using two different domains of schematic knowledge, two sources presented information that was expected for one source and somewhat unexpected for the other. In a later source-monitoring test, participants decided whether items had been presented by Source A, by Source B, or were new. The results of both experiments show that source identification is better for expected items than for somewhat unexpected items. Multinomial modeling analyses revealed that when participants do not remember the source of information, they guess that it was presented by the expected source. These results provide evidence for the claim that source monitoring can be based on prior knowledge and support a guessing hypothesis.

(34)

**Is Contextual Relevancy Relevant to False Memory?** SETH GREENBERG & KATHERINE JOHNSON, *Union College*, & DAVID G. PAYNE, *SUNY, Binghamton*—Subjects studying categorized lists of words frequently exhibit false memories for strongly associated exemplars not appearing in the lists (e.g., *chair* in a list of furniture). What happens if such word lists are embedded in real text? Words belonging to categorized lists were embedded in passages that were highly relevant to college subjects (e.g., dorm room) or less relevant (e.g., Paris hotel). Recognition of embedded words was worse in low-relevant than in high-relevant passages. Of particular interest, though, was that the low-relevant passages also prompted more false recognition of strong exemplars not in the passages than did the high-relevant passages. No effect of relevancy was found for unrelated words or low associated exemplars. The results are discussed with regard to gist versus verbatim processing and the impact that contextual familiarity has on attention given these two sources of input.

(35)

**The Effects of Source-Monitoring Versus Standard Instructions on the DRM Memory Illusion.** KRISTI S. MULTHAUP & CHRISTA CONNER, *Davidson College*—False memories in the Deese/Roediger–McDermott (DRM) paradigm demonstrate a memory illusion akin to the false fame effect and the misinformation effect found in the Loftus eyewitness memory paradigm. All three memory illusions can be considered source memory errors. Reported attempts to eliminate false memories in the DRM paradigm with warnings and instructions at the beginning of the session have reduced, but not eliminated, the false memory effect. In two experiments we used standard DRM instructions and trial-by-trial source-monitoring instructions that have been shown to eliminate the false fame effect (e.g., Multhaup, 1995) and the misinformation effect (e.g., Lindsay & Johnson, 1989), presumably by increasing the strictness of the decision criteria used by participants. In both experiments, false memories in the source-monitoring condition were reduced compared with the standard condition, but not eliminated. The role of source memory errors in the DRM memory illusion will be discussed.

(36)

**Implicit and Explicit Learning and the Role of Working Memory in Complex Sequence Learning.** JONATHAN REED, *East Carolina University*, CHRIS STARK & SCOTT A. OTTAWAY, *Western Washington University*, & PEDER JOHNSON, *University of New Mexico*—This study explored the correlation between working memory (WM) and both implicit and explicit learning. Given that both explicit learning and WM are highly associated with controlled attention and conscious processing, we assessed whether individual differences in implicit learning ability are similarly related to WM. Adolescents and college-aged participants completed three phases: (1) tests of WM capacity, (2) a complex SOC sequence task under either implicit or explicit learning instructions, and (3) direct tests of awareness. Although both groups learned the sequence, both performed close to chance on the recognition memory test and the explicit group did not have greater awareness of the SOC sequence and that investigators of implicit learning should include an explicit learning control group. Moreover, contrary to Frensch and Miner (1994), both implicit and explicit learning ability were unrelated to three measures of WM. It is not surprising that dual-task procedural learning is unrelated to WM.

(37)

**False Memory and Suggestion.** RAYMOND J. SHAW, DAVID H. WALSH, & DONNA M. IORIO, *Merrimack College*—False memory is routinely attributed to suggestion, a term abandoned by social psychologists because of its imprecision. However, we find suggestion a useful concept when defined precisely as social influence intended to produce cognitive change. Our previous research found that suggestion is more likely to verify than falsify memory. We report on current research, exploring the effects on memory of levels of processing, type and number of suggestions, and the role of status associated with the source of a suggestion. During a recognition test, subjects were given suggestions that particular words had appeared on a previously studied list; those suggestions varied in their veridicality. On a subsequent recognition test, level of processing and status interacted: Deeper processing reduced false memory when the suggester was a student, but increased false memory when the suggester was a professor. False memory increased with repeated suggestions, whereas memory for original items declined.

(38)

**Egocentric Orientation in Spatial Memory for Route and Survey Learning.** AMY LYNNE SHELTON, *Stanford University*, & TIMOTHY P. McNAMARA, *Vanderbilt University*—Participants learned the spatial layout of a virtual environment by way of written description or desktop VR tour. For each mode of presentation, half of the participants learned the environment from a route perspective

and half learned it from a survey perspective. Memory was tested with old–new scene recognition: participants discriminated between views of the learned environment and views of similar distractor environments. Test scenes were taken from several orientations in the space and from both route and survey perspectives. Results revealed that both route and survey learning led to orientation-dependent performance regardless of the mode of presentation (text vs. VR). Moreover, there was a tendency to perform faster on recognition in the perspective from which the environment was learned (route vs. survey). Together, these findings suggest that the mental representations were tied to the specific egocentric experiences participants had during learning.

(39)

**Working Memory Capacity, Intelligence, and Goal Neglect in the Stroop Task.** MICHAEL J. KANE & ADRIAN SANCHEZ, *Georgia State University*, & RANDALL W. ENGLE, *Georgia Institute of Technology*—We examined attentional capabilities of high and low working memory (WM)-span subjects on the view that if WM capacity reflects capability for controlled attention, then span differences should predict differences in simple attention tasks. High and low WM-span subjects participated in one of three versions of a computerized Stroop color-naming task that differed in the proportion of congruent trials (e.g., “RED” appearing in red): 0%, 50%, or 75% of 288 trials were congruent. WM span scores did not predict Stroop interference with low proportions of congruent trials, consistent with prior research on intelligence and Stroop. However, in the 75% condition, low spans showed more Stroop interference than did high spans, and interference correlated negatively with Ravens Progressive Matrices scores. We argue that WM capacity and fluid intelligence reflect attentional control and predict Stroop interference in contexts wherein it is difficult to actively maintain goals, or task demands, owing to significant environmental interference.

(40)

**Does Span Really Equal “ $rt + c$ ”?** MARIE POIRIER, *Université Laval*, & RICHARD SCHWEICKERT, *Purdue University*—There are clear limits to the number of words that can be recalled in their order of presentation. Often referred to as the memory span, these limits are reasonably well expressed by a simple equation:  $\text{span} = rt + c$  (1), where  $r$  is the pronunciation rate for a given material, and  $t$  is frequently interpreted as the useful lifetime of the internal representation supporting performance. Various interpretations of the intercept “ $c$ ” have been proposed. With the objective of clarifying the interpretation of equation (1), three experiments were run. This poster summarizes the first two studies and reports a third. Thirty-two subjects completed an immediate serial recall task where list length (2–7), modality, and word length (short/long) were manipulated. All factors had significant effects on performance. The results are discussed in terms of the adequate interpretation of equation (1).

(41)

**Accuracy and Systematic Distortion of Autobiographical Memory.** STEPHANIE A. BERGER, *College of Mount St. Vincent*—Prior research demonstrated the independence of loss of autobiographical memory content and systematic distortion of that content (Bahrick, Hall, & Berger, 1996). This study replicated that finding and tested an explanation based on the fuzzy-trace theory, which postulates independent gist and verbatim memory. College students recalled grades from four years of high school in five subject areas and rated their achievement for the year, difficulty in each class, and enjoyment of each class. Instructions encouraged either access of a gist memory of each semester or of verbatim information. Measures of accuracy and distortion were calculated on the basis of high school transcripts. Distortion ratios were the number of inflated grades divided by the total number of incorrectly recalled grades. Results showed differences in distortion for grades of B and C as a function of course, GPA, and instructions, with no corresponding differences in accuracy. This

independence of recall and distortion is consistent with fuzzy-trace theory.

(42)

**Relations Between True and False Memory in Recall and Recognition.** MAIA B. COOK, GINA M. GRIMSHAW, & MIRIAM SCHUSTACK, *California State University, San Marcos*—The present study examined the relationship between levels of true and false memory. Spreading activation theory predicts that true and false memory should be positively correlated, with manipulations that increase true memory also increasing false memory, whereas the distinctiveness hypothesis predicts that true and false memory should be inversely correlated. This study tested these hypotheses by examining the effects of multimodal presentation (auditory, visual, and combined) on memory for lists of related words (Roediger & McDermott, 1995). Recall was tested after each list and recognition was tested after 8 lists in the same modality. Combined presentation led to higher proportions of true memory in recall and recognition. For recall, combined presentation led to lower proportions of false recall, consistent with the distinctiveness hypothesis. However, for recognition, rates of false memory paralleled those of true memory, supporting spreading activation. Generation of false memory in recall and recognition may involve different processes.

(43)

**Investigating the Dual Process Model of Serial Recall.** DEBORAH L. JONAS, MATT SERRA, KARL OSWALD, & ANAND KRISHNA, *Duke University* (sponsored by Gregory Lockhead)—A series of experiments investigated the dual process model of forward and backward serial recall (Li & Lewandowsky, 1995). We hypothesized that relative to items presented in center or random spatial locations, presentation in predictable locations would be beneficial to backward recall but have no effect on forward recall. For 5- and 8-item lists, results showed that only backward serial recall was affected by manipulating the locations of the presented items. Specifically, random spatial presentation enhanced backward serial recall while predictable presentation had no effect. The benefit found in backward serial recall when presenting items in random locations is inconsistent with the unitary model of serial recall (Farrand & Jones, 1996). Our results support and extend the dual process model of serial recall by demonstrating that unique visual spatial information can benefit backward serial recall and can affect recall of both short and long lists.

(44)

**Proactive Interference Effects in Immediate Serial Recall.** GERALD TEHAN, *University of Southern Queensland*, & JOSÉE TURCOTTE, *Université Laval*—For the last 30 or so years, it has been presumed that immediate serial recall was supported by some kind of transient, limited capacity store. Such a store (e.g., phonological loop) provides a simple mechanism for explaining many of the effects observed in the task. It also provides a simple mechanism for producing immunity to proactive interference (PI), which may be one reason why PI has not been widely studied in immediate serial recall. The experiments reported here explore PI effects in immediate serial recall as a function of word pool, list length, word length, and phonemic similarity. We show that PI effects can readily be observed in the task but so too can immunity to PI. We conclude that the range of PI effects can best be understood in terms of the cues and codes that are involved in the immediate serial recall task.

(45)

**Eliminating Young Children's Retroactive Interference Through Perceptual Recoding.** MARK L. HOWE & JANICE PEDDLE, *Lakehead University*—Conceptual recoding of information in memory has proved effective in reducing retroactive interference in adults and older children. Such recoding has only been effective in younger children when instructions to recode are provided at the time of learn-

ing but not at retention. In the current study, grades 2 and 4 children learned 2 lists of "food," the second of which could be recoded as "green." The results showed similar reductions in interference for all children regardless of when recoding instructions were provided. The primary locus of these effects was in memory storage, a finding that is interpreted in terms of distinctiveness effects in long-term retention.

(46)

**Neural Network Model of Multiple Traces in Hippocampus and Retrograde Amnesia.** LYNN NADEL & ALEXEI SAMSONOVICH, *University of Arizona*, & MORRIS MOSCOVITCH, *University of Toronto*—According to multiple trace theory (MTT; Nadel & Moscovitch, 1998), autobiographical memory depends on the hippocampal complex. As episodic memories age, they will either be forgotten or, as a consequence of reactivation, will have benefited from the formation of multiple traces in hippocampal complex and neocortex. Older memories will be associated with a greater number of sparse and distributed traces. Multiplying them should render the memory they support less susceptible to disruption. We have developed a neural network model of MTT in which memories are replicated within hippocampus as they age. Lesions of various extent were then implemented in the hippocampal module and the effect on retrieval of memories of various "ages" assessed. As predicted, partial lesions led to a temporally graded retrograde amnesia, with recent memories more susceptible to loss than remote ones, while complete lesions resulted in a flat gradient reflecting loss of almost all episodic memories.

(47)

**Remembering Objects: An Object-Construct Model of Memory.** LEE M. STADTLANDER & LATONA D. MURDOCH, *Montana State University*—The authors propose an integrated model of object memory: the object-construct model. Previous research on objects has tended to focus on perceptual attributes of the object as opposed to the integrated or embodied object in memory. The object-construct model attempts to rectify this deficit in this literature by inclusion of defining and differentiating features, as well as, episodic memories for the object. Thus, the object is considered relative to the body within its environment. In accord with Glenberg (1997), a qualitative study is discussed, which permitted a test of the model without the artificiality of memorization of lists.

(48)

**Collaborative Remembering: Are Groups Susceptible to Misleading Post Event Information?** KRISTAL D. BELLINGER & MARY SUSAN WELDON, *University of California, Santa Cruz*—Remembering often takes place as a group activity in which people collaborate to recall an event. We examined whether groups are susceptible to the effects of misleading postevent information, and whether the source of the misleading information (i.e., expert or nonexpert) changes its impact. Groups of 3 participants viewed slides of a bookstore theft (Weingardt, Loftus, & Lindsay, 1995) and then received a summary containing misleading information, said to have been written either by a security guard or a participant from a previous experiment. People either worked alone or collaborated on a cued recall test about the slides, and rated their confidence in their answers. Collaboration did not counteract the effect of misleading information; collaborative groups recalled the misinformation to the same extent as individuals. Confidence ratings discriminated the planted misinformation from other types of incorrect recalls.

(49)

**All Rehearsals Are Not Created Equal: Effects of Varied Focus on Eyewitness Suggestibility.** SEAN MICHAEL LANE, *University of Nevada, Las Vegas*, MARA MATHER, *Princeton University*, & DIANE VILLA & SHELBY MORITA, *University of Nevada, Las Vegas*—Witnesses to a crime or an accident perceive the event only

once, but will most likely think or talk about the event multiple times. The way they review the event may affect their later memory. In particular, some types of review may increase suggestibility if the witness has been exposed to postevent misleading information. In the present study, participants viewed a videotaped crime and then received false suggestions about the event. We found that participants who were then asked to focus on specific details when reviewing the event were more suggestible than participants asked to focus on the main points. These findings suggest that the type of rehearsal engaged in after witnessing an event can have important consequences for memory and, in particular, suggestibility. These results also indicate that focusing on specific details will sometimes actually lead to more false memories than focusing on the gist of an experience.

(50)

**Retention of Spatial Representations: Orientation Specificity, Virtual Reality, and Restricted FOV.** MICHAEL S. MILLER, DEBORAH M. CLAWSON, MARC M. SEBRECHTS, & LIGIA A. NAVAS-LATIFF, *Catholic University of America*—Participants learned a complex route through a building using virtual reality (VR), a floor plan, or the real building. After a two-week retention interval, all participants were tested on route-walking and on locating occluded objects in the real building. At retention, the VR and real groups had better route performance than the map group when tested in the same orientation as training. However, when tested in the opposite orientation from training, the VR group showed decrements in performance similar to those we found previously with immediate testing. This specificity of orientation for the VR group was also evident on survey measures (i.e., estimates of distance and direction). Among the possible sources of this specificity is the restricted field-of-view (FOV) in VR. This hypothesis was tested in an experiment using blinders during training in the real building.

(51)

**Sequence Learning Without Awareness: Signal Detection Analysis Rights Past Wrongs.** DANIEL B. WILLINGHAM & JOANNA SALIDIS, *University of Virginia*—Unconscious learning, while important to many theories of memory and learning, is difficult to demonstrate due to the methodological challenges of measuring awareness. For example, subjects may be conscious of an aspect of the to-be-learned material that is sufficient to alter performance, but the test of awareness requires knowledge about a different aspect. The present experiment solves the four key methodological problems associated with measuring awareness that have been reported to date. Simultaneous measures of conscious (recognition judgments) and unconscious learning (RTs) were collected in a serial response time task. The results showed that unconscious learning is possible.

(52)

**Self-Regulation of Study Time and the Retention of Rare and Common Events.** MONICA DASHEN, *U.S. Bureau of Labor Statistics*, & LYNNE M. REDER, *Carnegie Mellon University*—People tend to underreport common events and overreport uncommon events in surveys. For example, in the Consumer Expenditure Survey, people overreport refrigerators purchased but underreport sodas. We contend that this tendency is due to the amount of time spent thinking about the event during acquisition, with less time allocated to typical events. We tested this processing hypothesis in two studies by examining whether amount of preexperimental and experimental exposure affected study time in a self-paced acquisition task. Prior frequency, whether naturally or artificially determined, was inversely related to study time on a given exposure. Study time also was inversely related to the recency with which a word had been experienced, suggesting that the more active or available a word's representation, the less additional time was allocated to further study. Amount of study time, in turn, influenced frequency judgments and word recall. Theoretical and practical implications will be discussed.

(53)

**Virtual Exploration Effects on Spatial Navigation and Recall of Location.** MARC M. SEBRECHTS, LAURA N. MULLIN, DEBORAH M. CLAWSON, *Catholic University of America*, & BENJAMIN A. KNOTT, *Booz-Allen and Hamilton*—Participants learned a building layout either by using exploration in a virtual environment (VE) or by tracing routes on a floor plan. A subset of objects to be located were previewed using photographs from the actual building. Participants then went to the physical building, where they attempted to walk to specified locations by the shortest possible route. VE participants showed significantly more efficient spatial navigation than those who had learned using a floor plan. Following completion of the navigation task, participants returned to the laboratory, where they identified the location of photographed objects using the same format as during learning. On a free recall task, floor plan participants correctly recalled more previewed items. However, VE participants were reliably more accurate in their object placement. On a cued recall task, the VE group placed the objects more accurately than the floor plan group for both previewed and novel photographs.

(54)

**Sequence Smoothing in Human Memory.** RICHARD B. ANDERSON, *Bowling Green State University*—An experiment explored the notion that image blur, across space, has a temporal analogue within the memory system. It was hypothesized that when a person memorizes a sequence of abstract quantitative values (i.e., digits), the values become blended, or “blurred” across time. Such sequence smoothing could have adaptive value for detecting trends within a noisy sequence. However, the present study was designed simply to demonstrate the sequence-smoothing phenomenon. Twenty-seven subjects studied and recalled 10, random, 16-digit sequences. Smoothing was conceptualized as “gravitation” of remembered digit values toward prior or subsequent values in the studied sequence. Backward gravitation was the degree of correlation between the remembered value at the current sequential position ( $V'[i]$ ) and the studied value at the previous sequential position ( $V[i-1]$ ), partialling out any preexisting sequential correlation within the studied sequence. Likewise, forward gravitation was the partial correlation between  $V'[i]$  and  $V[i+1]$ . As predicted, both forward and backward gravitation were statistically significant.

(55)

**Interference Effects and Individual Differences in Instructed Category Learning.** DAVID C. NOELLE, *Carnegie Mellon University*, & GARRISON W. COTTRELL & CRAIG R. M. MCKENZIE, *University of California, San Diego*—Learners acquiring knowledge of a new category are often given direct instruction concerning the structure of the category before being presented with labeled examples. Explicit instructions can often be smoothly integrated with knowledge garnered by exposure to instances, but interference can also occur. Despite perfect consistency between instance labels and the provided rule, training on specific exemplars can drive categorization behavior away from rule following and toward a more instance-based pattern (Allen & Brooks, 1991). We present experimental results that demonstrate that this kind of interference can arise even when categorizing simple visual stimuli, varying along only two unintegrated dimensions, given a sufficiently complex categorization rule. These experiments also display an effect of individual differences, showing a decline in interference with rule-following skill. We also present a connectionist model of instructed category learning, providing an account of the cognitive mechanisms that give rise to these effects.

• REPETITION/PRIMING EFFECTS •

(56)

**Testing the Counter Model: Effects of Repetition Priming and Word Frequency.** RENÉ ZEELLENBERG, ERIC-JAN WAGENMAKERS, & JEROEN G. W. RAAIJMAKERS, *University of*

*Amsterdam*—The counter model for perceptual identification (Ratcliff & McKoon, 1997) differs from alternative views of word recognition in two important ways. First, it assumes that prior study of a word does not result in facilitation but rather in bias. Second, the effects of word frequency and prior study are explained by different mechanisms. In the present experiment, study status and word frequency of target and foil were varied independently. Using a forced choice task, we replicated the bias effect. However, we also found several interactions between frequency and prior study that are in direct conflict with the counter model. Most important, prior study of both alternatives resulted in (1) an attenuation of the frequency effect and (2) an increase in performance for low-frequency targets but not for high-frequency targets. These findings suggest that the effects of frequency and prior study are not mediated by completely independent mechanisms.

(57)

**Mediated Priming: The Role of Verbal Ability and Contextual Consistency.** KAY LIVESAY, *UCLA*, & CURT BURGESS, *University of California, Riverside*—A series of experiments demonstrated that the mediated priming effect (e.g., *lion–stripes*) was replicable using both the lexical decision and naming latency tasks. These experiments also showed that the magnitude of mediated priming was not predicted by semantic relationship or simple lexical co-occurrence, as suggested by McKoon and Ratcliff (1992). The representational mechanism underlying mediated priming appears to be the contextual similarity of the prime and target. Furthermore, it was demonstrated that the mediated priming effect is influenced by individual differences in verbal ability. Subjects with low verbal ability were not sensitive to mediated prime–target word relationships, whereas subjects with higher verbal ability manifested a robust mediated priming effect. These findings are discussed within the framework of a distributed memory system.

(58)

**Endogenous Negative Priming: Separate Contributions of Response Modality and Proportion Repeated.** CECILE A. MARCZINSKI & BRUCE MILLIKEN, *McMaster University*—Priming effects can be explained either by reference to the activation state of abstract memory representations or by reference to the match between episodic qualities of a prime and target presentation. This distinction has taken on considerable importance recently in the study of negative priming effects. This issue was addressed in a series of three experiments that examined the endogenous negative priming effect (Neill & Mathis, 1998). Participants were asked to categorize two successive colored rectangles that were identical, that matched in category label but not color, or that matched in neither category label nor color. Response times were slowest for probes that matched the category but differed in color from the prime. Response modality and the proportion of repeated color trials made separate contributions to this effect. Only the proportion manipulation appeared to modulate the episodic component of the effect. Implications for retrieval accounts of priming are discussed.

(59)

**Negative Priming of Famous Faces: Can You Ever Really Ignore Madonna?** AMY ISENBERG COOKE & WILLIAM MARKS, *University of Memphis*—The focus of the present study was to examine whether there are forms of attentional control that affect the processing of faces by preventing other faces from interfering—namely, an inhibitory mechanism. This question was explored in two experiments using the negative priming paradigm with famous faces as stimuli. Probe displays were manipulated by either probing the exact same photograph of the previous attended/ignored prime face or by probing a different photograph of the previous attended/ignored prime face. The results were not entirely consistent with predicted negative priming effects because positive priming of ignored photographs was observed in some instances.

## • IMPLICIT MEMORY •

(60)

**Biased Processing in Conceptual Implicit Memory Tasks.** ANJALI THAPAR, *Bryn Mawr College*, & JEFFREY N. ROUDER, *University of Missouri, Columbia*—In recent years, Ratcliff and colleagues have argued that priming in perceptual implicit memory tests is the result of biases in information processing as opposed to the formation of new implicit memory representations. Three experiments are presented that extend this framework to the conceptual implicit memory domain. Before receiving a set of general knowledge questions, participants studied a list of words. For some questions, participants studied the correct answer; for others, they studied a very similar but incorrect answer. Although study of a correct answer facilitated performance, study of the similar alternative hurt performance. The pattern of results indicates that participants were biased to report the words from the study list on the conceptual implicit memory task. This pattern is concordant with the biased information processing approach to priming.

(61)

**Effects of Prior Experience on Word Frequency Judgments: Automatic Influences and Counter-Control.** JEFFREY P. TOTH & KAREN A. DANIELS, *Georgia Tech*—We introduce a new implicit memory task and explore some of its properties. Following various encoding manipulations, participants were asked to make a binary (high/low) decision concerning the background (acontextual) frequency of words, some of which had been previously encountered in a prior encoding task. Results showed that a single prior presentation could significantly influence the probability of judging a word as “high frequency.” Moreover, these frequency judgments were found to dissociate from recognition memory judgments as a function of a number of experimental variables, including item repetition, levels of processing, and response speed at test. However, while clearly satisfying accepted criteria for being “implicit,” the processes underlying frequency judgments displayed complex temporal properties suggesting the simultaneous operation of other, more controlled processes. We discuss the results in terms of prior research on frequency judgments, implicit memory, processing fluency, and reactance.

(62)

**Attribution Processes in Implicit Learning.** CAROL A. SEGER, *Colorado State University*—I will present a theory that implicit knowledge is applied to a novel stimulus through a process of attribution of “familiarity” or “gut feelings” elicited by the stimulus to a property of the stimulus, such as grammatical well-formedness. I will present a series of experiments using the artificial grammar task that demonstrate attribution of implicit knowledge to judgments of liking and perceptual clarity as well as to grammaticality judgments. The experiments will further explore the degree to which perceptual, liking, and grammatical judgments are sensitive to the same features of stimuli.

(63)

**The Effects of 2-D Versus 3-D Study on Eye Movement–Based Measures of Implicit Memory.** FRANK M. MARCHAK, *Veridical Research and Design*, & AMY E. ALBERTS, *Montana State University*—Althoff et al., (1998) describe a measure of implicit memory based on changes in eye movement patterns, providing evidence that prior exposure to stimuli both facilitates performance on explicit memory tasks and affects visual processing. The eye movement–based memory effect distinguishes between repeated and novel items, with previously seen items showing fewer fixations to fewer regions in a scene, and lower levels of constraint in the patterns of eye movement transitions between regions. In the present study, subjects viewed photographs of faces of famous media and political figures known only from magazines, television and cinema (2-D) and faces of co-work-

ers with whom they have had direct interactions (3-D). The effects of the 2-D versus 3-D prior exposure on subsequent eye movement-based measures of priming are discussed and related to current issues of implicit memory.

(64)

**Cross-Format Priming in Word Stem and Word Fragment Completion: Word Versus Pictures.** PETER J. BRUSS & DAVID B. MITCHELL, *Loyola University*—The present experiment investigated the effects of picture and word primes on two seemingly similar tests of implicit memory, word stem completion (WSC) and word fragment completion (WFC). For WSC, robust and similar priming effects were found for both pictures and words, whereas only words showed this robust priming effect in WFC. These data suggest that these tests differ in their processing requirements and may utilize different neural components. These findings are interpreted as supporting the component processes theories of implicit memory.

• LETTER/WORD PROCESSING •

(65)

**Word Repetition, Working Memory Capacity, and the Processing of Lexically Ambiguous Words.** GARY E. RANEY & TIMOTHY K. MIURA, *University of Illinois, Chicago*—A cross-modal priming procedure was used to study how context influences the processing of lexically ambiguous words. Participants listened to short passages that contained two occurrences of a biased homograph. Both occurrences of the homograph referred to the same meaning, and passages (context) were strongly biased toward the dominant or subordinate meanings. Naming times were facilitated for probes related to contextually appropriate meanings in both dominant and subordinate-biased passages. Repeating the homograph did not facilitate naming times when the passages were biased toward the dominant meanings. When the passages were biased toward the subordinate meanings, repeating the homograph facilitated naming times for probes related to both the contextually appropriate and inappropriate meanings. Probe word naming times also varied as a function of working memory capacity.

(66)

**Flexible Use of Lexical and Phonological Information in Word Recognition.** GREG DECKER, GREG B. SIMPSON, MARK YATES, & ANTHONY C. ADAMOPOULOS, *University of Kansas*—Subjects named high- and low-frequency regular words embedded in a list consisting mostly of additional regular words or irregular words. There was a large effect of word frequency when the list was dominated by irregular words, but no frequency effect when all words were regular. The results replicate those we have reported for a shallow orthography (Simpson & Kang, 1994), and indicate flexible use of phonological and lexical information in word recognition in English.

(67)

**Response Modality Modulates Single-Letter Effects in Color-Word Interference.** HARVEY H. C. MARMUREK, *University of Guelph*—Responding to the color of a display is slowed down when the display is a conflicting color word (e.g., *green* printed in red leads to longer latencies than a red color patch). This color-word interference effect (Stroop, 1935) may be reduced (Kahneman & Henik, 1981) or eliminated (Besner, Stolz, & Boutilier, 1997) by coloring a single letter in the color word. Those studies, however, differed in the modality of response (oral vs. manual) and type of control item (neutral words vs. nonwords). The present studies combined those variables factorially. Only manual responding coupled with nonword controls led to the elimination of interference. Manual responding taps fewer sources of color-word interference (Sharma & McKenna, 1998) and letter search is slower in nonwords than in words. These effects may conceal the automatic reading processes underlying classic color-word interference effects.

(68)

**Division of Labor in the Triangle Model of Visual Word Recognition.** MICHAEL W. HARM, *Carnegie Mellon University*, & MARK S. SEIDENBERG, *University of Southern California*—We created a large-scale connectionist model of visual word recognition, employing interconnected orthographic, phonological, and semantic representations (the “triangle” model of Seidenberg & McClelland, 1989). The model was used to identify the computational principles underlying the “division of labor” between semantic and phonological codes in word recognition. It was found that a number of factors influence the division of labor, including word frequency, regularity, homophony, and reading skill level. We present novel accounts of several empirical findings, such as pseudohomophone priming under masked presentations and imageability effects in naming. A complementary simulation in which the model received limited feedback on word pronunciations (analogous to “whole language” reading instruction programs) was also explored; this simulation showed an increased reliance on semantic rather than phonological representations. This led to slower initial learning, and reduced ability to generalize to novel words. Implications concerning theoretical and educational issues will be discussed.

(69)

**Interaction Between Lexical and Sublexical Processes in Spelling.** JOCELYN R. FOLK, *Kent State University*, & BRENDA C. RAPP, *Johns Hopkins University*—We examined the interaction between spelling processes dedicated to spelling familiar words (lexical processes) and those dedicated to spelling unfamiliar words or nonwords (sublexical processes). Participants listened to lists of intermixed words and nonwords and were required to spell only the nonwords. In the priming condition, nonwords were preceded by real word primes that rhymed with the nonwords on 11% of the trials. We found that the spellings of nonwords could be influenced by previously heard rhyming words, replicating previous work (Barry & Seymour, 1988). For example, the nonword /plv/ was more likely to be spelled P-I-E-V-E when preceded by “sieve” than in a no-prime condition, indicating that the sublexical spelling system is open to lexical influence. In subsequent experiments we examined the mechanism of this lexical/sublexical interaction by investigating whether it is phonologically or orthographically based and the size of the spelling units over which it operates.

(70)

**Persisting Letter Activation in Spelling and Implications for the Graphemic Buffer Hypothesis.** MONICA FREEDMAN & RANDI C. MARTIN, *Rice University*—A brain-damaged patient (H.T.) shows a spelling pattern similar in some ways to that shown by patients termed “graphemic buffer deficit.” His performance declines as a function of word length and he shows no effect of type of spelling task, grammatical class, or orthographic regularity. However, he does not show these patients’ typical bow-shaped serial position curve for within-word spelling accuracy, instead demonstrating a linear decline in letter accuracy across serial position. Whereas the majority of spelling errors of graphemic buffer deficit patients generally reflect a loss of letter identity or order information, H.T.’s errors often reflect perseveration of single letters or letter combinations from previous responses. The results suggest a deficit in inhibiting previously activated letters. Consistent with this hypothesis, H.T.’s spelling improved when a delay was introduced between the spelling of successive words. The ability of current spelling models to account for this pattern will be evaluated.

(71)

**Linguistic Gender and Spoken Word Recognition in French.** DELPHINE DAHAN, DANIEL SWINGLEY, MICHAEL K. TANENHAUS, & JAMES S. MAGNUSON, *University of Rochester*—Eye movements were monitored as French participants followed spoken instructions to click on one of four displayed pictures with a com-

puter mouse. Experiment 1 demonstrated that, in the absence of grammatical gender in the context preceding the referent name (i.e., “cliquez sur les bouteilles,” click on the [neutral] bottles), participants fixated pictures with names sharing initial sounds with the target (e.g., “boutons,” buttons) more than they fixated pictures with phonologically unrelated names. When a gender-marked article immediately preceded the noun (e.g., “cliquez sur la bouteille”), the early activation of the gender-inconsistent “cohort” competitor was completely eliminated (Experiment 2). However, when a gender-marked adjective preceded the noun (e.g., “cliquez sur l’astucieuse bouteille”) (Experiment 3) or when a gender-neutral adjective was interposed between the article and the noun (e.g., “cliquez sur la ridicule bouteille”) (Experiment 4), activation of the cohort competitor was observed, despite the presence of inconsistent gender marking in the preceding context. We propose that frequent form-based local co-occurrences, and not grammatical gender per se, constrain initial lexical access.

(72)

**Nonconscious Processing of Briefly Presented Visual Letter-String Stimuli.** BART A. VANVOORHIS, *University of Wisconsin, La Crosse*, & LLOYD L. AVANT, *Iowa State University*—Participants made brightness or duration judgments to briefly presented (15 msec) letter-string stimuli. Two pre- and postmasked stimuli were presented on each trial, and participants were to estimate which “flash” appeared to be brighter/last longer. Stimuli were high-image nouns, abstract nouns, verbs, or pseudowords (pronounceable) or nonwords (not pronounceable) created by rearranging letters of the word stimuli. For high-image and abstract nouns, participants reliably judged the nonword to be the brightest, and the word to be the dimmest. This pattern, however, was reversed for the verb stimuli. Across all word types, participants judged the word stimuli to last longer than their pseudo- and nonword counterparts. Results are discussed in the context of a neurobiological model of visual word processing (Avant, 1998, annual meeting of the Psychonomic Society).

(73)

**Spelling Skills and Metalinguistic Awareness: Visual, Phonological, and Morphological Processing.** SUSAN J. RICKARD LIOW & KENNETH K. L. POON, *National University of Singapore*—Sequential stage theories of literacy development (e.g., Frith, 1985) were evaluated for bilingual pupils attending an English-medium school. The 83 participants, 9–10 years of age, were drawn from three different L1 backgrounds (Mandarin, Malay, or English) and they had been taught to read and spell in English using the same whole-language approach. Quantitative analyses of English spelling accuracy showed that the Mandarin–English subgroup made greater use of visual processing, the Malay–English subgroup relied more on phonological processing, and the English subgroup used both and also showed greater sensitivity to morphological structure. Qualitative analyses of spelling errors confirmed the view that metalinguistic awareness affects spelling skill development in ways that can be predicted from the child’s oral and written language experiences. In place of stage theories that stress alphabetic/phonemic abilities, we propose a generic triaxial model akin to Seymour’s (1997) that can accommodate differential effects of *visual*, *phonological*, and *morphological* processing.

• PSYCHOLINGUISTICS •

(74)

**Aging and Grammatical Encoding.** DOUG DAVIDSON & ROSE T. ZACKS, *Michigan State University*—Little research has directly addressed whether there are age differences in how speakers formulate the grammatical structure of sentences. In a speech production study comparing healthy younger and older adults, we investigated variables believed to affect preferences for alternative grammatical constructions. Specifically, we asked subjects to produce simple sentences incorporating agent-theme or theme-experiencer verbs (presented in either active or passive form) together with two nouns, one animate and

one inanimate. We found that older adults show much the same pattern as the young in terms of the sentence types produced, the latencies to formulate the sentences, and the number of dysfluencies produced. For example, for both age groups, sentences with theme-experiencer verbs are more likely to be encoded as passives than sentences with agent-theme verbs. The impact of the relative accessibility of the two nouns will also be discussed.

(75)

**What You Can Get From a TOT and What NOT.** NINA SILVERBERG, *Temple University*, TAMAR GOLAN, *University of California, San Diego*, & MARRILL F. GARRETT, *University of Arizona* (sponsored by Jeffrey Bowers)—Several recent studies report data from tip-of-the-tongue (TOT) states as a way to evaluate language production models. They assume that, like word substitutions, TOTs reflect the mechanisms of intact lexical retrieval. However, we report two sources of evidence indicating that TOTs also reflect other processes. First, we compared databases of naturally occurring TOTs and word substitutions (in English) and found significant and unexpected differences between them. Second, in contrast to data reported in Italian, we found that Hebrew speakers were unable to report grammatical gender during TOTs. These findings require either a change in the way we model gender access in normal lexical retrieval or a change in the way we relate TOT states to lexical retrieval mechanisms. We pursue the latter option, and suggest that variation in TOT data signals a need to evaluate other factors (e.g., episodic contributions to performance and variation in systems of gender representation).

(76)

**An Initial Computational Analysis of Figurative Language: The Role of Density in Idiomatic and Metaphoric Expressions.** ROBERT H. MORROW, *University of California, Riverside*, ROBERT R. PETERSON, *Illinois State University*, & CURT BURGESS & JANET EAKINS, *University of California, Riverside*—We present initial computational results of metaphoric and idiomatic representation. The HAL model of memory was used to compute the semantic density of content words in figurative expressions and their meanings. We found that metaphors that were judged as more apt had semantically sparse vehicles. Sparser vehicles should provide the representational framework for creating new associations and minimize the likelihood of interference from neighboring concepts consistent with Camac and Glucksberg’s (1984) view of metaphor as knowledge creator. With idioms, we observed that the frequency of an idiom’s meaning in the lexicon was reliably related to the semantic density of an idiom’s first content word. Also, meanings were closer to the idiom initial word when that word was semantically denser. This result supports the view that idiomatic meaning can be accessed early in the idiomatic reading (Tabossi & Zardon, 1993).

(77)

**Comparative Effects of Presentation Modality, Age, and Working Memory in Sentence Comprehension.** KAREN A. KEMTES & ARTHUR WINGFIELD, *Brandeis University*, & DAVID CAPLAN, *Massachusetts General Hospital*—An extensive literature has documented that structurally complex sentences are more difficult to comprehend than simpler ones, particularly for older adults. Unresolved issues include the degree to which differences in working memory (WM) and allocation of processing resources affect sentence comprehension and whether this allocation of resources is similar across auditory and visual modalities. We examined younger and older adults’ comprehension of simple single clause sentences and more complex reduced relative clause and multiply-embedded sentences. The effect of presentation modality was explored using word-by-word self-paced reading and listening tasks. WM was defined as a composite index of performance on WM-associated tasks. Results are discussed in terms of (1) the comparative effects of presentation modality, (2) the degree to which differences in WM relate to allocation of processing resources during sentence comprehension, and (3) the ex-

tent to which age differences in sentence comprehension derive from age differences in WM.

(78)

**Focusing Stress Influences Infants' Recognition of Words in Fluent Speech.** HEATHER BORTFELD & JAMES MORGAN, *Brown University*—In a series of studies, we examine how natural prosodic marking of the given/new distinction influences infants' use of speech rhythm in identifying multisyllabic words. Two groups of 24 English-exposed infants (7 and 10 months of age) were tested on their ability to detect familiarized disyllabic words in fluent speech. Stimuli were chosen on the basis of acoustic analyses and independent ratings of the given/new stress present in naturally produced infant-directed speech (Bortfeld & Morgan, 1998). Stimuli consisted of English target words (for familiarization) and sentences (for testing). A key manipulation between experiments was the age of infants. Within each experiment, familiarization items carried either all given or all new stress, or alternated between the two. Mean listening times were higher for new-stressed stimuli across both ages, reflecting the superior attention-attracting and -maintaining qualities of new-stressed words. We discuss mothers' alternation between new and given stress in terms of distributed learning.

(79)

**Generalization From Limited Input.** REBECCA L. GOMEZ, *Johns Hopkins University*, & LOUANN GERKEN, *University of Arizona*—Despite a finite amount of input, children generalize to grammatical combinations they have never heard. Whether accomplished by means of innate rules or by statistical learning, we must assume fairly powerful induction mechanisms. Presumably such mechanisms enable learners to generalize after exposure to a smaller as compared with a larger subset of a learning space. A salient aspect of child-directed input is that caregivers tend to use multiple presentations of a reduced set of forms. We investigated the extent to which reduced input is used to abstract relations among word classes in a distributionally defined artificial language. Adult learners generalized as well after more frequent exposure to a small set of grammatical exemplars as compared with less frequent exposure to a larger set (the number of critical examples was reduced by half in the smaller set), demonstrating a fair degree of flexibility with respect to such learning.

(80)

**Planning Scope in Older, Younger, and Aphasic Speakers.** RANDI C. MARTIN, *Rice University*, & MICHELLE D. MILLER, *Northern Arizona University*—Onset latencies were measured for sentences describing moving picture displays in a paradigm developed by Smith and Wheelton (in press). The displays elicited two target sentence types: (1) simple phrase/complex phrase (e.g., “the fork moves above the kite and the dog”) or (2) complex phrase/simple phrase (e.g., “the fork and the kite move above the dog”), thereby varying complexity of the initial noun phrase but not overall sentence complexity. The results for younger and older adult subjects replicated previous findings in showing longer onset latencies for the sentences beginning with the complex noun phrase, implying that subjects plan just the initial noun phrase before beginning production. An aphasic patient with a semantic short-term memory deficit showed a greatly exaggerated effect of complexity of the initial noun phrase, suggesting that this planning occurs at a lexical-semantic level and that the same semantic retention capacity is used in production and comprehension.

(81)

**Individual Differences in Relative Clause Attachment Preferences.** AURORA MENDELSON & NEAL J. PEARLMUTTER, *North-eastern University*—Two free-choice questionnaires and a self-paced reading experiment examined relative clause attachment preferences in sentences like “Sam inspected the drawing of the building that was the architect's best work,” for low and high working memory span subjects. Four types of connecting prepositions were compared: locatives, “with,” functional “of,” and representational “of.” The questionnaire

results showed an early attachment preference for low span subjects but not for high span subjects. “With” elicited more late attachments than other prepositions regardless of span. The difference between the “of”s and “with” cannot be explained by a simple argument/adjunct distinction, because locatives did not display the same pattern as “with.” Span and preposition type interacted: For high span subjects only, functional “of” displayed the same late attachment preferences as “with.” Preliminary results of the self-paced reading experiment show an overall late attachment preference for low span subjects and differences between preposition types.

• DEVELOPMENTAL/AGING PROCESSES •

(82)

**What Tongue Twisters Tell About Aging and Speech Production.** JENNIFER TAYLOR, *Claremont Graduate University*, DEBORAH BURKE, *Pomona College*, & ISABELLE AMBROSE, *Pitzer College*—Word finding failures increase in old age, a finding that has been attributed to deficits in transmission of priming because of weak connections among phonological representations. Transmission deficits predict that certain types of speech errors increase in old age, (e.g., omissions, perseverations). Using tongue twisters to increase production of speech errors, we found no age difference in 30 young and 30 older adults' ( $M = 20$  years and 72 years, respectively) overall error rates in repeating aloud visually presented tongue twisters, with speech rate constant across age. Omissions were the only type of speech error that increased for older adults and all speech errors decreased with repetition of twisters over trials. The findings are consistent with transmission deficits, although age-related differences may have been reduced by the availability of the twister text.

(83)

**Mapping Number Symbols and Their Meaning: New Developmental Evidence From Estimation.** JOHN WHALEN, *University of Delaware*, & ROCHEL GELMAN & C. R. GALLISTEL, *UCLA*—There are at least two cognitive representations of number. The verbal number system learned in school uses numerical symbols (e.g., “9,” “nine”) to represent exact numerical quantities. In contrast, nonverbal number magnitude representations are imprecise, used early in life, and provide meaning to verbal number symbols. A fundamental developmental question is how children form mappings between verbal number symbols and nonverbal number representations. We contrast the estimation abilities of 6-year-old children and adults during both nonverbal tasks (e.g., estimate a quantity by pressing a key that many times without verbal counting) and verbal tasks (say aloud how many items are present without verbal counting). Nonverbal tasks reveal nearly identical nonverbal number representations for children and adults. However, verbal tasks reveal important limitations in the children's ability to map between nonverbal numerical magnitude representations and number symbols. The nature of these limitations and their educational implications will be discussed.

• DEVELOPMENTAL/AGING: MEMORY •

(84)

**Cognitive Aging: Implications for Everyday Remembering.** KATHLEEN COLLINS INSEL, *University of Arizona*—The purpose of this investigation is to describe the influence of cognitive function on medication adherence in older adults. Medication adherence is an important self-care activity impacting on health and well being; yet adherence may be particularly problematic for older adults who have been shown elsewhere to experience cognitive decline associated with normal aging. Specifically, this investigation seeks to increase the interpretability of laboratory findings of age-related cognitive decline in a metric meaningful to everyday living. Consistent with laboratory findings indicating that performance on a cognitive battery predicts remembering item and remembering context, performance on this battery also predicts medication adherence.

(85)

**Aging and Effectiveness of Environmental Support at Encoding and Retrieval.** ANDERSON D. SMITH & CHUCK L. ROBERTSON, *Georgia Institute of Technology*, & DENISE C. PARK, *University of Michigan*—Three age groups (young 18–32, young-old 60–74, and old-old 75+) participated in a recall task for which differential support was provided at encoding and retrieval. During encoding, target words were presented alone, with an unrelated cue, or with a related cue. At retrieval, free recall, cued recall, or cued recall with a word fragment of the target was used. Fragments increased the recall across all conditions. Related cues helped more than unrelated cues or no cues at all. Differences were found between all three age groups with the related cues, but the two old groups did not differ in the unrelated or target-only conditions. In the target-only condition, older subjects did better in free recall than with the word fragments. The younger subjects did better with the word fragments. Older adults have problems using environmental support if there are increased processing requirements in doing so.

(86)

**Item-Specific and Relational Processing Across the Lifespan.** NOBUO OHTA, *University of Tsukuba*, & ULRICH OLOFSSON, *University of Linköping*—Age-related effects on hypermnnesia, as a measure of item-specific and relational processing, were investigated. Hypermnnesia refers to an increase in recall performance over successive tests of the same study episode. It has been found that the components of hypermnnesia, reminiscence and forgetting, are influenced by item-specific processing and relational processing, respectively. In the experiment, 50 pictures were presented to 15 young and 15 old subjects, then three recall tests were administered successively. The results showed that young and old subjects produced similar amount of reminiscence, but there was significantly more forgetting in the old subjects. These results supported the hypothesis that there would be age-related effects on forgetting but not on reminiscence. It was suggested that older adults are deficient in relational processing.

(87)

**Age Differences in the Speed of Working Memory.** JULIE DUMAS & MARILYN HARTMAN, *University of North Carolina, Chapel Hill*—Two experiments used a delayed matching-to-sample task to examine age differences in working memory. When study times were calibrated to produce equivalent performance for young and old in a 0-delay condition (85% accuracy in Experiment 1 and 100% in Experiment 2), no age differences were found in a condition with 6-sec delays between study and test. However, older adults were slower to perceive the stimuli, as reflected in their longer study times. Experiment 2 also showed that increasing study times beyond those used to calibrate performance improved performance for young and old. However, older adults required more additional time to produce the same degree of improvement as younger adults. The overall pattern of results indicates that age differences in working memory are associated with slowing both in perception and the encoding of already-perceived items into working memory.

(88)

**Age Differences in the Suffix Effect.** MAURA PILOTTI, *Washington University*—Appending an irrelevant item (suffix) to the end of a short list of items impairs recall of the list, primarily in the recency portion of the serial position curve (suffix effect). This study examined age differences in the extent to which the suffix effect is modulated by strategic factors. Presentation rate (i.e., time allocated to rehearsal: 1, 2, 4 digits/2 sec) and practice with suffix and no-suffix lists were factorially manipulated in the standard suffix procedure. In young adults, the serial recall results indicated that presentation rate and practice modulated to a greater extent the preterminal than the terminal suffix effect. In older adults, practice had a larger impact on the preterminal than on the terminal suffix effect, whereas the effect of presentation rate was marginal at all the serial positions. These findings

are discussed in terms of age differences in the efficiency of rehearsal of short-term memory contents.

• MOTIVATION •

(89)

**Emotional Modulation of the Attentional Blink.** ADAM K. ANDERSON & ELIZABETH A. PHELPS, *Yale University*—We employed the attentional blink effect to investigate the emotional modulation of attentional processes. The attentional blink is an impairment in awareness thought to reflect a limitation in the temporal allocation of attentional resources. In the present study, participants were asked to identify two colored target words presented at variable temporal lags in a stream of black distractor words. The emotionality of the second target word (T2) was manipulated. We found that the attentional blink was attenuated by the emotional significance of T2. Further, this effect was graded, such that words of negative valence (e.g., *grief*) showed less attenuation than those that were also arousing in content (e.g., *rape*). Manipulations of word frequency did not modulate the size of the attentional blink. We interpret this finding as indicating that less attention is required for emotional words to reach awareness.

(90)

**Impact of Underlying Motivational Biases on Execution of Attention Control Processes.** CATHERINE POULSEN & NORMAN SEGALOWITZ, *Concordia University*—This research examined the influence of experimentally manipulated motivation (Derryberry, 1993) on on-line cognitive processes during performance of a task requiring attentional set switching and cross-talk inhibition (Rogers & Monsell, 1995). Results revealed that prior motivational experience had a selective effect on attentional set switching. Importantly, it had no effect on either simple response execution time or inhibition. Since all subjects received equal incentives for both judgment tasks during the switch task itself, this effect cannot be attributed to intentional strategies. Rather, we suggest that prior motivation due to differential training incentives introduced a lower level bias on set switching that current executive control was able to overcome only at a cost in efficiency. This biasing effect was robust, lasting throughout the 768 equal-incentive switch task trials. In a follow-up experiment, reverse incentives applied during the switch task were able to neutralize, but not significantly reverse, this effect.

(91)

**The Influence of Self-Efficacy on Learning in a System.** REGINA VOLLMEYER, ANKE LEHNIK, & FALKO RHEINBERG, *University of Potsdam*—Bandura and Wood (1989) assumed that high self-efficacy helps learning: When learning a complex task, people develop either high or low self-efficacy, which then affects performance. In contrast, we proposed that initial self-efficacy levels, formed after reading the task instruction, are the main influence on performance. To test this hypothesis, we developed a model of how self-efficacy should influence the learning process. In our study, 121 students learned the structure of a complex system. Two variables were measured: (1) self-efficacy initially and during learning and (2) knowledge acquisition during learning. After learning, participants applied their knowledge. A path-analytic model showed that initial self-efficacy affected the learning process, whereas self-efficacy during learning did not contribute extra explanatory power. This was despite self-efficacy during learning being only weakly correlated with initial self-efficacy. Application of knowledge, however, was strongly related to self-efficacy but not to acquired knowledge.

• NEUROPSYCHOLOGY •

(92)

**The Contribution of the Prefrontal Cortex to Feeling-of-Knowing and Tip-of-the-Tongue Reports.** ROBERT L. WIDNER, JR., *University of Colorado*, HAJIME OTANI, *Central Michigan University*,

& CHRISTINE FALCONER, *University of Colorado*—We examined the contribution of the prefrontal cortex (PFC) to feeling-of-knowing (FOK; Experiment 1) and tip-of-the-tongue (TOT; Experiment 2) experiences. We used the number of perseverative errors on the Wisconsin Card Sort Test as our index of PFC functioning. Older adults ( $M$  age = 64.70 and 62.63, Experiments 1 and 2, respectively) were included as participants to widen the range of PFC functioning. Using our index of PFC functioning we generated a group of participants ( $n = 12$  and 15, Experiments 1 and 2, respectively) with relatively intact PFC functioning ( $M$  errors = 6.08 and 5.00, Experiments 1 and 2, respectively) and a group ( $n = 12$  and 15, Experiments 1 and 2, respectively) with deficient PFC functioning ( $M$  errors = 16.00 and 14.07, Experiments 1 and 2, respectively). We found that the PFC plays a substantial role in FOK reporting (as assessed by frequency, accuracy, and FOK strength) but not in the reporting of TOT experiences. We discuss various explanations for these findings.

(93)

**An fMRI Study of Visual and Auditory Sentence Comprehension.**

ERICA B. MICHAEL, TIMOTHY A. KELLER, PATRICIA A. CARPENTER, & MARCEL ADAM JUST, *Carnegie Mellon University*—A comparison of visual and auditory sentence comprehension revealed that left-lateralization in the perisylvian language areas is much stronger for reading than for listening comprehension. The fMRI-measured cortical activation was monitored while 9 young adults read or listened to sentences that were structurally more complex (object-relative) or less complex (conjoined active). The more complex sentences produced significant increases in activation in several cortical regions, consistent with the added computational burden of object-relative sentences. The activation in the posterior temporal region (excluding primary auditory areas) was significantly higher and more bilateral in the auditory than in the visual conditions. The amount of activation in Broca's area was nearly identical in the two modalities. In many nonsensory regions, not identical but overlapping sets of vowels were activated in the two modalities. Overall, the results suggest that the nonsensory cortical processes supporting sentence comprehension show considerable modality dependence.

(94)

**Spatial Updating During Self-Rotations After Posterior Parietal Lesions.**

JOHN W. PHILBECK & MARLENE BEHRMANN, *Carnegie Mellon University*, & JACK M. LOOMIS, *University of California, Santa Barbara*—Posterior parietal cortical (PPC) lesions are associated with deficits in updating the remembered location of targets in the contralesional hemifield. This suggests that target updating may be asymmetrically impaired in the contra- and ipsilesional hemifields, depending on the target's imagined path during self-motion. We tested the ability of PPC-injured patients to update remembered target locations during passive whole-body rotations executed without vision. Visual targets presented before the turn appeared on either the contra- or ipsilesional side; after acknowledging the target's presence, the observer covered the eyes and was passively rotated. During the turn, the target (now invisible) either remained in the same hemifield or passed into the opposite hemifield. Most patients showed deficits in sensing self-rotations (as indicated by blindfolded pointing); asymmetrical deficits were more rare but did occur. Future testing will clarify the role of the PPC in spatial updating during self-rotations.

(95)

**H.M.'s Comprehension of Words and Nonwords: Spared and Impaired Abilities.** LORI E. JAMES & DONALD G. MACKAY, *UCLA*—Four experiments compared comprehension of visually presented words in the famous amnesic patient H.M. and memory-normal controls. H.M. was inferior to controls in discriminating low-frequency (but not high-frequency) words from pseudo-words and also in defining words that he recognized as words. Longitudinal evidence

indicated age-linked deterioration in H.M.'s lexical decision accuracy for low- but not for high-frequency words. Contrary to these comprehension deficits, H.M. performed similarly to controls in describing two meanings of ambiguous words and phrases presented without sentence context. H.M.'s pattern of spared and impaired language comprehension abilities contradicts stages of processing theories that attribute H.M.'s deficit to a storage stage that is independent of processes for comprehending verbal materials, and instead supports distributed-memory theories with inseparable storage and content processes.

(96)

**Action Sequencing Deficits in Frontal Lobe Patients.**

SERGIO ZANINI & RAFFAELLA IDA RUMIATI, *Scuola Internazionale Superiore di Studi Avanzati* (sponsored by Raffaella Ida Rumiati)—We submitted 9 patients with executive function disorder to a sequencing task of object-related actions (e.g., preparing a cup of coffee) and nonobject-related actions (e.g., going to the doctor). They failed in rearranging pictures as well as verbal descriptions (Experiments 1 and 2) of both types of actions (Experiments 3 and 4). The difficulty in the first two experiments cannot be explained either in terms of action schema disruption, in that they were intact in the production of the object-related actions (Experiment 5) or in terms of lack of understanding the tasks, in that patients were able to sequence stimuli other than actions (e.g., shapes and numbers) (Experiment 6). These results confirm that patients with an executive function disorder have a selective deficit in sequencing actions, irrespective of their format (e.g., photos or verbal descriptions) or of the type of action (e.g., object and nonobject related).

(97)

**Neural Correlates of Goal Neglect Revealed by Event-Related Brain Potentials.**

ROBERT WEST, *University of Notre Dame*, & CLAUDE ALAIN, *Rotman Research Institute*—The neural correlates of goal neglect were explored using event-related brain potentials (ERPs). Goal neglect was operationalized as the occurrence of intrusion errors in the Stroop task, where individuals read the name of a color word instead of naming the color of the stimulus. In Experiment 1, two modulations differentiated the ERPs elicited by intrusion errors from the ERPs elicited by correct incongruent, congruent, or word reading trials. The first modulation reflected an enhancement of the P1 wave for intrusion errors over the occipital-parietal region, and the second modulation reflected a negative slow wave over frontal regions. In Experiment 2, the attentional demands of the task were varied across blocks of trials. For this experiment the enhancement of the P1 wave and the negative slow wave was greatest when the attentional demands of the task were reduced. These findings are consistent with the proposal that a frontally mediated attention system supports goal-directed thought and action.

• CATEGORIZATION •

(98)

**The Impact of Exception Patterns on Learning of Not Linearly Separable Categories.**

MARK BLAIR & DONALD HOMA, *Arizona State University*—The present study expanded on findings we recently reported (Blair & Homa, 1999) on the difficulty of learning linearly separable (LS) and not linearly separable (NLS) categories of different sizes. In our earlier study, we showed that NLS categories were more difficult to learn than LS ones, and that when category size was increased, the exception patterns that violated linear separability were classified at or below chance for 25 trial blocks, the duration of the experiment. In the present study, we show that these exception patterns retard the learning of the of the remaining category members. Furthermore, an individual subject analysis demonstrates that an exemplar model of category learning cannot account for the persisting difficulty of learning the exception patterns. A prototype and a prototype-exemplar mixed model are also explored.

(99)

**The Influence of Naive Causal Theories on Lay Diagnoses of Mental Illnesses.** NANCY S. KIM, *Yale University*, & WOO-KYOUNG AHN, *Vanderbilt University*—The theory-based view of categorization suggests that a concept is represented by people's theories about how the features of a concept fit together. In this study, we investigate the mechanism by which undergraduate students' naive causal theories of mental illnesses influence their diagnosis decisions. Our data conform to the model of Sloman, Love, and Ahn (1998), which posits that features of a concept are conceptually central to the degree that they are thought to be causally central. Preliminary data from clinical trainees are also presented. The implications of these results for how people's background knowledge influences the importance of features in categorization are discussed, as well as some possible ramifications for the atheoretical *DSM-IV* (APA, 1994), and for researching diagnostic reliability between clinicians with differing theoretical backgrounds.

(100)

**Transformational Paths and Category Learning.** SAFA R. ZAKI, *Indiana University*—Previous research (Zaki & Homa, 1999) has demonstrated that people are faster at categorizing items that continue a transformation if they see the sequential states of the transformation in a systematic order. This study extends these findings by demonstrating that participants classify items in a previously unseen region of the stimulus space differently as a function of their transformational training. In this study, participants were trained on patterns from two categories that converged to a single point and were tested on items that extended the path of the categories past that point. While similarity to the old items played the large role in determining responses, participants were more likely to choose the path-continuing category if they saw patterns in a systematic order during training. Similarity structure following training and implications for models of categorization are discussed.

(101)

**Infants' Categorization of Static and Kinetic Stimuli.** MARTHA E. ARTERBERRY, *Gettysburg College*, & MARC H. BORNSTEIN, *National Institute of Child Health and Human Development*—Three experiments investigated the information infants may use in categorizing. In Experiment 1, 3- and 6-month-olds were habituated to full color static photographs of animals or vehicles. Following habituation, infants viewed a new exemplar of the habituation category and an exemplar from the novel category. Using a similar design in Experiment 2, infants were presented with kinetic point-light displays that created animal or vehicular motions. In both experiments, infants showed a significant preference for the novel category exemplar. Experiment 3 tested 6-month-olds' ability to transfer category membership across cues. Half of the infants were habituated to static dis-

plays and tested with kinetic displays, and the other half were habituated to kinetic displays and tested with static displays. Infants showed transfer across cues only when habituated to kinetic displays, suggesting that under some conditions infants process cue independent information about category membership.

(102)

**Interpreting Novel Noun–Noun Combinations.** LLOYD K. KOMATSU, MICHAEL L. KHORSANDI, CAITLIN M. KASMAR, BRIGID E. VANCE, & JENNIFER A. RUPPERT, *Carleton College*—Interpreting noun–noun combinations involves transferring or applying a property of the modifier to the target. For example, interpreting the novel combination *giraffe dog* as a long-necked dog involves transferring the giraffe property “long neck” to *dog*. But we cannot simply transfer the property as instantiated in the modifier (e.g., the giraffe's long neck). Is it possible to interpret the combination simply by substituting the appropriate property of the target with an abstract representation of the modifier property (e.g., substituting the dog property “neck” with “long neck”), or must we specifically instantiate the property in the target (e.g., imagine a *dog* with a long neck) before coming to an interpretation? Whereas Wisniewski (1998) provided indirect evidence supporting the latter, we examine evidence that bears on the question more directly.

(103)

**An Evaluation of Exemplar and Decision-Bound Models of Categorization.** JEFFREY N. ROUDER, *University of Missouri, Columbia*, & ROGER RATCLIFF, *Northwestern University* (sponsored by Roger Ratcliff)—Exemplar and decision-bound models for categorization behavior make similar predictions for many experimental paradigms. We present data from a paradigm in which these models make qualitatively different predictions. In our paradigm, stimuli are probabilistically assigned to one of two categories and the categories are distributed across a set of unidimensional stimuli, but in a non-normal fashion. The category distributions are designed to produce stimuli that are far from any decision bound yet have a high proportion of exemplars for both categories. We present four experiments using stimuli that are squares varying in luminance. Exemplar models (GCM) failed to account for the data when the set of to-be-classified stimuli were confusable. But decision-bound models (GRT) failed to account for the data when the stimuli were not confusable. The results show that single-process models are not sufficient and provide some support for dual-process models (e.g., ATRIUM, RULEX).

(104)

**Research Support From the National Science Foundation.** FRED STOLLNITZ & JOE YOUNG, *National Science Foundation*—Information about the various programs of the NSF will be available.

**ATTENTION: DUAL TASK**  
**Pacific Palisades, Friday Morning, 8:00–9:45**

*Chaired by Marisa Carrasco, New York University*

**8:00–8:10 (105)**

**On the Dual-Task SRT Experiment: It's Probably Not Dual-Task.** SIMON K.-Y. RAH & ARTHUR S. REBER, *Brooklyn College, CUNY*, & ANDREW HSIAO, *Moss Rehabilitation Institute* (read by Arthur S. Reber)—In the standard SRT experiment, subjects are required to respond rapidly to a structured sequence of visual targets. Evidence that subjects have acquired knowledge of the structure is obtained by modifying the structured nature of the sequence and noting whether RTs increase. In the dual-task SRT experiment, a “secondary” tone-counting task is introduced and the extent to which learning of the “primary” target sequence is compromised is noted. Here we present data that strongly imply that, although the psychologists who designed this “dual-task” experiment may have viewed it this way, this may not be the best way to characterize it. The suggestion is that this “duality” is illusory and that we should probably be treating the tone-counting task as a potential source of additional patterns of covariation in a complex, multicomponent display and not as a “secondary,” attention-diverting factor.

**8:15–8:35 (106)**

**The Effects of Task Cuing on Performance of an Unexpected Task.** ROBERT S. McCANN, *San Jose State University*, ROGER W. REMINGTON, *NASA Ames Research Center*, & CHARLES L. FOLK, *Villanova University*—What happens when people prepare for one task and then have to perform a different task? We report experiments that explicitly manipulated task expectancy (lexical decision vs. digit magnitude comparison) to assess the effects of setting up a specific “task set” on unexpected task processing. Two cuing experiments measured the combined effects of task cuing (valid vs. invalid) and within-task difficulty (lexical decision: word frequency; magnitude comparison: symbolic distance) on choice response times. Valid task cues produced significantly faster response times than did invalid task cues. Easy task conditions produced faster response times than did hard conditions. The combined effects of task cuing and within-task difficulty were additive. The results indicate that task-related processing is subject to postponement while task set is being reconfigured. This suggests that adopting a task set creates a temporary bottleneck when it comes to processing an unexpected task.

**8:40–9:00 (107)**

**Individual Differences in Attention Control.** DANIEL GOPHER, ANAT FIELD, & HADAS HARAMATI, *Technion*—Are individuals who excel at focusing attention also good at dividing their efforts and at switching attention between tasks? These are all actions of attention control. Are they separate abilities, or different manifestations of the same ability? To date, research on individual differences in attention capabilities has focused exclusively on issues of capacity limitations. The present study changes this focus, to investigate individual differences in attention control activities. We report the results of two studies with 100 subjects each, in which individual differences in control were compared within and between task context and modes of processing. Highly consistent differences were obtained in focusing, dividing, and switching attention among tasks. They also correlated with performance on a complex task. Control activities were found to constitute separate dimensions, with a common joint factor. Divided and focused attention were found to be closer to each other than attention switching, which was removed from both.

**9:05–9:20 (108)**

**Driven to Distraction: Dual-Task Studies of Driving and Cellular Phone Use.** DAVID L. STRAYER, WILLIAM A. JOHNSTON, & SARAH GRISON, *University of Utah*—Dual-task studies assessed the costs of cellular phone use on performance of a simulated driving task. Driving was not disrupted by listening to radio broadcasts. Nor was it

disrupted by a continuous shadowing task, ruling out dual-task interpretations associated with holding the phone, listening, or speaking. However, significant interference was observed in a word generation variant of the shadowing task, and this deficit increased with task difficulty. Moreover, unconstrained conversations using either a manual or hands-free cell phone resulted in deficits when subjects were talking but not when they were listening. Conversing also led to a threefold increase in failing to react to imperative signals (e.g., brake lights) and slower reactions to those signals that they did detect. We suggest that cellular phone use disrupts performance by diverting attention to an engaging cognitive context other than the one immediately associated with driving.

**9:25–9:40 (109)**

**The Psychological Refractory Period Effect: One Central Bottleneck or Several?** JAMES C. JOHNSTON, ERIC RUTHRUFF, & ROGER W. REMINGTON, *NASA Ames Research Center*—The psychological refractory period effect is widely believed to occur because central mental operations (e.g., stimulus classification and response selection) can execute on only one task at a time. Several possibilities remain viable. There might be a heterogeneous pool of central processes, no two of which can operate simultaneously—for example, response selection from one task cannot overlap with stimulus classification on the other. Alternatively, there might be multiple specific central bottlenecks (e.g., stimulus classification cannot operate on two tasks simultaneously, nor can response selection, but stimulus classification and response selection can operate simultaneously). We tested these competing hypotheses by jointly manipulating response selection difficulty on Task 1 and stimulus classification difficulty on Task 2. The single-central bottleneck model predicts an additive interaction, whereas the multiple-central bottleneck model predicts an underadditive interaction. We discuss the implications of our findings for unified treatments of dual-task interference phenomena.

**LEARNING AND INDIVIDUAL DIFFERENCES**  
**Plaza, Friday Morning, 8:00–9:50**

*Chaired by Ronald T. Kellogg, University of Missouri, Rolla*

**8:00–8:15 (110)**

**Learning of New Facts by High- and Low-Knowledge Participants.** JAMES P. VAN OVERSCHELDE & ALICE F. HEALY, *University of Colorado* (read by Alice F. Healy)—Research on expertise and research on verbal learning offer different predictions for how participants will perform during learning and memory tasks. We found in Experiment 1 that participants showed superior learning and recall of a large quantity of new, discrete, nondomain relevant facts about concepts within their domain of high knowledge than about concepts for which they had low-domain knowledge. Experiment 2 investigated whether the participants' superior recall of new facts related to concepts within their domain of high knowledge was due to the number of prior facts associated with the concepts or to the prior frequency of repetition of those concepts. We found that participants' recall of new facts was better for concepts with five prior associated facts than for concepts with a single prior association, but the number of previous repetitions of each associated fact did not affect the level of recall for the new facts.

**8:20–8:40 (111)**

**Does Practice Lead to Skills That Are Specific, General, or Both?** CRAIG SPEELMAN, *Edith Cowan University*—A series of experiments was conducted to compare features of Anderson's ACT theory of skill acquisition with Logan's Instance theory of automatization. The particular focus of the experiments was the issue of whether or not skills are specific to the circumstances experienced during training. Participants practiced solving a simple mathematical problem on a computer, with a restricted set of initial conditions that were repeated throughout training. In the transfer phase, the same problem was solved with a different set of initial conditions. Initial performance in the trans-

fer phase was slower than at the end of training, indicating that to some extent skills are specific to the circumstances in which they are acquired. However, initial transfer performance was significantly better than initial training levels, indicating that the participants' skills could be generalized to items not previously experienced. This conclusion is more consistent with the ACT theory than with the Instance theory.

#### 8:45–9:05 (112)

**A Present-Moment Management Model of Everyday Memory Failures.** DOUGLAS J. HERRMANN, *Indiana State University*, & MICHAEL GRUNEBERG, *University of Wales*—Memory failures have been attributed to encoding failures and various difficulties in remembering: absence of cues, fatigue, and stress prior to and during action. This paper proposes that prior explanations of memory failures, as well as new explanations, may be subsumed by the ongoing process of managing one's life from minute to minute. A model is advanced that rests on the assumption that memory for an intention fails because people sometimes find it too difficult to manage their memory processes (such as decay, interference, suppression, etc.) while simultaneously controlling nonmemory processes (poor physical state, extremes in emotionality) and taking account of how the environment and social context may cue memory. This paper will describe the model and then review a variety of everyday memory failures that demonstrate that memory tasks in some situations are extremely difficult to perform successfully.

#### 9:10–9:25 (113)

**Using an Individual Differences Approach to Examine Different Types of Suggestibility.** MITCHELL L. EISEN, WILLIAM LOBER, ROSE KISTORIAN, & DANIELLE MORGAN, *California State University, Los Angeles*—This study was designed to examine individual difference factors associated with two different types of suggestibility: (1) the immediate acceptance of misinformation (errors on misleading questions) and (2) the production of delayed retrieval errors (memory errors created through the employment of a "classic" suggestibility paradigm). Eighty subjects took part in a staged event and were administered an unexpected postevent memory interview 2 days later. Half the subjects were presented with misinformation during a relaxation tape administered subsequent to the event but prior to a postevent interview (classic misinformation group). The other half received misinformation in the form of misleading questions administered during the postevent interview (immediate acceptance of misinformation group). Conformity (the Asch task), agreeableness, visualization, and short-term memory were also measured. As predicted, conformity was related to errors on misleading questions, but not the production of delayed retrieval errors. Findings will be discussed in terms of developing theories of suggestibility.

#### 9:30–9:45 (114)

**Individual Differences and Characteristics of False Memory.** JIAN-JIAN QIN, *Princeton University*, & GAIL S. GOODMAN, *University of California, Davis* (sponsored by Gail S. Goodman)—The present study examined individual differences in and characteristics of false memory in adults. One-hundred nineteen undergraduate and community participants (81 females, 38 males; mean age = 27.1 years) completed two interviews during which they attempted to recall several parent-provided true childhood events and an experimenter-created false event. They also filled out individual-difference questionnaires. Results indicated that 26.2% of the participants reported partial (15.9%) or clear (10.3%) false memory. In addition to previous findings regarding dissociation and imagination, it was found that pathological dissociation, social desirability, and parental fearful avoidant attachment style predicted false memory. As compared with true memories, false memories had lower confidence ratings, overall clarity, and judged likelihood of occurrence, and included less spatiotemporal and descriptive information. However, false and true memories did not differ in the amount of mental/cognitive and emotions/feelings information. Theoretical implications of the results for understanding mechanisms of false memory construction will be discussed.

## PSYCHOPHYSICS I

Santa Monica, Friday Morning, 8:00–10:05

Chaired by Albert J. Ahumada, Jr., *NASA Ames Research Center*

#### 8:00–8:10 (115)

**Familiar Size Produces Slower Responses Than Other Depth Cues.** ALBERT YONAS & MAUMI EBIHARA, *University of Minnesota*—Much evidence supports the notion of two visual pathways: a dorsal stream that selects actions and a ventral stream that recognizes objects. One depth cue, familiar size, requires that a familiar object is recognized before visual angle can retrieve the object's distance from memory. Depth information must then enter the dorsal stream so that actions, such as reaching, can be selected. In this study, pointing indicated perception of spatial location. Participants monocularly viewed photographs of large and small objects that were printed the same size and placed at the same depth. Rapid responses (343 msec) showed little evidence of depth perception, whereas 612-msec responses showed clear perception of depth. In a binocular control condition, the object was placed at different distances, and in a monocular relative size condition, large and small unfamiliar objects were presented at the same distance. In the control conditions, responses were under 400 msec and indicated depth perception.

#### 8:15–8:30 (116)

**Boundary Extension in the 3-D World.** HELENE INTRAUB, AMANDA E. TURNER, & E. RENEE CLEMENT, *University of Delaware*—When viewers remember a picture of a scene, they usually remember having seen a greater expanse than was actually shown—a phenomenon called *boundary extension* (BE). Previous research suggests that BE is the result of mental extrapolation during perception that serves to overcome the physiological constraints of the visual system (e.g., eyes only in front, a small fovea, and input composed of numerous fixations over time). For the first time, memory for the spatial expanse of real scenes (*not* pictures) was tested. In three experiments, using two methods of test and 13 scenes, subjects were exposed to 6–7 real scenes (via *vision* or *touch*), and were asked to remember them. Two questions were asked: Will BE occur when viewing real 3-D scenes? And will the phenomenon generalize to the sense of *touch*? The answer to both questions was "yes." Implications for a theory of scene perception will be discussed.

#### 8:35–8:50 (117)

**Visual Illusions and the "Antigravity" Chair.** WILLIAM PRINZMETAL, *University of California, Berkeley*, & DIANE M. BECK, *University College London*—We propose that the Ponzo, Zöllner, and Poggendorff illusions, as well as the tilt-induction effect, are caused by the same mechanisms that cause the tilted-room and the rod-and-frame effects (e.g., Asch & Witkin, 1948). Both of these effects are due to the misperception of orientation induced by misleading visual information. It has been found that both the tilted-room and the rod-and-frame effects are increased when the observer sits in a tilted chair. Presumably, this result indicates that when observers are tilted, they rely more on visual cues to orientation and less on gravity-based cues. Illusions that are caused by the same orientation mechanisms as the tilted-room and rod-and-frame effects should also increase when the observer sits in the "antigravity" chair. We found that tilting the observer substantially increased orientation-related illusions but not other visual illusions.

#### 8:55–9:10 (118)

**Testing a Perceptual–Oculomotor Account of Effects Deemed Due to Representational Momentum.** DIRK KERZEL, *Max Planck Institute for Psychological Research, Munich*, J. SCOTT JORDAN, *Saint Xavier University*, & JOCHEN MÜSSELER, *Max Planck Institute for Psychological Research, Munich* (read by J. Scott Jordan)—When asked to indicate the final position of a moving target, subjects reliably produce mislocalization patterns consistent with the laws of

physics (Hubbard, 1995), and memory distortion due to representational momentum is often proposed as an explanatory mechanism. The present experiments tested whether such displacement patterns can be accounted for in terms of perceptual factors related to oculomotor control. In Experiments 1 and 2 we demonstrate that for horizontal target motion, the reported displacement patterns can also be found in perceptual, identification judgments. In Experiment 3 we demonstrate that the magnitude of displacement judgments for horizontally moving targets is significantly reduced if one inhibits oculomotor smooth-pursuit during target presentation. In Experiments 4 and 5 we demonstrate that displacement patterns in the vertical plane do not replicate in perceptual, identification variables. Thus, perceptual-oculomotor factors can account for horizontal displacement patterns. Vertical displacement patterns, however, seem to reflect the cognitive internalization of gravity dynamics.

9:15–9:35 (119)

**Attention and Other Determinants of Perceived Direction in Ambiguous Stimuli.** GEORGE SPERLING, *University of California, Irvine*, & CHING ELIZABETH HO, *California Institute of Technology*—Werkhoven et al. (1994) and Ho (1998) showed that a motion stimulus, consisting of side-by-side grating patches, can appear to move in either of two directions. We designate these as the second- and third-order directions, hypothesizing that they are computed by the corresponding motion systems. We demonstrate that the third-order direction is perceived when subjects attend to a particular grating slant at temporal frequencies below about 3 Hz, whether viewing is monocular or interocular (so that left- and right-eye signals must be combined to perceive motion). Subjects perceive only the second-order direction at higher temporal frequencies and only with monocular viewing, or when *not* attending to slant, or when the slant cue is removed. All these results are consistent with higher-order motion properties: Second-order motion is monocular, corner frequency 10–12 Hz, and computed from outputs of texture grabbers. Third-order motion is binocular, corner frequency of 3 Hz, and computed from the output of a salience field.

9:40–10:00 (120)

**Lightness Perception: Anchoring or Intrinsic Images?** ALAN L. GILCHRIST, *Rutgers University*—In recent times the most sophisticated models of surface lightness perception have been the intrinsic-image models, according to which edges in the retinal image are encoded, classified, and integrated to split the image into two component images, a reflectance image and an illumination image. But work to add a final missing component, an anchoring rule, has severely undermined the intrinsic-image approach, suggesting a different kind of model in which the lightness of a target is a weighted average among values computed by anchoring the target in several frameworks simultaneously. Several key experiments are presented in which lightness is shown to depend on factors, such as the number of elements in a framework and the size of the framework, that make no sense within the intrinsic-image approach. Finally, a critical test is reported in which the new anchoring model predicts results that are opposite to predictions made by the intrinsic-image model.

**MEMORY: BRAIN AND DRUG EFFECTS**  
Beverly Hills, Friday Morning, 8:00–10:00

*Chaired by Lawrence M. Parsons, University of Texas, Health Science Center*

8:00–8:15 (121)

**Nondeclarative Hippocampal Memory.** ANTHONY J. GREENE, BARBARA A. SPELLMAN, & DONALD S. CHRISTMAN, *University of Virginia*, JEFFERY A. DUSEK, *Harvard University*, & WILLIAM B. LEVY, *University of Virginia* (read by William B. Levy)—The Eichenbaum–Cohen theory of hippocampal function implies that

flexible learning is equivalent to declarative memory. Here we report their disassociation in learned transitive inference (i.e., given premise pairs  $A > B$ ,  $B > C$ ,  $C > D$ ,  $D > E$ , infer  $B > D$ ), a hippocampally dependent task. Stimulus items were novel, nominally unorderable shapes in order to exclude reasoning based on syllogism or verbal strategies as well as to provide a closer comparison to studies of transitive inference in animals. On the basis of experience with adjacent pairwise comparisons, an ordering of these stimuli was learned. By appropriate manipulations of training, we could control the formation of declarative memory. When training was minimal for learning the transitivity relationship, performance on the transitive pair ( $B > D$ ) was not correlated with awareness. The results suggest that hippocampal learning can precede declarative memory and that the teach-back to neocortical regions from the hippocampal intermediate-term memory store—as would be required for verbalization—is noninstantaneous.

8:20–8:35 (122)

**Interactive Versus Independent Context: Closed Head Injured Patients Versus Controls.** ELI VAKIL, ANAT ALTMAN, AMIR BARNEA, & HADAS KARNI, *Bar-Ilan University*—Sixteen closed head injured patients and 16 control participants were presented with pairs of pictures of faces of males and females. For one half of the participants, the male's face was defined as the target (i.e., to be remembered) and the female's face as the context, and for the other half, it was the other way around. The context effect on face recognition was measured under “interactive” (i.e., how compatible are the male and female?) versus “independent” (i.e., how friendly is each one of the faces?) encoding conditions. Results indicated that the control group recognized target and context faces more accurately. Overall, recognition of target faces was better under interactive than independent encoding. In addition, the encoding effect was the same for both groups. The findings are discussed in terms of the distinction between item and source memory and the contribution of the middle temporal and the prefrontal structures to these processes.

8:40–9:00 (123)

**Functional Dissociation of Two Regions of Frontal Cortex With Respect to Episodic Memory Using fMRI.** KATHLEEN B. McDERMOTT, RANDY L. BUCKNER, STEVEN E. PETERSEN, WILLIAM M. KELLEY, & AMY L. SANDERS, *Washington University*—Frontal cortex has been described as playing both “set-specific” and “code-specific” roles in human memory processing. Set specificity refers to goal-oriented differences in activation patterns (e.g., encoding relative to retrieval). Code specificity refers to activation patterns that differ across stimulus type (e.g., verbal/nonverbal). Using a two (code: verbal, nonverbal) by two (set: encoding, retrieval) within-subjects design and fMRI, we explored the influence of type of code and mental set in two regions in frontal cortex previously shown to be involved in memory. A region in the dorsal extent of inferior frontal gyrus (BA 6/44) demonstrated code-specific effects: Words produced left-lateralized activation, whereas unfamiliar faces elicited right-lateralized activation. A region of right frontal polar cortex (in or near BA 10) showed set-specific activation in that it was more active during retrieval than encoding. Distinct regions in frontal cortex contribute in different yet systematic ways to human memory processing.

9:05–9:20 (124)

**Functional Neuroimaging of Drug-Induced Anterograde Amnesia.** RUTH REINSEL & ROBERT A. VESELIS, *Memorial Sloan-Kettering Cancer Center* (sponsored by Elliot Hirshman)—Some sedative-hypnotic drugs produce anterograde amnesia. We have studied midazolam (a benzodiazepine) and propofol (an alkylphenol) using functional neuroimaging techniques to localize the neuroanatomical substrate of drug-induced amnesia. Functional MRI in single subjects establishes that the neural transmission of primary sensory information to cortex is preserved during drug administration. PET studies with  $^{15}\text{O}$  in subjects who received low or high doses of midazolam or

propofol indicate that regional cerebral blood flow (rCBF) changes over the anterior brain in a dose-dependent fashion. Before drug, subjects asked to learn words showed increased rCBF in the left prefrontal cortex when compared with an auditory control condition (nonsense syllables). After propofol, this activation was abolished, coincident with severely impaired recall and recognition. The left prefrontal cortex has been identified as an area involved in verbal encoding. Neural activity in this area may be decreased by certain sedative agents, resulting in reversible drug-induced amnesia.

#### 9:25–9:40 (125)

**Midazolam and the Influence of Conceptual Processing on Implicit Memory Tests.** JASON ARNDT, ANTHONY PASSANNANTE, & ELLIOT HIRSHMAN, *University of North Carolina, Chapel Hill* (read by Elliot Hirshman)—Understanding the influence of conceptual processing has been a central issue in the implicit memory literature. Empirical examinations of this have produced mixed results (e.g., Toth and Hunt, 1990, vs. Jacoby and Dallas, 1981). Although this pattern may indicate that conceptual processing has heterogeneous effects on implicit memory, an alternative interpretation is that the effects of conceptual processing on implicit memory tests arise from contamination by explicit memory processes. In our experiment we inject subjects with midazolam prior to study to explore the role of explicit memory processes in Toth and Hunt's (1990) paradigm. Midazolam is a safe, fast-acting benzodiazepine that induces a dense anterograde amnesia while leaving components of implicit memory performance intact. Our results replicate Toth and Hunt's (1990) finding of a generation effect in perceptual identification and demonstrate that this effect is not diminished by midazolam, even though midazolam induces dense amnesia in cued and free recall.

#### 9:45–9:55 (126)

**Triazolam and False Recognition.** MIRIAM Z. MINTZER & ROLAND R. GRIFFITHS, *Johns Hopkins University*—Following repeated exposure to study lists, healthy subjects exhibit reduced false recognition rates to nonstudied words that are associatively related to studied words, suggesting that they use their increased memory for item-specific information following repeated exposure to suppress false recognition. In contrast, Korsakoff amnesics exhibit increased false recognition rates following repeated exposure, suggesting that they rely primarily on memory for general semantic or gist information. In the present placebo-controlled study, effects of the benzodiazepine sedative-hypnotic triazolam (.25 mg/70 kg) on false recognition suppression were examined. Results revealed a significant interaction such that following repeated exposure to study lists, subjects exhibited decreased false recognition rates in the placebo condition but increased rates in the triazolam condition. These results suggest that under triazolam conditions, subjects rely primarily on memory for general semantic information, and support the usefulness of triazolam as a tool to study normal/abnormal memory processes.

### MEMORY PHENOMENA AND PROSPECTIVE MEMORY Westside, Friday Morning, 8:00–9:55

*Chaired by Steven M. Smith, Texas A&M University*

#### 8:00–8:15 (127)

**Generation and Hypermnnesia.** NEIL W. MULLIGAN & ALAN S. BROWN, *Southern Methodist University*—Generation effects often occur in within-subjects but not between-subjects designs, a pattern attributed (at least partly) to enhanced item-specific processing and disrupted order/relational processing in the generate condition. We investigate this hypothesis by examining the effects of generation over multiple recall tests, conditions that sometimes foster hypermnnesia (increased recall over multiple tests). The components of hypermnnesia, item gains and losses across tests, have been used to examine differential item-specific and relational encoding. It is hypothesized that

increased item-specific encoding leads to more item gains, whereas enhanced relational encoding leads to fewer item losses. In two experiments, subjects generated and/or read words at encoding. Five recall tests followed. In both experiments, the generate but not the read condition produced hypermnnesia. In addition, generation led to both more gains and losses. Finally, in the between-subjects design, a generation effect, which was not present on the first recall test, emerged in later tests.

#### 8:20–8:35 (128)

**Hypermnnesia, Reminiscence, and Forgetting Within a Face-Name Learning Paradigm.** LOWELL D. GRONINGER & KENNETH N. MURRAY, *University of Maryland, Baltimore County*—Two experiments were performed wherein subjects saw 24 students introduce themselves, using surnames, on videotape at a 20-sec per name rate. Subjects were then tested twice at that rate with a 20-min interval between the two tests. During testing, the videotaped faces served as cues for the attempted retrieval of names using recognition memory in Experiment 1 and cued recall in Experiment 2. Experiment 1 varied processing times for the testing conditions; Experiment 2 varied the type of activity that occurred during the interpolation period. The five types of activity involved a control and playing "memory" with either faces (same as or different from target) or names (same as or different from target). The results showed significant hypermnnesia effects using both recognition memory and cued-recall measures. Within the cued-recall measures, forgetting was small and consistent, while reminiscence was significant in all conditions, with the largest effect coming from the same name condition.

#### 8:40–8:55 (129)

**Von Restorff Revisited: Isolation, Generation, and Memory of Order.** MATTHEW R. KELLEY & JAMES S. NAIRNE, *Purdue University* (read by James S. Nairne)—The effects of isolation and generation on memory for order were investigated in four experiments. Experiments 1 and 2 demonstrate that isolation enhances, rather than disrupts, memory for order. Experiments 3 and 4 show that generation can enhance, disrupt, or have no effect on memory for order, depending on the relative number of generation items appearing within a list. These results have implications for theories of order and position as well as for accounts of isolation and distinctiveness.

#### 9:00–9:10 (130)

**Personality and the von Restorff Isolation Effect.** RICHARD S. CIMBALO & ALEXANDER MATAYEV, *Daemen College*—Individual differences are explored in a short-term memory task involving the free recall of a 10-item list of consonants with (isolated) and without (unisolated) a distinctively larger item in the fifth position. Twenty-four college students were given a test of introversion/extroversion and of sensation seeking. Generally, unisolated lists are remembered better and the larger letter is remembered better [the isolation effect (IE)], but the latter occurs only at the shorter duration (2 vs. 8 sec). Personality variables showed no effect on overall list performance. However, the strongest IE occurred for introverted low sensation seekers. The historical effect of the isolated item on overall list performance presents a rather confusing theoretical picture. Performance on the isolate itself seems best explained as a perceptual process that is affected by one's personality.

#### 9:15–9:35 (131)

**Pro- and Retrospective Memory.** BOB UTTL & PETER GRAF, *University of British Columbia*—Prospective memory (ProM) tasks require retrieval of target information in response to cues, in the absence of task-relevant instructions given at the time of testing; ProM tasks are difficult because the cues for retrieval usually appear as a natural part of other tasks or situations. In a series of experiments with university students, we developed a new method for assessing ProM task performance, and we used it to examine questions such as: How is ProM performance affected by cue distinctiveness and study-test delay manipu-

lations? What is the nature of its relationship to explicit episodic memory (RetM) task performance, and to various indexes of processing resources? The results show that the manipulated variables have different effects on ProM and RetM task performance, and multivariate analyses point to distinct processing components in ProM and RetM.

9:40–9:50 (132)

**Prospective Remembering of Korsakoffs as a Function of the Ongoing Task.** GÉRY D'YDEWALLE & ELS BRUNFAUT, *University of Leuven*—Since Korsakoff patients are known to suffer from a general cerebral atrophy and a frontal lobe atrophy in particular, they are expected to show considerably impaired prospective memory. In three experiments, the availability of a reminder and the degree to which the ongoing and the prospective-memory tasks share the same type of processing (superficial/semantic) were manipulated. When the processing nature of the ongoing task differs from the one of the prospective-memory task, Korsakoff patients performed worse than nonamnestic alcoholics; however, when the performance in the ongoing task prompted the required responses for the prospective-memory task, Korsakoff patients greatly improved their prospective remembering to reach the performance level of nonamnestic. Although some former studies have illustrated a negative tradeoff between performance in the ongoing and prospective-memory tasks, the current study shows that the nature of the ongoing task can also positively affect prospective remembering.

#### PSYCHOLINGUISTICS: METAPHORS AND READING Century, Friday Morning, 8:00–10:05

Chaired by Albert N. Katz, *University of Western Ontario*

8:00–8:15 (133)

**Inhibition of the Literal: Figurative Expressions as Judgmental Primes.** ADAM D. GALINSKY, *Northwestern University*, & SAM GLUCKSBERG, *Princeton University* (read by Sam Glucksberg)—When people understand metaphors, irrelevant literal information is inhibited and only metaphor-relevant information is activated and retained. When metaphors or idioms are used as primes in a person perception context, are relevant and irrelevant properties analogously differentiated? In Experiment 1, participants read the word “fire” in one of three contexts: a figurative use that implied recklessness (“playing with fire”), a figurative use referring to a hot streak (“on fire”), or a literal use (“played by the fire”). Differential priming effects were obtained in a subsequent person perception task that were consistent with the context-appropriate meanings of the priming expression. In Experiment 2, a conventional idiom, “break a leg,” produced divergent priming effects when used idiomatically than when used literally, suggesting active inhibition of irrelevant literal meanings. Experiments 3 and 4 provided further support for the role of inhibitory processes in metaphor and idiom comprehension.

8:20–8:35 (134)

**Word Metaphors as Generative Domain Mappings.** DEDRE GENTNER, *Northwestern University*, & CONSUELO B. BORONAT, *University of Illinois, Urbana*—Participants were timed as they read passages containing extended metaphors between domains. The final metaphor (which was always the same) was from either the same base domain or a different base domain as the preceding passage. For example, the final sentence “Her mind was too dulled with fatigue for her to think well” could follow either a *mind as blade* passage (consistent mapping) or a *mind as machine* passage (inconsistent mapping). Both passages conveyed the same meaning in the target domain. For novel metaphors, but not conventional metaphors, there was a metaphor consistency effect: Participants were slower to read the last sentence when the metaphor shifted. These results are consistent with the *career of metaphor* proposal (Bowdle & Gentner, 1995; Gentner & Wolff, 1997) that novel metaphors are processed as mappings be-

tween domains, but conventional metaphors are processed by accessing stored metaphoric senses.

8:40–8:55 (135)

**The Comprehension of Metaphorical Descriptions Using Color Names.** CRISTINA CACCIARI, *University of Modena*, & MANFREDO MASSIRONI, *University of Verona*—Many metaphors use the perceptual properties of events and things that surround us for giving names to mental contents. In a set of experiments, subjects were presented with short excerpts from a Virginia Woolf novel (*The Waves*) that contained a color label (e.g., yellow, red) used metaphorically to refer to a character's subjective experience. We used a variety of different tasks to determine whether during the comprehension processes of these metaphors the subjects indeed used the perceptual information provided by the specific color mentioned in the text or relied mostly on the abstract-conceptual representation that we associate with color labels. Results are discussed in a framework according to which one of the main functions played by metaphor is to provide a way to fill the gap between the complexity of the perceptual world and the limitations of our literal repertoire to mean it.

9:00–9:10 (136)

**Evidence for a Late-Occurring Effect of Phoneme Repetition During Silence Reading.** SHELIA M. KENNISON, JESSICA P. SIECK, & KIMBERLEY A. BRIESCH, *University of Oklahoma* (sponsored by Art Glenberg)—Two reading experiments were conducted to investigate the effect of phoneme repetition during silent reading (also referred to as the visual tongue-twister effect, see McCutchen & Perfetti, 1982; Perfetti & McCutchen, 1982) in conjunction with end-of-clause and end-of-sentence wrap-up effects (Just & Carpenter, 1982; Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). In both experiments, reading time was measured on sentences containing either six or zero words sharing the same initial phoneme. Sentences were presented in a phrase-by-phrase moving window, with each phrase either containing one word that involved a repeated phoneme or a matched word not involving a repeated phoneme. The sixth presentation region either contained or did not contain a comma (Experiment 1) or a period (Experiment 2). The results showed that the effect of phoneme repetition occurred relatively late during sentence processing, only after integration processing related to end-of-clause and end-of-sentence wrap-up occurred.

9:15–9:35 (137)

**Long-Term Working Memory: A Frequency Effect on Retrieval Time During Reading.** GUY DENHIÈRE & CÉDRICK BELLISSENS, *CNRS and Université de Provence*—Bellissens and Denhière (submitted) showed that semantic retrieval cues can be used during reading to readily retrieve encoded information from long-term working memory (Ericsson & Kintsch, 1995). We assume that if readers hold knowledge on the read words' meaning, they should use this knowledge to encode retrieval structure during reading in long-term working memory. A reading interruption procedure was used. In a first experiment, reading time was free. Texts were presented in two versions according to frequency of the words (high or low). Comprehension questions were manipulated. In a second experiment, the same procedure was used but the sentence presentation was time-limited. Sentences reading times, and answers to comprehension questions, led us to conclude that (1) encoded information can be readily retrieved from long-term memory upon reading resumption, and (2) frequency manipulation has an effect on the encoded information generalization and on retrieval time from long-term memory during reading.

9:40–10:00 (138)

**Visually Based Developmental Reading Deficit: Implications for Normal Cognition and Developmental Dyslexia.** MICHAEL MCCLOSKEY & BRENDA C. RAPP, *Johns Hopkins University*—A.H., a university student with a developmental deficit in perceiving the location and orientation of visual stimuli, presented with apparently

normal reading of connected text. However, testing revealed severely impaired performance in reading aloud isolated words (e.g., *dear* → “pear”; *snail* → “nails”) and sequences of unrelated words (e.g., *pouch cedar culture jacket* → “cedar pouch jacket culture”). Experiments manipulating visual presentation conditions convincingly linked A.H.’s impaired reading performance to her deficit in visual location/orientation perception. Additional experiments demonstrated that A.H. achieves good comprehension for meaningful material by exploiting knowledge-based constraints (e.g., syntactic constraints) to “repair” the errors introduced by her visual system. These findings have implications for research on developmental dyslexia, normal reading, and the organization of the normal visual system.

**ATTENTION: VISUAL SEARCH**  
**Pacific Palisades, Friday Morning, 10:00–11:45**

*Chaired by Arthur S. Reber, Brooklyn College, CUNY*

**10:00–10:20 (139)**

**Beware the Shadows! Preconstancy Information Can Influence Visual Search.** CATHLEEN M. MOORE & LIANA E. BROWN, *Pennsylvania State University*—Laboratory visual search tasks are analogues of real-life situations in which animals visually search their environment for interesting objects, such as mates, predators, and food. This functional interpretation suggests the hypothesis that search should be based on postconstancy representations—that is, ones in which accidental characteristics of the scene, such as shadows, point of view, and distance, have been discounted. We tested a specific version of this general hypothesis by addressing lightness constancy, the fact that surface lightness is perceived as relatively unchanged despite spurious changes in illumination and transparency conditions. Our experiments indicate that search is not always based on postconstancy representations. Instead, it was consistently influenced by the preconstancy (spurious) information in the displays. This finding suggests a dissociation between that which is phenomenologically experienced (i.e., perceived) and that which determines the allocation of attention within a scene.

**10:25–10:45 (140)**

**Electrophysiological Evidence for Serial Scanning in Visual Search.** STEVEN J. LUCK & GEOFFREY F. WOODMAN, *University of Iowa*—For many years, attention researchers have debated whether difficult visual search tasks involve serial shifts of attention among the search items or a limited-capacity parallel process that identifies all of the search items concurrently. To address this issue, we measured the moment-by-moment allocation of attention with the attention-related “N2pc” component of the event-related potential waveform. The N2pc component is more negative at electrode sites contralateral to the current focus of attention, and rapid shifts of attention between search items in the left and right visual fields should therefore be accompanied by rapid shifts of the N2pc between the right and left hemispheres. In accord with this prediction, the N2pc was found to shift between items in the left and right hemispheres with a dwell time of approximately 100 msec. These results support serial models of visual search and are inconsistent with most limited-capacity parallel models of search.

**10:50–11:05 (141)**

**The Grasping Eye.** HAROLD BEKKERING & BAS NEGGERS, *Max Planck Institute for Psychological Research, Munich*—There is accumulating evidence that the selection of one target among a number of distractors (other objects) is not only based on the relative saliency of elements in the search display, but that it is also partially determined in a top-down (also called goal-driven) fashion. In the present study, subjects either saccaded or saccaded and grasped a target among distractors. Fewer saccades to the wrong object shape were made in the saccade-and-grasping condition compared with the saccade-

only condition, whereas object color was not influenced by task condition. This dissociation might reflect the notion that shape, but not color, is an important feature for preparing grasping, since grasping trajectories are known to be influenced by object features such as orientation and shape. Importantly, saccadic reaction times were not significantly different over task conditions. Observers apparently utilize task-related information during saccadic target selection.

**11:10–11:25 (142)**

**Top-Down Attentional Guidance Based on Implicit Learning of Visual Covariation.** MARVIN M. CHUN, *Vanderbilt University*, & YUHONG JIANG, *Yale University*—The visual environment is extremely rich and complex, producing information overload for the visual system. But the environment also embodies structure in the form of redundancies and regularities that may serve to reduce complexity. How do perceivers internalize this complex informational structure? We present new evidence of visual learning that illustrates how observers learn how objects and events covary in the visual world. This information serves to guide visual processes such as object recognition and search. Our first experiment demonstrates that search and object recognition are facilitated by learned associations (covariation) between novel visual shapes. Our second experiment shows that regularities in dynamic visual environments can also be learned to guide search behavior. In both experiments, learning occurred incidentally and the memory representations were implicit. These experiments show how top-down visual knowledge, acquired through implicit learning, constrains what to expect and guides where to attend and look.

**11:30–11:40 (143)**

**Guided Search 3.5: A Bottom-Up Fix for What Found Found.** JEREMY M. WOLFE, *Harvard Medical School and Brigham and Women’s Hospital*—In Guided Search 2.0 (GS2) and several other models of visual search, attention can be attracted to salient items in a bottom-up, stimulus-driven manner and to task-relevant items in a top-down, user-driven manner. In GS2, bottom-up guidance is derived from local differences computed separately for various preattentive features (color, size, etc.). Top-down guidance is based on categorical knowledge of target properties (“red,” “tilted,” etc.). A recent experiment by Andrew Found (*P&P*, 1998, Vol. 6) contradicts predictions of GS2. His subjects performed two color × orientation conjunction searches. In one, an irrelevant size feature was correlated with color and orientation. In the other, it was uncorrelated. In GS2, correlation of irrelevant features should not affect search. However, even though size information was uninformative, the correlated condition was more efficient. We replicated and extended this finding. A minor modification to GS2 (now GS3.5) can account for this finding without requiring parallel processing of conjunctions.

**ANIMAL COGNITION**  
**Plaza, Friday Morning, 10:15–11:45**

*Chaired by Karen L. Hollis, Mount Holyoke College*

**10:15–10:35 (144)**

**Is the Rat an Ideal Detector of Changes in Rate of Reward?** C. R. GALLISTEL & TERRENCE A. MARK, *UCLA*, & ADAM KING, *Fairfield University*—Rats responding for brain stimulation reward on concurrent VI schedules adjust their time allocation to changes in the relative rates of reward abruptly and completely when they experience such changes frequently. The evidence for a change in behavior rises along with the evidence for a change in the rates of reward. Thus, the rat adjusts to changes in rates of reward as fast as it is, in principle, possible to do so. This is further evidence that matching behavior is unconditioned behavior (Heyman, 1982). It is not produced by the law of effect—that is, not by a feedback process in which differential reward differentially strengthens behavior patterns. The locus of learning for this operant is in the subject’s knowledge of rates of reward (its

representation of the stimulus situation), not in the mapping from the subject's representation of the stimulus situation to the optimal pattern of behavior.

#### 10:40–10:55 (145)

**Control of Spatial Choice by a Checkerboard Pattern.** CHRISTINE A. ZEILER & MICHAEL F. BROWN, *Villanova University* (read by Michael F. Brown)—Rats searched for sucrose pellets hidden on top of 15.5-cm-tall poles, in a  $4 \times 4$  matrix of poles. One of two complementary sets of eight poles was baited on each trial. The sets consisted of every other pole being baited, so that there was a “checkerboard” pattern of baited and unbaited poles. The data showed that choice behavior came under the control of this spatial pattern. Results from probe trials, in which various pole-to-pole moves were prevented, indicate that the results cannot be explained in terms of learning a stereotypic response. Therefore, the results are best interpreted in terms of spatial pattern learning. These data contribute to a growing body of evidence from our laboratory indicating that choice behavior can be controlled by the spatial pattern of hidden food items.

#### 11:00–11:15 (146)

**Where's That Other Shoe? A Comparative Study of Visuospatial Memory.** DAVID A. WASHBURN & JONATHAN P. GULLEDGE, *Georgia State University*, & BRIDGETTE A. MARTIN, *Furman University*—A familiar memory game, in which one flips pairs of cards in the attempt to locate matching pictures, has proved to be a useful test of visuospatial memory for children, young adults, and aged adults. Previously, we reported preliminary data from rhesus monkeys using a computerized version of this memory game. The monkeys readily learned the task, but tended to perseverate on certain errors such that performance was not only significantly worse than that characteristic of humans, but also was frequently worse than chance! In the present paper, we report the results from tests of chimpanzees on this task, and discuss the findings from a series of experiments and simulations designed to elucidate the cognitive operations responsible for these species differences (i.e., the degree to which errors by monkeys, apes, and humans are caused by failures of visual memory, spatial memory, or executive functions such as response strategy).

#### 11:20–11:40 (147)

**Possible Representations of Serial Patterns in the T-Maze.** JEROME COHEN & ANN MARIE SIMPSON, *University of Windsor*—Rats learned two serial reinforcement sequences in a T-maze: R–R and R–N in Experiment 1 and R–N–R and R–R–N in Experiment 2. These sequences were either associated with specific arms for some rats (*associated serial patterns* group) or not associated for others (*non-associated serial patterns* group). Although all rats learned to run more slowly on the N run in a trial when a session contained only one sequence on every trial, only rats in the associated group could more completely transfer this performance to sessions containing both sequences over trials. Possible differences in the nature of the representation of these sequences between these two groups were examined by free-choice multiple runs trials following forced-choice acquisition and testing. Data from these free-choice tests indicate that rats in the associated group acquired “chunked” representations, whereas rats in the nonassociated group acquired sequential rule-based representations of these reward patterns.

### PSYCHOPHYSICS II

Santa Monica, Friday Morning, 10:15–12:15

Chaired by J. Scott Jordan, *Saint Xavier University*

#### 10:15–10:35 (148)

**A Constant Effect of Stimulus Contrast Across Very Different Stimulus–Task Combinations.** ERIN M. HARLEY & GEOFFREY R. LOFTUS, *University of Washington* (read by Geoffrey R. Loftus)—

Processing visually degraded stimuli is a common experience: We struggle to find house keys on dim front porches, to decipher slides projected in bright seminar rooms, or to read bad photocopies of bad photocopies. This research addresses two questions: Why is it difficult to process degraded compared with undegraded stimuli, and is the cause of the difficulty the same (qualitatively and quantitatively) for two quite different stimulus–task combinations? In parallel experiments, we measured recognition of randomly generated forms and recall of four-digit strings. Stimuli were presented at two contrast levels combined with seven exposure durations. Lowering contrast slowed processing by a factor that was virtually identical for the two tasks and whose magnitude was about 1.5 times the ratio of the two contrast levels. We suggest that lowering contrast exerts a simple, universal effect that is usually confined to early perceptual processes and is thus indifferent to stimulus type and task.

#### 10:40–10:55 (149)

**Perceiving Roughness Via a Rigid Probe: Exploration Speed and Mode of Touch.** SUSAN J. LEDERMAN, *Queen's University*, ROBERTA KLATZKY, *Carnegie Mellon University*, & CHERYL HAMILTON & GILLIAN RAMSAY, *Queen's University*—The current research focuses on the exploration and perception of surface roughness via a rigid probe. We report the results of two experiments that considered the psychophysical consequences for roughness perception of altering the speed of motion. Two ranges of speed were employed: a 10-fold change (Experiment 1) and a 4-fold change (Experiment 2). Relative motion was altered by moving both the probe actively over a stationary surface (active mode) and the surfaces under the stationary probe (passive mode). Substantial effects of speed were obtained. The results are examined both in terms of the complex effects of speed on the attributes of the psychophysical roughness functions and in terms of the systematic change in the magnitude of the speed effect dependent on the size of speed range used. The results have implications for the use of haptic interfaces for teleoperation and virtual environment systems.

#### 11:00–11:15 (150)

**Judgment of Fit Predicts Identification of Tactile Pictures, Recognition Memory.** JOHN M. KENNEDY & JUAN BAI, *University of Toronto*—D'Angiulli, Kennedy, and Heller (1998) found blind and sighted children can identify objects in raised outline drawings. In addition, the children corrected themselves without feedback, which suggests subjects successfully assess how well their labels fit the tactile pictures. If so, we conjectured, judgments of fit should predict accuracy of identification. Further, a good fit should help successful recognition memory. Blindfolded college students participated in experiments with eight raised-line drawings of common objects. The results supported our conjectures. In Experiment 1, subjects tried to identify the object in the picture, and judged the fit between the object and their suggested label. In Experiment 2, subjects tried to identify the pictures, judged the fit as before, and then tried to recognize the pictures they had just explored, in the midst of distractors. As judged fit increased, so did the accuracy of identification and the likelihood of recognition.

#### 11:20–11:35 (151)

**The Weber Fraction Versus Perceived Similarity.** DONALD L. KING, *Howard University*—The Weber fraction type of discrimination result means that two high-magnitude objects are more difficult to discriminate than are two low-magnitude objects that differ by the same absolute amount. But both errors and response times indicated that a simultaneous same–different discrimination between two lines was not poorer when the lines were long than when they were short with absolute differences in length equated. Only the successive same–different discrimination between the two long lines was poor. This last discrimination also produced the poorest performance on *different* stimuli relative to *same* stimuli. Very similar outcomes occurred for objects high and low in luminance. A poor performance on *different* stimuli, relative to *same* stimuli, should indicate a high perceived sim-

ilarity. Therefore, physical magnitude and time (simultaneous vs. successive) were not consistently associated with discrimination performance, whereas perceived similarity was.

#### 11:40–11:55 (152)

**Isolating the Decision Stage Using Noise and Reverse Correlation.** STANLEY KLEIN & THOM CARNEY, *University of California, Berkeley*—Exotic mechanisms (filters) and interactions are sometimes introduced to explain discrimination data. We believe that simpler explanations in terms of plausible decision rules are preferable. We can isolate decision-stage properties by detecting patterns with noise masking. Our test and mask are limited to the first nine harmonics of a one-dimensional sinusoidal luminance grating. The mask consisted of all nine harmonics with random amplitude and random phase. The test consisted of structured combinations of the nine harmonics. We carried out two types of analysis: (1) An ideal observer analysis showed that, for a wide range of stimulus conditions, humans' thresholds were low, less than twice the ideal observer's threshold. (2) A linear regression improvement on a reverse correlation technique keeps track of trial-by-trial information about the noise, allowing determination of what stimulus features contribute to detection. We found that the decision template is quite flexible.

#### 12:00–12:10 (153)

**Response Correlation Functions From Multiple Sensor Models.** ALBERT J. AHUMADA, JR., *NASA Ames Research Center*; & BETTINA L. BEARD, *San Jose State University*—Analyses of the noises on individual trials of a yes/no signal detection task can provide information about the features of the stimulus that the observer is using to detect the signal. If the observer is using a linear classifier to make the yes/no decision, correlating the noises with the observer responses on either the signal-present or signal-absent trials can provide estimates of the relative weights of the classifier. Using analyses and simulations, we have investigated the question of what these correlation functions should look like when the observer has multiple linear features that are combined in a nonlinear way to form the decision. Examples will be shown for the visual detection of Gabor targets using Gabor sensors with physiologically plausible receptive fields, where data and theory can be compared.

### MEMORY FOR COMPLEX STIMULI Beverly Hills, Friday Morning, 10:10–12:05

*Chaired by Charles J. Brainerd, University of Arizona*

#### 10:10–10:25 (154)

**Subjective Organization and Recollection of Faces.** JAMES C. BARTLETT & GERALD A. EPLING, *University of Texas, Dallas*—Research conducted over 20 years ago suggests a recall-like process is involved in recognition, and that this process is improved by organization at study. Yet, recent studies of the experience of “remembering” in recognition memory have ignored the factor of organization. In a study of recognition memory for faces, we tested the hypothesis that the experience of remembering is linked to prior organization, though only if a stable organization is achieved. In support of this hypothesis, a study task requiring subjects to sort faces into subjective categories produced more recognitions with reports of “remembering,” and fewer recognitions with reports of just “knowing,” than a task of sorting faces by perceptual distinctiveness. However, the effect occurred only with three learning trials; it was absent or reversed with only one learning trial (cf. Mäntylä, 1997). The findings clarify the roles of organization and distinctiveness in the subjective experience of remembering faces.

#### 10:30–10:45 (155)

**The Role of Distinctiveness in Models of Face Recognition and Metacognition.** THOMAS A. BUSEY & ANNE D. ARICI, *Indiana*

*University*—Distinctive target faces are often easily recognized and distinctive distractors are easily rejected in face recognition paradigms. In this talk we describe how the role of distinctiveness may change over time, and how it may differentially affect recognition processes such as familiarity and recollection. These processes can in turn produce dissociations of confidence and accuracy in recognition and forced-choice tasks. Implications for models of face recognition and eyewitness identification are discussed.

#### 10:50–11:05 (156)

**The Effect of Repeated Photo Identification on Memory for a Face.** MAKIKO NAKA, *Chiba University*; YUKIO ITSUKUSHIMA, *Nihon University*; YUJI ITOH, *Keio University*; & SATOSHI HARA, *Surugadai University*—In a historically well-known case of Teigin Jiken (the case of Imperial Bank), the eyewitnesses were presented with a large number of photos and were asked repeatedly whether they could identify a suspect, before they finally identified one. In this paper, by partially modeling after Teigin Jiken, we examined the effect of repeated photo identification on the accuracy of memory (the final identification), and the subjects' ratings of the state of memory and confidence. Two hundred and seventy-one undergraduate subjects participated in a staged event followed by a delay (30 min to 5 months) with or without repeated attempts of photo identification, and then the final photo identification or confrontation. The results showed that the subjects who attended the repeated photo identification were less accurate in the final photo identification and confrontation, and their ratings of the state of memory and confidence did not reflect the accuracy.

#### 11:10–11:25 (157)

**Effects of Number of Intervening Study Items on Memory Conjunction Errors.** MARK TIPPENS REINITZ, *University of Puget Sound*; & SHARON L. HANNIGAN, *Boston University*—We tested whether false alarms to conjunction stimuli (constructed by combining parts of separately studied items) in a recognition test decrease as the temporal distance on the study list between the parent items increases. Experiment 1 subjects studied a series of face pairs; within-pair faces were presented simultaneously, with one just above and one just below fixation. There was a strong proximity effect for conjunction stimuli on the subsequent recognition test, with the most false alarms for within-pair conjunction faces. Experiment 2 was the same as Experiment 1 except that the second face in each study pair was presented immediately following the offset of the first face (sequential, rather than simultaneous, presentation). There was no evidence for proximity effects, and there was a reliable experiment by test-condition interaction. A new theory incorporating both familiarity and recollection processes is used to explain these and previously obtained results.

#### 11:30–11:45 (158)

**On the Other Side of the Mean: Perceiving the Dissimilarity of Faces.** ALICE J. O'TOOLE, *University of Texas, Dallas*; VOLKER BLANZ & THOMAS VETTER, *Max Planck Institute for Biological Cybernetics*; & HEATHER A. WILD, *University of Texas, Dallas*—We created a “face space” using a laser scan representation of faces. In this space, a caricature can be made by moving a face away from the average, along the line connecting it to the average. If we go in the other direction, we can move the face through the mean and out the other side. We call the result of this process an “antiface” because it is an opposite, in a computational sense, to the original face. We morphed faces into their antifaces and sampled the transition in five discrete steps. We then collected similarity ratings for all possible pairs of morphed faces. The data revealed a perceptual discontinuity of face identity as the face crosses over to the other side of the mean. We consider these results in the context of face space models of human face processing.

#### 11:50–12:00 (159)

**Mediating Aircraft Identification by Manipulating Distinctiveness, Stimulus Similarity, and Learning Presentations.** ITIEL E. DROR,

*Southampton University*, ALAN R. S. ASHWORTH, *Air Force Research Laboratory*, & SARAH STEVENAGE, *Southampton University*—Relatively similar and relatively dissimilar aircraft were studied at canonical or noncanonical orientations. Half of the participants studied images of the original aircraft; the other half studied morphed images that enhanced the distinctiveness of each aircraft. At test, participants were required to identify the aircraft in a variety of novel orientations. All conditions were fully counterbalanced. The relatively similar aircraft were more difficult to learn than the relatively dissimilar ones, but both were easier to learn when aircraft distinctiveness was enhanced. During testing on the novel orientations, the similar aircraft were harder to identify than the dissimilar ones. The canonical presentation during learning affected performance during testing on novel orientation, but this effect disappeared when the images with enhanced distinctiveness were used during learning. The results are discussed in terms of object identification, aircraft recognition training, categorization, learning, and mental representations.

### METACOGNITION

Westside, Friday Morning, 10:05–12:05

Chaired by James Erickson, *University of Texas, Arlington*

10:05–10:20 (160)

**The Phenomenology of Naturally Occurring Tip-of-the-Tongue States.** BENNETT L. SCHWARTZ, *Florida International University*—The tip-of-the-tongue state (TOT) is the phenomenological experience that a word is on the verge of being recalled. Although the information accessible during a TOT has been extensively studied, there has been little research delineating phenomenological characteristics of the TOT. The current study employed a diary methodology to examine TOT phenomenology. Participants recorded phenomenological and objective characteristics of natural TOTs over a four-week period. Rememberers averaged 5.1 TOTs over the four-week period. Nearly 90% of TOTs were resolved (eventually retrieved), and most TOTs were for proper nouns. Spontaneous retrieval was the most reported method of resolution, suggesting that target words' representations were temporarily blocked. Strength, emotionality, and imminence of TOTs were correlated with each other. However, high emotionality was often associated with failed resolution, whereas imminence positively predicted resolution. These data suggest that the TOT is a multidimensional mental experience reflecting both word retrieval and metacognitive processing.

10:25–10:45 (161)

**The Role of Metacognition in Study-Time Allocation.** JANET METCALFE & LISA SON, *Columbia University*—The role of meta-knowledge in people's active control over their own learning—potentially freeing them from being mere passive recipients of the events impinging on them from the world—is one of the most important, but also most neglected, areas of human cognition. The question investigated here concerns the nature of the relation between people's metacognitions and their study-time allocation. The 19 studies (including 46 experimental conditions) reported in the literature indicate that people allocate their study time to items judged to be most difficult. In contrast, we present evidence from three experiments exploring the contingencies affecting metacognitively guided study-time allocation that people sometimes devote their time, not to the difficult items, but to items judged to be easy. Both overall study-time constraints and test expectations are crucial. We suggest that people may be attempting to optimize learning as a function of the particular constraints of the situation.

10:50–11:05 (162)

**Metacognitive Processes in Eyewitness Memory.** MARK R. PHILLIPS, RONALD P. FISHER, & MARIA KRIOUKOVA, *Florida*

*International University* (read by Ronald P. Fisher)—College students witnessed a videotaped crime simulation and shortly thereafter attempted to describe the major components of the crime (perpetrators, car, actions). The witnesses were instructed to use either a stringent (answer only if certain) or a lenient (answer even if uncertain) output criterion. These instructions affected accuracy of recollection, but only to closed-ended questions; there was no effect on open-ended questions. The relationship between confidence and accuracy also differed between closed- and open-ended questions. We discuss some of the differences between the mental processes when answering closed- and open-ended questions.

11:10–11:25 (163)

**Judgments of Learning Exhibit Increased Underconfidence With Practice.** ASHER KORIAT, LIMOR SHEFFER, & HILIT MA'AYAN, *University of Haifa*—When participants are presented with the same list of paired-associates for several study–test blocks, their judgments of learning (JOLs) exhibit relatively good calibration on the first block, with a tendency toward overconfidence. However, a shift toward marked underconfidence occurs from the second block on. This underconfidence-with-practice effect (UWP) was found to be very robust across several experimental manipulations, such as self-paced versus fixed presentation, feedback or no feedback regarding the correctness of the answer, and different incentives for correct performance. The UWP effect was observed in both item-by-item JOLs and in aggregate JOLs. Possible explanations for this counterintuitive effect will be examined.

11:30–11:40 (164)

**What Is the Basis for Judgments of Learning (JOLs) for Recallable Items?** THOMAS O. NELSON & PETRA SHECK, *University of Maryland*, JOHN DUNLOSKY, *University of North Carolina, Greensboro*, & LOUIS NARENS, *University of California, Irvine*—Previous research has suggested that one basis for JOLs is whether the target is retrievable or nonretrievable at the time of the JOL. What is the basis for JOLs when discriminating between only items that are retrievable at the time of the JOLs? One hypothesis is that these JOLs are based (at least in part) on the latency of retrieval at the time of the JOL. Subjects attempted to recall the target immediately prior to making the JOL (“pre-JOL recall”), with JOLs occurring either immediately after studying the item or after a delay. Although the inverse relationship between the latency of pre-JOL recall and the magnitude of JOL was nearly negligible when the JOLs were made immediately after study, the inverse relationship increased when the JOLs were delayed. Thus the latency of retrieval may serve as one basis for delayed JOLs but apparently is negligible as a basis for immediate JOLs.

11:45–12:00 (165)

**Dissociation of Monitoring and Control Processes Under the Effect of Lorazepam.** ELIZABETH BACON, *INSERM*, & MARILYNE MASSIN-KRAUSS & JEAN-NAIVE DANION, *University of Strasbourg*—The effects of a single dose of the benzodiazepine lorazepam (0.038 mg/kg) on monitoring and control were investigated in healthy volunteers. We investigated the subject's ability to take into account an external incentive by studying two processes: the monitoring process, which assesses the correctness of potential memory responses, and the control process, which determines whether to volunteer or withhold the best available candidate answer. The results confirm the deleterious effect of lorazepam on semantic memory. Both lorazepam and placebo subjects were able to improve their accuracy, from nonincentive to moderate incentive condition, by taking into account the situational demands. Lorazepam impaired the monitoring process for the incorrect answers (confidence level), whereas the control process, evaluated by the response criterion (Prc), was preserved. The results suggest a relative independence of monitoring and control, since they may be differently affected by an amnesic drug.

**PSYCHOLINGUISTICS: COMPREHENSION**  
**Century, Friday Morning, 10:20–12:30**

*Chaired by Laurie Feldman, SUNY Albany & Haskins Laboratories*

**10:20–10:35 (166)**

**fMRI Evidence of the General Cognitive Processes Underlying Discourse Comprehension.** DAVID A. ROBERTSON & MORTON ANN GERNSBACHER, *University of Wisconsin, Madison* (read by Morton Ann Gernsbacher)—Traditional accounts of the brain regions supporting language functions have emphasized the role of language-specific modules in the left hemisphere. Three fMRI (functional magnetic resonance imaging) experiments from our lab seriously challenge this view. In the fMRI experiment to be reported, we measured brain activity while subjects comprehended written narratives, spoken narratives, and narratives told completely without words (i.e., picture stories). Reading or listening to narratives was alternated with reading or listening to independent, unrelated sentences; comprehending picture narratives was alternated with viewing independent, unrelated pictures. As we have observed before, the right hemisphere, rather than the left hemisphere, appears to be more involved in comprehending connected discourse. Moreover, similar neural circuitry is involved in the processing of language and nonlanguage narratives, suggesting that general cognitive processes underlie many aspects of discourse processing.

**10:40–10:55 (167)**

**When Is Conversational Collaboration Necessary for Accurate Comprehension?** MICHAEL F. SCHOBBER, *New School for Social Research*, & FREDERICK G. CONRAD, *Bureau of Labor Statistics*—The ability of speakers and addressees to interact has been proposed as central to comprehension, based on laboratory tasks. Here we manipulate the degree of conversational collaboration in survey interviews—how and when interviewers provide clarification. The survey domain allows us to examine more precisely how addressees' (survey respondents') conceptualizations of ordinary terms like "bedroom" or "job" match the conceptualizations of speakers (interviewers, as intermediaries for survey designers). In three studies, we demonstrate that noncollaborative interviews (in which interviewers leave the interpretation of survey terms entirely up to respondents) lead to poor comprehension when respondents' circumstances are nonprototypical, whereas more collaborative interviews lead to improved comprehension. But for some survey questions, under some circumstances, noncollaborative interviews can lead to excellent comprehension. Our data also show that respondents often don't know when their conceptualizations fail to match those of survey designers; leaving it up to respondents to ask for clarification may be insufficient.

**11:00–11:15 (168)**

**Grounding in Conversation Is Partner Independent.** BOAZ KEYSAR & DALE J. BARR, *University of Chicago*—As people converse, they often engage in a process of "grounding" in order to determine how an object is to be called. We used eyetracking techniques in a referential communication task to demonstrate that grounding confers an advantage on comprehension. As directors instructed their partners to move objects, they grounded referents as needed. Eye movements indicated that addressees identified grounded referents faster than nongrounded referents. This grounding advantage was greater when the word-referent relation was unconventional ("tent" referring to a folded paper) than conventional ("pen" referring to a pen). Surprisingly, this advantage was independent of whether the term had

originally been grounded with the same or a different partner. These results indicate that the grounding process does not involve common ground with a specific partner. Instead, we suggest that grounding reference benefits from a more general mechanism of language learning.

**11:20–11:40 (169)**

**Constructing Meaning: The Role of Affordances and Grammatical Constructions in Sentence Comprehension.** MICHAEL P. KASCHAK & ARTHUR M. GLENBERG, *University of Wisconsin, Madison* (read by Arthur M. Glenberg)—The indexical hypothesis is an embodied alternative to the abstract, amodal symbol theory of meaning common in cognitive science. According to the indexical hypothesis, meaning emerges when phrases are indexed to objects, affordances (how a person can interact with an object to accomplish a goal) are derived from the objects, and the affordances are integrated, or meshed, as guided by syntax. Here we examine how syntactic constructions (cf. Goldberg's *Construction Grammar*) guide the mesh of affordances. Our experiments demonstrate that (1) syntactic constructions convey scenes that guide the process of mesh, and (2) meaning emerges only when the syntactically guided mesh respects embodied constraints on action. Thus, the work helps us to understand how some novel sentences (e.g., "The newsboy porched the newspaper") make immediate sense, whereas other novel sentences (e.g., "The newsboy pillared/windowed/doorbelled the newspaper") do not.

**11:45–12:05 (170)**

**A New Tool for Measuring and Understanding Reading Comprehension Ability.** BRENDA HANNON & MEREDYTH DANEMAN, *University of Toronto, Mississauga* (read by Meredyth Daneman)—We propose a new individual-differences tool that provides estimates of a reader's ability to access and integrate long-term memory knowledge with text information, to make text-based inferences, and to recall text. This task is based on a rather simple but ingenious task developed by Potts and Peterson (1985). Our modified version of the task is easy to administer and accounts for a substantial proportion of the variance in performance of university students on a global, standardized test of reading comprehension ability. We describe four studies we conducted as part of the process of developing and validating the task, and we consider the potential applications of our task for advancing our understanding and measurement of reading comprehension ability and complex cognition.

**12:10–12:25 (171)**

**Inferring Complex Narrative Goal Structure.** MURRAY SINGER & ERIC D. RICHARDS, *University of Manitoba*—The study distinguished among competing analyses of narrative comprehension, including minimalist, resonance, and constructionist. Stories presented a complex goal structure, according to which two characters had to accomplish independent subgoals to achieve a superordinate goal. The stories had the form: introduction, Subgoal 1, Subgoal 2, target region, wrap-up. The first subgoal either succeeded or failed, and the second subgoal always succeeded. In the target region, the second character attempted to execute the superordinate goal. This region was locally coherent with the Subgoal 2 section, and included no surface overlap with the Subgoal 1 section. Converging measures of processing were obtained in the target region: When Subgoal 1 succeeded (as opposed to failed), reading time in the target region was longer, and the time to recognize a Subgoal 1 word was shorter. Consistent with a constructionist analysis, the results indicate that readers monitor narrative goal structure even in the absence of local coherence breaks and surface overlap.

## BRAIN FUNCTIONS

Pacific Palisades, Friday Afternoon, 1:00–2:45

Chaired by Anne P. Hillstrom, University of Texas, Arlington

1:00–1:15 (172)

**Recognition Memory in Amnesics: Familiarity-Based Access to Object Attributes.** KAVITHA SRINIVAS, *Boston College*, & MIEKE VERFAELLIE, *Boston University*—We examined whether amnesic patients retain individuating features of objects by investigating the effects of study–test orientation changes on recognition memory, object naming, and orientation discrimination. Amnesic subjects, like controls, were adversely affected by orientation changes in recognition memory but not object naming. This sensitivity to orientation in recognition occurred even when amnesic patients had poor recollection of studied orientation. The results therefore suggest that orientation effects in recognition are mediated by familiarity.

1:20–1:35 (173)

**The Neural Basis of Deduction.** LAWRENCE M. PARSONS, *University of Texas Health Science Center*; & DANIEL N. OSHERSON, *Rice University*—We used fMRI to localize brain areas responding to changes in logical complexity of a deduction in order to distinguish the primary mechanisms of deduction from other activated areas. Whole brain, 2-sec images were acquired of subjects reasoning for 22 sec about each of 24 three-sentence arguments. The arguments, based on the propositional calculus, were composed of logically simple and complex pairs, with each argument in a pair different in rated inferential difficulty but equal in linguistic complexity. Right hemispheric areas in middle temporal, middle frontal, and inferior frontal cortex, as well as right basal ganglia, were more active during complex than simple trials. Amygdala (right) was more active during simple than complex. The activity in these areas occurred subsequent to activation of left language areas, further implicating them in deduction. These findings replicate the right hemisphere primacy observed in our PET study for deduction contrasted with language comprehension control.

1:40–1:55 (174)

**Real-Life-Type Problem Solving After Anterior Brain Injury.** SHELLEY CHANNON, *University College London*—Clinical studies have described patients who show marked impairments in everyday life, including planning, problem solving, and decision making. Several factors potentially contribute to such impairments, including difficulties in generating possible problem solutions and difficulties in selecting an appropriate solution. Participants with unilateral anterior or posterior lesions were compared with healthy controls in ability to solve real-life-type problems, the “predicaments” test. The problems covered a range of everyday interpersonal situations, and were presented both in video and story format. Those with brain lesions showed impairment relative to controls in both everyday problem solving and on more abstract tests involving executive function and memory. The anterior group was impaired on more aspects of everyday problem solving than the posterior group, showing reduced fluency in generating possible solutions, and also impairment in selecting appropriate problem solutions. The implications for our understanding of impairments in everyday-life problem solving after brain injury are discussed.

2:00–2:15 (175)

**Hemispheric Strategy Differences Are Independent of Level of Performance.** JOSEPH B. HELLIGE, N. LEE MARKS, & ARPITA DOSHI, *University of Southern California*—Previous visual lateral-ity studies in which nonword consonant-vowel-consonant (CVC) tri-grams were presented briefly to the left visual field (LVF), right visual field (RVF), or to both visual fields simultaneously (BVF) have revealed that in English speakers, the right hemisphere relies on a sequential strategy, whereas the left hemisphere allocates attention more holistically. Although statistical corrections are invoked to normalize performance across the three visual field conditions, it remains pos-

sible that these qualitative results are at least partially an artifact of the difference in performance levels that results when exposure times for all three conditions are equal. The present experiment varied exposure times independently for the three visual field conditions in one group of trials and varied exposure times for all conditions equally in another group of trials. Qualitative performance was the same in both groups of trials, adding to the converging evidence that hemispheric strategy differences are resistant to changes in stimulus parameters.

2:20–2:40 (176)

**Electrophysiological Correlates of Recollection and Familiarity.** TIM CURRAN, *Case Western Reserve University*—It is widely hypothesized that separate recollection and familiarity processes contribute to recognition memory. The present research measured event-related brain potentials (ERPs) from 128 head locations to identify patterns of brain activity related to recollection and familiarity. In two experiments, subjects performed a recognition memory task requiring discrimination between previously studied words, similar words that changed plurality between study and test, and new words. An early, N400-like ERP component (300–500 msec) varied with the familiarity of words (new < studied = similar). A later, parietally positive component (400–800 msec) was associated with the recollection of plurality (studied > similar = new). ERP differences in timing and spatial topography suggest that these electrophysiological correlates of familiarity and recollection arise from distinct neurocognitive processes.

## ANIMAL LEARNING AND CONDITIONING I

Plaza, Friday Afternoon, 1:00–2:45

Chaired by P. A. Couvillon, University of Hawaii

1:00–1:15 (177)

**Can Spaced-Trial Instrumental Extinction in Rats and Pigeons Be Explained by the Same Processes?** STEVEN C. STOUT, BRIAN L. THOMAS, & MAURICIO R. PAPINI, *Texas Christian University* (read by Mauricio R. Papini)—Spaced-trial extinction (1 trial per day) of runway performance is slower after acquisition with either partial (rather than continuous) or small (rather than large) rewards in rats. Analogous runway experiments with pigeons produced similar results after partial reinforcement training, but extinction was slower after training with large (rather than small) reward. The same pattern of results was obtained when pigeons were trained in a spaced-trial, key-pecking situation and, surprisingly, also when rats received spaced-trial training in a leverpressing situation. Factors contributing to different patterns of spaced-trial instrumental extinction across species and situations will be discussed.

1:20–1:35 (178)

**How Magnitude of Competitive Reinforcement Determines Escape Conditioned Response Speed.** ROBERT FRANK WEISS, ROSEMARY ANN SCHULTZ, JOHN M. NOMURA, WESLEY H. DOTSON, & K. BROOKE SMITH, *University of Oklahoma*—People will learn an instrumental response, the reinforcement for which is the cessation of competition, and the strength of this escape conditioned response can be measured by its speed. Increasing the number of people who compete as individuals in “a war of all against all” is analogous to increasing the intensity of electric shock. We now report an experiment in which a reduction in the number of competitors reinforces an instrumental response. A parametric design with five levels of reduction (R) in the number of competitors resulted in an analogue of a magnitude of reinforcement curve ( $p = .0010$ ), which is nicely described by the negatively accelerated function:  $Speed = M(1 - 10^{-iR}) + d$ , ( $R^2 = .9425$ ). We also report an analogue of duration of the shock-free period and its effect.

1:40–1:55 (179)

**Visual Discrimination and Within-Session Changes in Responding.** JOHN M. HINSON, *Washington State University*, & LINDA R.

TENNISON, *St. John's University*—We examined the responding of pigeons within sessions during several successive discrimination procedures. Under training conditions that produced stable asymptotic discrimination between positive and negative stimuli, no significant within-session changes in responding occurred. Increasing the duration of the food magazine for each reinforcer led to greater amounts of food consumed per session and higher overall rates of responding to both positive and negative stimuli. These changes in overall responding occurred without significant within-session changes in responding. Decreasing the presentation probability of negative stimuli led to decreased relative discrimination between negative and positive stimuli. Presentation probability had no consistent effect on responding within sessions. These results confirm our earlier finding that within-session changes in responding do not ordinarily occur in discrimination training procedures. Moreover, the current findings suggest that when variables related to satiation are controlled, within-session changes in responding are absent.

**2:00–2:20 (180)**

**Latent Inhibition as a Deficit in US Processing.** BERNARD BALLEINE, *UCLA*—Nonreinforced exposure to a stimulus (e.g., a noise or a tone) subsequently retards the acquisition of conditioned responding to that stimulus in rats. This effect is controlled by primary motivation; exposure to a stimulus while hungry retards learning about its relation to food delivery but not its relation to a nonfood commodity such as saline. Here we report that exposing hungry rats to two serially presented stimuli, A and B, retarded learning about B's relation to food. Nevertheless, in a subsequent test, responding to A was selectively enhanced compared with appropriate controls. The motivational control of sensory preconditioning suggests that, during exposure, rats learn a relation between the preexposed stimulus and motivational state. In this view, latent inhibition constitutes an example of blocking; during conditioning the preexposed stimulus competes with the sensory properties (e.g., color, texture, taste) of the unconditioned stimulus for association with its biologically potent feature (i.e., its nutrients). Further evidence for this account will be described.

**2:25–2:40 (181)**

**Contrasting the Comparator Hypothesis With Acquisition-Focused Models of Retrospective Revaluation: Relative Validity.** AARON P. BLAISDELL, RALPH R. MILLER, & MARTHA ESCOBAR, *SUNY, Binghamton* (read by Ralph R. Miller)—The performance-focused comparator hypothesis and the acquisition-focused models of learning capable of retrospective revaluation predict similar changes in responding to a target CS as a consequence of posttraining revaluation of first-order comparator stimuli (i.e., stimuli possessing within-compound associations to the CS), but diverge concerning the consequences of posttraining revaluation of second-order comparator stimuli (i.e., stimuli possessing within-compound associations to first-order comparator stimuli). We used a relative stimulus validity preparation with rats to test these predictions and observed behavior consistent with cue competition arising from information processing at the time of testing. Following AX+/BX− training, massive extinction of A not only potentiated the excitatory value of X, but it gave B inhibitory value as evidenced in summation and retardation tests for conditioned inhibition.

**PERCEPTION AND REASONING**  
**Santa Monica, Friday Afternoon, 1:00–3:00**

*Chaired by Earl Hunt, University of Washington*

**1:00–1:10 (182)**

**Set Switching and Long-Term-Memory Retrieval.** ULRICH MAYR & REINHOLD KLIEGL, *University of Potsdam*—We tested the hypothesis that intentional processes involved in set switching are iden-

tical with set retrieval from long-term memory. We used a 4:2 mapping between task cues and task sets to dissociate costs associated with the change in retrieval path (cue-switch costs) from actual set-switch costs. Cue-switch costs were found to make up at least 50% of the total switch costs. Further, cue-switch costs but not set-switch costs were reduced through practice and eliminated for long preparatory intervals. Thus, much of traditional switch costs and possibly the entire preparatory switch component are associated with a change in retrieval path rather than with the actual change in set.

**1:15–1:30 (183)**

**Retrieval Interference Increases Adults' Reported Procedure Use for Simple Addition.** JAMIE I. D. CAMPBELL, JENNIFER C. TIMM, & SHANNON FUCHS, *University of Saskatchewan*—Simple addition (e.g., 3+2, 7+9) may be performed by direct memory retrieval or by procedures such as counting or transformation. The distribution of associations (DOA) model of simple arithmetic (Siegler, 1988) predicts that procedure use should increase if retrieval difficulty increases. To test this, 100 undergraduates performed simple addition problems and indicated their strategy on each trial. Prior to the addition task, half of the participants performed simple multiplication and half performed simple division problems. Addition RTs were longer following multiplication than following division. Addition errors also were more common following multiplication, an effect due to increased multiplication confusion errors on small addition problems (e.g., 3+2=6, 4+3=12). According to the DOA, greater interference for small problems should increase procedure use more for small than for large problems. Indeed, reported use of procedures for addition was greater following multiplication, especially for small addition problems.

**1:35–1:45 (184)**

**Division Before Multiplication—A Radical Proposal.** STEVEN H. SCHWARTZ, *University of Massachusetts, Boston*—The nearly universal model by which young children are taught multiplication is repeated addition. However, this model leads to difficulties in generalization for a majority of the population once fractions and decimals are introduced, since if multiplication is nothing more than repeated addition, how can one add positive things together and get less than one began with! There appears to be no simple verbs that are used to explain division (e.g., separate, break into parts, segment, etc.). Because such action on an object is so fundamental to human language and thought, and thus salient in children's thinking, this void creates far-reaching difficulties in developing a reasonable model of multiplication for the novice. We conclude by urging research that reverses the order by which students are introduced to these mathematical operations.

**1:50–2:05 (185)**

**Mental Comparisons With Family Trees.** CLAUDE G. ČECH, *University of Southwestern Louisiana*—How sensitive are mental comparisons to dimension-irrelevant information? People made mental comparisons using a tightly structured domain of items: a family tree. Two groups learned different four-generation family trees, and subsequently determined the relative ages of family members. *Generation* and *lineality* thus, respectively, represented the relevant and irrelevant dimensions. Both tree conditions displayed *distance effects*: Time to compare decreased as generational distance increased (including and excluding end anchors). Both trees also displayed *congruity effects*: People more rapidly chose the older rather than the younger of a relatively old pair, but there was no difference in instruction for comparisons involving the youngest generations. No interaction of congruity with tree approached significance. These findings authenticate the standard symbolic comparison results with complex family tree structures, and thus highlight the importance of an additional finding relevant to evaluating single-process models of comparison: Difficult comparisons took longer when they involved colineals.

2:10–2:20 (186)

**Representational Momentum and Michotte’s “Launching Effect” Paradigm.** TIMOTHY L. HUBBARD, SUSAN E. RUPPEL, & JESSICA A. BLESSUM, *Texas Christian University*—When a launcher (i.e., moving stimulus) contacts a target (i.e., stationary stimulus), and the launcher stops and the target begins moving in the direction of previous motion of the launcher, observers report the launcher “caused” the target to move; this has been called a “launching effect” (Michotte, 1963). When a moving stimulus vanishes without warning, memory for the position of that stimulus is displaced forward in the direction of motion; this has been called “representational momentum” (Freyd & Finke, 1984). The forward displacement of a launched target is decreased relative to the forward displacement of a target (1) presented in isolation, (2) moved in a direction different from previous motion of the launcher, or (3) moved in tandem with the launcher. We suggest that representational momentum of a launcher inhibits forward displacement of a launched target. Implications regarding the perception of causality and implicit physical knowledge are discussed.

2:25–2:40 (187)

**Does Language Shape Thought? Mandarin and English Speakers’ Conceptions of Time.** LERA BORODITSKY, *Stanford University* (sponsored by Roger N. Shepard)—Does the language you speak affect how you think about the world? This question is taken up in three experiments. English and Mandarin speakers talk about time differently. Is this difference reflected in the way they think about time? In Experiment 1, Mandarin–English bilinguals were compared with native English speakers. The results suggested that Mandarin speakers used a “Mandarin way of thinking” even when they were “thinking for English.” In Experiment 2, native English speakers were trained to talk about time in a “Mandarin way.” Even after a short training, native English speakers behaved more like Mandarin speakers than like untrained English speakers. Experiment 3 showed that the extent to which Mandarin–English bilinguals thought in Mandarin was related to how old they were when they first began to learn English. It is concluded that language can be a powerful tool in shaping thought.

2:45–2:55 (188)

**Out of Sight Is Out of Body: Spatial Updating During Imagined and Physical Self-Movement.** MARYJANE WRAGA, *Harvard University*—Updating an array of objects during imagined self-movement is optimal when accompanied by physical movement to the new perspective (e.g., Farrell & Robertson, 1998; Rieser, 1989). We tested whether this finding varies as a function of response measure. In Experiment 1, participants were given a target object in an array and asked to point to a second object from the target perspective. In the *imagined* condition, participants mentally turned to the target. In *aligned*, they were physically turned to the target. In *misaligned*, they were turned to a different target. As in previous studies, performance was best in *imagined* compared with *aligned* or *misaligned*. Experiment 2 tested the same updating conditions using a *verbal* response. Performance was best in *imagined* compared with *aligned* and *misaligned*. The latter finding may be explained by the fact that verbal responses do not anchor the observer to the physical body framework, as pointing responses do.

**FALSE MEMORY FOR WORDS**  
Beverly Hills, Friday Afternoon, 1:00–2:45

Chaired by Michael P. Toglia, *SUNY, Cortland*

1:00–1:15 (189)

**Category and List Structure in Primed False Recall.** STEVEN M. SMITH & DAVID P. GERKENS, *Texas A&M University*, CYNTHIA M. SIFONIS, *University of Illinois*, MERRYL J. WILKENFELD, *Texas A&M University*, DEBORAH R. TINDELL, *Wilkes University*, & BENTON H. PIERCE, *Texas A&M University*—In category cued recall, critical nonpresented category members are falsely recalled more often if they are incidentally primed. Primed false recall of high-output dom-

inance (common) category members was higher when studied lists contained high, rather than low-output dominance members. Low-output dominance items were not falsely recalled, regardless of the composition of studied lists. Thus, list structure affected false recall of common category members, but did not affect false recall of unusual members.

1:20–1:35 (190)

**Processing and Structure in the False Memory Illusion.** KATHARINE KRAUSE SHOBE, *Yale University*, & LILLIAN PARK, & JOHN F. KIHLMSTROM, *University of California, Berkeley* (read by John F. Kihlstrom)—Two experiments studied factors affecting the false memory illusion discovered by Deese and extended by Roediger and McDermott. Experiment 1 showed that both true and false recognition was higher from lists subject to “deep” semantic processing, compared with lists subject to “shallow” phonemic processing. Experiment 2 obtained essentially no false recognition of category labels (e.g., *\_fruit\_*) when study lists were composed of category exemplars (e.g., *\_apple\_*, *\_pear\_*). However, there was false recognition for other, unrepresented, category exemplars. In both experiments, false recognition was associated with recollective experiences of “remembering” more often than those of “knowing” or “feeling.” Nevertheless, false recognition was associated with lower levels of confidence than true recognition. False memory is not just a matter of associative strength, but also of the processing activities performed at encoding and of the type of association involved: horizontal (coordinate) versus vertical (subordinate).

1:40–2:00 (191)

**Is There Memory to Be Found in False Memory?** JAMES H. NEELY, JEFFREY D. JOHNSON, W. TRAMMEL NEILL, & KEITH A. HUTCHISON, *SUNY, Albany*—In the Deese/Roediger–McDermott false memory paradigm, we compared both hits and false alarms (FAs) for “critical” versus “list” items for intermixed related versus unrelated study lists given with or without a warning to subjects to avoid false memories. FAs for critical items were (1) similar to hits for list items and (2) considerably higher than FAs for list items, especially following related lists, replicating the standard false memory effect. The warning reduced FAs to the same degree in all conditions. Most important, *d'* was lower for critical items than for list items but to the same degree for related and unrelated lists. We discuss the implications these data have for using signal detection theory to delineate the concept of “false memory.”

2:05–2:25 (192)

**Dual Processes in Recall and False Memory.** CHARLES J. BRAINERD & R. WRIGHT, *University of Arizona*—In dual-process models of recognition, one retrieval operation is usually called “recall” or “recall-like.” Although this suggests that recall itself engages only a single retrieval operation, fuzzy-trace theory has posited two operations (direct access and reconstruction) to explain robust false recall effects and cognitive triage effects. We present a simple experimental paradigm and model that allow researchers to quantify the contributions of direct access and reconstruction to most standard recall tasks. We report findings from a series of preliminary experiments that bear on questions about goodness of fit and process validity.

2:30–2:40 (193)

**Putting It in Writing: Consequences for Verbal False Memories.** RONALD T. KELLOGG, *University of Missouri, Rolla*—False memories were studied for aurally and visually presented lists of words that were either spoken or written at the time of recall. The proportion of written intrusions of critical list associates was reliably lower for words that had been presented visually rather than aurally. The presentation modality apparently did not matter in the production of false memories when recall was spoken rather than written. Of interest, only visual presentation and written recall supported a level of correct recall nearly three times the rate of false memories. The results are tentatively interpreted in light of the semantic, phonological, and

orthographic codes activated during encoding and then later at retrieval in preparation for either spoken or written output.

**LETTER/WORD PROCESSING: READING**  
Westside, Friday Afternoon, 1:00–3:10

*Chaired by Randi C. Martin, Rice University*

**1:00–1:20 (194)**

**The Processing of Derived and Inflected Suffixed Words During Reading.** ELIZABETH NISWANDER, ALEXANDER POLLATSEK, & KEITH RAYNER, *University of Massachusetts, Amherst* (read by Alexander Pollatsek)—Two experiments, one with derived words and one with inflected words, were conducted. In both, the surface frequency of the word and the root frequency were separately manipulated (holding the other variable constant). The target words were embedded in sentences and measures of silent reading, such as gaze duration on the target word, were examined. For derived words, both the root and surface frequency affected reading, although root effects appeared earlier. For inflected words, the primary influence was from surface frequency, although root frequency appeared to have an effect for some of the words. It thus appears that both root morphemes and whole-word lexical entries are playing parts in identifying morphemically complex words during silent reading.

**1:25–1:40 (195)**

**The Relative Contribution of Consonants and Vowels in Word Recognition in Reading.** HYE-WON LEE, KEITH RAYNER, & ALEXANDER POLLATSEK, *University of Massachusetts, Amherst* (read by Keith Rayner)—In two experiments, the relative contribution of consonants and vowels in word identification in English was assessed in a paradigm in which the onset of consonants and vowels was delayed at the beginning of a fixation in reading. In both experiments, delaying the onset of the consonant for 30 msec at the beginning of an eye fixation increased the gaze duration on the target word, whereas delaying the onset of the vowel did not. With 60-msec delays, delaying the onset was equally disruptive for consonants and vowels. The results suggest that there is a temporal distinction between the contribution of consonants and vowels during reading: Consonants play a more important role than vowels at the early stage of word recognition in reading English.

**1:45–2:05 (196)**

**Reading Polysyllabic Words: Cross-Language Differences.** MARCUS TAFT, *University of New South Wales*, & CARLOS ALVAREZ & MANUEL CARREIRAS, *Universidad de La Laguna*—This study examines language differences in the reading of polysyllabic words. A comparison is made between Spanish, where the phonological syllable boundary is clear-cut, and English, where it is not. In a lexical decision experiment, words were split according to the principle of maximal onset (giving a syllabic analysis, e.g., FI-NAL) or maximal coda (giving a BOSS analysis, e.g., FIN-AL); the same words were used in both languages. Spanish readers preferred the syllabic split regardless of reading ability. In English, however, preference for the syllabic split correlated negatively with reading ability. A second experiment showed that the ease of detecting a word at the beginning of a nonword (e.g., detecting BAR in BARTOS or BAROS) depended on whether it coincided with the syllable for Spanish speakers, but with the BOSS for English speakers. Orthographic syllabic processing strategies therefore appear to be affected by the phonological structure of the language.

**2:10–2:20 (197)**

**Effects of Speech on Eye Movements in Reading.** WEIMIN LIU, ALBRECHT INHOFF, & CYNTHIA M. CONNINE, *SUNY, Binghamton* (read by Albrecht Inhoff)—Neighborhood effects in reading are generally used to argue that visual word recognition in-

cludes a processing stage during which the visual signal is used to activate a set of structurally similar lexical representations. The current study examined whether activated lexical representations are modality specific. Sentences were read that contained a target word. Briefly before the target was viewed, the reader heard the target, a lexical neighbor, or a phonologically dissimilar word. Preliminary results show relatively short target viewing durations when the spoken word and the viewed target were identical. Auditory presentation of a lexical neighbor and of a dissimilar word were equally disruptive when first-pass target viewing durations were measured, although spoken neighbors were particularly likely to trigger a rereading of the visual target word. Neighborhood activation thus appears modality specific so that intermodal effects accrue relatively late.

**2:25–2:45 (198)**

**Away With Words? Orthography and the Development of Reading in Chinese and English.** GARY FENG, SHIOU-YUAN CHEN, & KEVIN F. MILLER, *University of Illinois, Urbana-Champaign*, & HUA SHU & HOU CAN ZHANG, *Beijing Normal University* (read by Kevin F. Miller)—Two developmental studies on the relation between orthography and reading will be reported, including the first developmental eyetracking study on reading in Chinese and English. Both compare English with Chinese, an orthography that uses nonalphabetic characters and does not explicitly mark word boundaries. The first study shows that English-speaking children quickly develop explicit understanding of word boundaries shortly after learning to read; Chinese speakers have much less agreement about where word boundaries might be. The second study presents eyetracking results from normal reading, finding (1) orthography differences are relatively small in adults but are substantial for children, (2) Chinese characters have some advantages in reading and may be more convenient units than words are for rapid lexical access, and (3) characteristics of *words* rather than *characters* predict fixation time for characters. Thus, “word” is an important but implicit concept in Chinese.

**2:50–3:05 (199)**

**Orthographic Cues in Proper Name Recognition.** REMO JOB, FRANCESCA PERESSOTTI, & ROBERTO CUBELLI, *University of Padua*—Lexical decision times to proper names and common nouns were investigated in four experiments. When the stimuli were presented either with the first or with all letters in uppercase, proper names were recognized faster than common nouns. However, no difference was found when the stimuli were presented in lowercase. These effects are accounted for by postulating differences at the level of the orthographic description of proper and common names. We hypothesize that the information on the first letter case is a relevant orthographic cue that speeds recognition times of proper names. To support this, we show that the proper name advantage disappears (1) in German, a language in which the first letter of both proper nouns and common names is capitalized, and (2) in an auditory lexical decision task, in which orthography is not relevant for the decision.

**INVITED SYMPOSIUM: ATTENTIONAL SWITCHING**  
Century, Friday Afternoon, 1:00–3:15

*Chaired by Alan Kingstone & Vincent Di Lollo, University of British Columbia*

**1:00–1:03 (200)**

**Symposium on Attentional Switching.** ALAN KINGSTONE & VINCENT DI LOLLO, *University of British Columbia*—Coherent coordinated goal-directed behavior requires that people select and switch from separate sources of information that may be available concurrently or in rapid temporal sequence. The present symposium examines the dynamics and characteristics of this attentional switching. The symposium begins by exploring the strength and the speed at which different types of information trigger an attentional switch

(Diller & Shiffrin). The attentional blink phenomenon is then used to consider in detail the temporal dynamics of attentional selection (Di Lollo et al.) and its relation to task switching (Chun & Jiang). Task switching is then examined further by relating it to dual-task interference (Pashler). The symposium ends by exploring the generality of attention switching with reviews from cross-modal (Spence) and computational perspectives (Spurling).

#### 1:03–1:20 (201)

**Effects of Switching From Highly Focused Attentional States.** DAVID DILLER & RICHARD SHIFFRIN, *Indiana University* (read by Richard Shiffrin)—Attention is focused strongly on a central visual region with a difficult task (typically, monitoring sequential checkerboard displays for a target pattern). Control conditions require spatially spread attention. Occasional interruptions require switching attention to the unattended regions of the displays or to a different task. Almost always, information in the unattended task or location does not affect performance until after the few hundred milliseconds needed to switch (although iconic registration is unaffected by attentional allocation). Secondary task measures include simple feature detection, flanker effects, duration estimation, and compatibility effects. However, implicit measures demonstrate that certain aspects of unattended information nonetheless briefly attract attention. One example involves the presentation of words in unattended regions. Later, word fragment completion demonstrates that unexpected word onsets, or switches from symbols to letters, briefly attract attention (but switches from consonant strings to words do not).

#### 1:25–1:42 (202)

**Changing of the Guard: Temporal Dynamics of Attentional Switching.** VINCENT DI LOLLO, TROY A. W. VISSER, & JUN-ICHIRO KAWAHARA, *University of British Columbia*, & WALTER F. BISCHOF, *University of Alberta*—Effective processing of sequential visual stimuli entails suppression of irrelevant information in the input stream. This can be achieved by input filters designed to pass targets and reject irrelevant items. If a task involves processing of similar targets, the filter set up for the first remains suitable for the next. But if the task involves processing of dissimilar targets, the input filter needs to be dynamically reconfigured to pass trailing targets. Such a reconfiguration can take several hundred milliseconds, during which processing of trailing targets is impaired. We studied the temporal characteristics of this reconfiguration using the attentional blink paradigm, in which perception of the second of two targets is impaired as a function of the temporal lag between them. As predicted on the basis of filter reconfiguration, perception of the second target was impaired over longer lags in tasks that required attentional switching.

#### 1:47–2:04 (203)

**Task Switching and the Attentional Blink.** MARVIN M. CHUN, *Vanderbilt University*, & YUHONG JIANG, *Yale University*—Dual-task paradigms, such as task switching and the attentional blink, reveal multiple capacity-limited stages along the information processing stream. Task-switching costs occur when subjects reverse their perceptual set from one category or object to another. The attentional blink reveals a deficit for consolidating visual information into working memory. Three experiments show that task-switching and attentional blink deficits are doubly dissociable. Experiment 1 introduces a new paradigm that demonstrates the attentional blink and task switching using identical stimulus sequences. Experiment 2 demonstrates that task-switching costs can occur without the attentional blink. Experiment 3 demonstrates the attentional blink without additional task-switching costs. The results indicate that attentional blink is sensitive to perceptual interference, whereas task switching is sensitive to stimulus–response compatibility. This double dissociation suggests that the attentional demands of configuring task sets are separate from the attentional limitations for consolidating visual information.

#### 2:09–2:26 (204)

**Dual-Task Interference and Task Switching.** HAROLD PASHLER, *University of California, San Diego*—Dual-task interference often occurs when people attempt concurrently to perform two or more tasks requiring planning and producing separate responses, even when neither task seems particularly cognitively demanding. This interference seems to reflect queuing of central processing (encompassing memory retrieval as well as response selection) and arises even in the absence of overlap in input or output modality. In some sense, then, attempts at simultaneous task performance seem to result in a form of task switching. When people alternate between two different tasks that do not overlap in time, a marked slowing is observed when each task maps the same stimuli onto different responses, as first noted by Jersild. This cost of having to switch tasks is partly, but not completely, eliminated when an individual has time to prepare for the upcoming task. This talk will explore the relationship between these two different task switching literatures.

#### 2:31–2:48 (205)

**Cross-Modal Attention Switching.** CHARLES JASON SPENCE, *Oxford University*—One fundamental cross-modal issue concerning attention is whether there are costs associated with shifting attention from one modality to another (i.e., whether people can attend selectively to a particular sensory modality). However, the majority of previous studies have confounded modality-switching effects with other factors such as spatial-switching or task-switching. Nevertheless, recent studies have shown that substantial behavioral costs are associated with shifting attention from one modality to another even when these confounds are removed. Moreover, it appears that switching attention to/from certain modalities (i.e., touch) may be harder than for others (e.g., vision, audition, or chemosensation). While reviewing recent findings from this literature, I will draw a distinction between endogenously and exogenously elicited shifts of attention between modalities. Finally, I will discuss the implications of this research for recent claims that various clinical populations show selective deficits in their ability to shift attention from one sensory modality to another.

#### 2:53–3:10 (206)

**Computational Models of Attention Switching.** GEORGE SPURLING, *University of California, Irvine*—In attention-switching paradigms, in which attention moves spatially while the eyes remain fixed, it has been shown that attention switches from one spatial location to another in discrete jumps. Attentional trajectories can be measured in great detail; switching time is independent of the distance traversed. In other respects, the timing of successive shifts of attention is, not surprisingly, quite similar to the timing of successive saccadic eye movements. Whereas attention operates concurrently at many levels of processing, the critical mechanism of spatial attention relies on a “salience field” that controls access to subsequent processes such as short-term memory and pattern recognition. Salience is controlled jointly by bottom-up and top-down processes, and it is conveniently assayed by attention-driven apparent motion, which yields direct measurements of attentional amplification. Computational, dynamic system models for these attentional processes provide efficient predictions of large data sets and suggest important principles about brain mechanisms of attention.

### CATEGORIZATION I

#### Pacific Palisades, Friday Afternoon, 3:00–5:15

Chaired by Jerome R. Busemeyer, *Indiana University*

#### 3:00–3:20 (207)

**Category-Based Induction and the Diversity Effect in Children.** EVAN HEIT, *University of Warwick*, & ULRIKE HAHN, *Cardiff University*—One of the hallmarks of inductive reasoning by adults is the diversity effect—namely, that subjects draw stronger inferences from a diverse set of premise categories than from a homogenous set

of categories (Osherson et al., 1990). However, past developmental work (Gutheil & Gelman, 1997; Lopez et al., 1992) has not found diversity effects with children ages 9 years and younger. In our own two experiments, we found robust and appropriate use of diversity information in children ranging in age from 5 to 8 years old. For stimuli we used pictures of people and everyday objects they possessed, such as clothing and chocolates, rather than the stimuli concerning animals and their hidden biological properties as in past studies. We discuss implications of these results for models of inductive reasoning.

### 3:25–3:45 (208)

**Evidence for Continuous Rather Than Categorical Perception of Facial Affect.** DIANE J. SCHIANO, SHERYL M. EHRlich, KYLE M. SHERIDAN, & DIANE M. BECK, *Interval Research Corp.*—Recent reports have claimed to demonstrate categorical perception of facial affect. These studies use morphing technology to vary the degree to which one of a pair of emotions is portrayed in a stimulus image. We conducted a set of experiments containing methodological improvements over the previous work. Stimuli were constructed from high-resolution video recordings of all pairwise transitions between seven emotional expressions (all six “basic” emotions plus “neutral”). Performance on morphed and natural sequences of images was compared. A multiple choice response format (plus intensity ratings) allowed us to assess the degree to which each emotion was perceived in each stimulus image; additional data were gathered from a paired comparison task. Our results suggest that the perception of facial affect is much more continuous than the previous work concluded. Theoretical and applied implications will be discussed.

### 3:50–4:10 (209)

**Rotation of Blondes and Brunettes in Eigenface Space: Exploring the Brunette Advantage.** HERVÉ ABDI, *University of Texas, Dallas*, DOMINIQUE VALENTIN, *Université de Bourgogne à Dijon*, & BETTY EDELMAN, *University of Texas, Dallas*—Previous work has shown that an image-based principal component analysis (PCA) model is able to detect the pose of faces. We present new data showing that the PCA model performs well for detecting the pose of faces of brunettes but less so for the faces of blondes. These data lead to the counterintuitive prediction that human participants’ ability to process face orientation depends on hair color. Surprisingly, experimental results show that, indeed, human participants perform better when detecting pose changes for brunettes than for blondes. A possible explanation is that both the model and human participants are using texture to detect orientation. In agreement with this hypothesis, eliminating texture information by keeping only the edges of images leads to the suppression of the brunette advantage for human participants and the model. However, human participants perform still better than chance. We conclude that texture favors brunettes, but is not necessary to detect face pose.

### 4:15–4:30 (210)

**The Role of Contrast Categories in Natural Language Concepts.** GERT STORMS, TIMOTHY VER BEEMEN, VEERLE VAN OVERBERGHE, & WIM RUTS, *University of Leuven*—Different experiments will be presented in which the effect of contrast categories on within-category structure of natural language concepts was studied. Intension-based and extension-based predictors originating from both the target category and a contrast category were used to predict typicality ratings and response times. No effect of the contrast category was found for superordinate level concepts and little effect was found for basic level concepts. The impact of the findings for Rosch and Mervis’s (1975) ideas and for exemplar models, in which contrast category effects are assumed, will be discussed.

### 4:35–4:55 (211)

**Linguistic Conventions in Object Naming: Implications From Non-Native Speakers.** BARBARA C. MALT, *Lehigh University*, & STEVEN A. SLOMAN, *Brown University*—We have argued (Malt,

Sloman, Gennari, Shi, & Wang, 1999; *JML*) that deciding what to call an artifact involves reference to language-specific conventions as well as to the object’s commonalities with other objects. To further test this hypothesis, we examined naming of 120 common containers by 60 non-native speakers of English. The non-native speakers show patterns of English naming that diverge from those of the native speakers, even when they know basic vocabulary words for the domain and can apply them appropriately to some objects. The patterns converge with native patterns only with many years’ exposure to the English language environment. The differences cannot be explained by standard similarity-based views of object naming. They support the view that object names are influenced by the individual histories of language communities, and that native speaker naming involves reference to these shared linguistic conventions.

### 5:00–5:10 (212)

**Are Color Categories Universal? New Evidence From a Traditional Culture.** DEBI ROBERSON & JULES DAVIDOFF, *Goldsmiths’ College*, & IAN DAVIES, *University of Surrey* (sponsored by Timothy R. Valentine)—Rosch Heider’s color research with a Stone-age Melanesian people (the Dani of Irian Jaya) provided the empirical basis for a paradigm shift in the study of cross-cultural perception and cognition. Rosch found that, despite having only two color terms, Dani color memory was much like that of English speakers. As a consequence, the dominant view that visual cognition was shaped by language (the linguistic relativity hypothesis) was replaced by belief in cognitive universals determined by innate biological mechanisms, the view that is still generally held 25 years later. Our research with a similar culture (the Berinmo of Papua New Guinea) was unable to replicate Rosch’s critical findings. Furthermore, studies of categorical perception (cross- vs. within-category discriminations) found evidence supporting linguistic relativity rather than color universals.

## ANIMAL LEARNING AND CONDITIONING II Plaza, Friday Afternoon, 3:15–4:40

Chaired by Nancy K. Dess, *Occidental College*

### 3:15–3:30 (213)

**Sequential Processes in Negative Contrast.** CHARLES F. FLAHERTY & COLIN MITCHELL, *Rutgers University*—Rats shifted from a 32% to a 4% sucrose solution show a negative contrast effect (NCE), which recovers over 4 postshift days. Morphine has a small but reliable anticontrast action that occurs earlier in the postshift phase than the effective point of ethanol or the benzodiazepines and earlier than the first evidence of corticosterone elevation. Does morphine affect the cognitive stages of contrast (detection and evaluation) as well as the later emotional stages (conflict)? A microstructural analysis of licking behavior shows that NCE occurs in the first licking burst (within 4 sec). This is not affected by morphine. The first evidence that morphine reduces NCE occurs at an average time of 28 sec after the shift. These data indicate that morphine does not affect detection and evaluation of the new solution, but may affect an earlier emotional response than that which is susceptible to benzodiazepine and ethanol effects.

### 3:35–3:55 (214)

**The Effect of Number of S+/S− Transitions on Operant Discrimination.** MIGUEL DIFRANCISCO, ROBERT ZELL, MATTHEW ANDRZEJEWSKI, PHILIP J. BERSH, & LYNN J. HAMMOND, *Temple University* (read by Philip J. Bersh)—Two groups of rats were exposed to a successive operant discrimination procedure. One group received alternating S+ and S− periods of 1-min duration. The other group received alternating 5-min S+ and S− periods. Sessions were 20 min long. The reinforcement schedule during S+ was RI (random interval) 15 sec. Total duration of S− exposure per session was held constant, but the 1-min group received 10

times as many S+/S− transitions as the 5-min group. The number of reinforcements per session was approximately the same for the two groups. The discrimination developed more rapidly and was superior for the 5-min group. This result was directly opposite to the suggestion of Keller and Schoenfeld in their text. When the conditions were reversed, the former 5-min group, after an initial disruption, quickly recovered its previous performance. The discrimination performance of the former 1-min group gradually approached the level of the 5-min group.

#### 4:00–4:15 (215)

**Simultaneous Temporal Processing in a Classical Conditioning Procedure.** KIMBERLY KIRKPATRICK & RUSSELL M. CHURCH, *Brown University* (read by Russell M. Church)—Six rats received a conditioning procedure in which a 45-mg food pellet was delivered at the end of a 30-sec noise stimulus; intervals between successive food presentations were 90 sec. Head entries into the food cup were recorded. Three rats increased responding during the food–food interval, but did not change responding after noise onset. The other three rats increased responding during the noise–food interval, but did not respond prior to noise onset. Subsequent tests, in which the noise was omitted or was presented at earlier times in the food–food interval, revealed that all 6 rats timed both the food–food and noise–food intervals. Thus, all rats learned both intervals in original training, but expressed timing of only one interval in performance. Simultaneous temporal processing is an important contributor to the conditioning process, but the combination rules for performance have not yet been determined.

#### 4:20–4:35 (216)

**Characterization of an Intra-Administration Association: Morphine-Onset Cues Conditionally Increase Anti-Opiate Peptide Activity.** SHEPARD SIEGEL, JOSEPH A. KIM, & MARTA SOKOLOWSKA, *McMaster University*—On the basis of a conditioning analysis of drug tolerance, drug-associated cues become associated with the drug effect. These cues elicit conditional compensatory responses and modulate the expression of tolerance. Results of recent research indicate that interoceptive pharmacological cues, as well as exteroceptive environmental cues, are paired with a drug effect. That is, within each administration, early drug-onset cues may become associated with the later, larger drug effect. These pharmacological cues may overshadow simultaneously present environmental cues. We demonstrate the effectiveness of such drug-onset cues to elicit conditional hyperalgesia in rats with a history of intravenous morphine administrations. We also present results that further characterize the nature of the drug-onset cue: What aspects of the early drug effect are effective as signals for the later, larger drug effect? Finally, we evaluate the extent to which the conditional compensatory response is mediated by an endogenous putative anti-opiate peptide–cholecystokinin.

### INTERSENSORY AND OBJECT PERCEPTION Santa Monica, Friday Afternoon, 3:15–5:15

*Chaired by Daniel J. Simons, Harvard University*

#### 3:15–3:30 (217)

**Cross-Modal Effects of Auditory Organization on Visual Perception.** JEAN VROOMEN & BEATRICE DE GELDER, *Tilburg University*, & PAUL BERTELSON, *Université Libre de Bruxelles and Tilburg University*—Four experiments demonstrated cross-modal influences from the auditory on the visual modality at an early level of perceptual organization. Participants detected a visual target in a rapidly changing sequence of visual distractors. An abrupt tone that segregated from a tone sequence (stream segregation) improved detection of the visual target (Experiment 1). Synchronization between the tone and the visual target was critical (Experiment 2). Perceptual

organization of the tone sequence was of crucial importance: Detection of the visual target was better when the tone segregated from the tone sequence than when the same tone was part of a melody (Experiment 3). This finding was robust under various display times of the visual target (Experiment 4). These results are compatible with the notion that the perceptual system makes coherent decisions about the input across modalities. Stream segregation in the auditory modality can therefore have an effect on segregation in the visual modality.

#### 3:35–3:50 (218)

**Mental Representation of Structure Obtained From Visual and Auditory Displays of Spatial and Quantitative Information.** JOHN H. FLOWERS, ERIC C. ODGAARD & JENNIFER A. CHERRY, *University of Nebraska, Lincoln*, & DION C. BUHMAN, *AgriDat Data Communications*—Technology advances are stimulating the development of novel formats for data display, some of which use auditory structures (data sonification) as substitutes or adjuncts to visual graphics. Ideally, such developments should be guided by basic research in visual and auditory pattern recognition to create guidelines for optimal mapping between data properties and display features. Recent experiments from our laboratory have studied perception of auditory, visual, and tactile representations of numeric data, spatial layouts, geographical borders of U. S. states, and contours of familiar objects. Our findings illustrate both equivalence and non-equivalence of mental representations produced by the different display modalities. We will describe experimental results indicating that some features may be better heard than seen and vice versa, but that certain types of information (notably, spatial layouts) may use common resources in working memory, regardless of the mode of presentation.

#### 3:55–4:10 (219)

**Inhibition and Facilitation of Object Memories During Image Segregation.** MARY A. PETERSON, *University of Arizona*—Previously, we reported that regions portraying familiar objects are more likely to be seen as shaped figures when they are upright than when they are inverted. We interpreted those results to imply that object memories accessed early in the course of perceptual processing affect image segregation. Here, we investigated the time course of access to object memories using displays in which regions potentially portraying familiar objects were seen as shapeless grounds rather than as figures. These stimuli served as primes for an object-decision task performed on a line drawing shown immediately after the primes. Results indicated that object memories matched by regions perceived to be shapeless grounds had been accessed in the course of image segregation. In addition, results showed that object memories accessed by regions ultimately determined to be grounds are inhibited. Unlike negative priming, the inhibition we observed seems to be relatively short-lived.

#### 4:15–4:30 (220)

**Elongation and Symmetry: Deriving Principal Axes for Object Recognition.** ALLISON B. SEKULER & MIRANDA B. SWIMMER, *University of Toronto*—Many theories of object recognition posit that objects are encoded with respect to a perceptual reference frame. Such theories assume that factors such as elongation are critical for assigning an object's primary axis and, consequently, for extracting an object's reference frame. Surprisingly, previous research has suggested that elongation does not play a major role in determining an object's primary axis. However, the stimuli used in previous studies may have minimized the relative salience of elongation. Thus, the present experiments reexamine the relative roles played by symmetry and elongation in the determination of an object's primary axis and the extent to which symmetry and elongation interact with one another. We find that observers use both symmetry and elongation in extracting an object's primary axis; the extent to which each cue dominates depends on its relative salience; and that symmetry and elongation are processed interactively, rather than in encapsulated modules.

**4:35–4:50 (221)**

**Cross- Versus Within-Racial Judgments of Attractiveness Revisited.** IRA H. BERNSTEIN & NICHOLAS O. FURL, *University of Texas, Arlington*—Bernstein, Lin, and McClellan (*Perception & Psychophysics*, 1982) had participants of different races judge pictures of faces for attractiveness. Specifically, Taiwanese and White Americans judged Taiwanese male, Taiwanese female, White male, and White female pictures. Several factor analytic models were compared. The results were best described by one in which races are equally coherent (consistent) but define attractiveness using different rules. Thus, attractiveness judgments of two Taiwanese participants and of two White Americans tend to correlate equally, regardless of whom they judge. However, the correlation between a Taiwanese and a White American participant tends to be lower because their cultures define attractiveness differently. Technological limitations prevented a determination of what these precise differences were in this earlier work. New data were obtained and analyzed using Abdi and O’Toole’s autoassociative network model to examine these cultural differences.

**4:55–5:10 (222)**

**It’s Written All Over Your Face: An Image-Based Analysis of Facial Expressions.** ANDREW JOHN CALDER, *MRC Cognition and Brain Sciences Unit*, MIKE BURTON & PAUL MILLER, *University of Glasgow*, & SHIGERU AKAMATSU, *ATR, Human Information Processing Research Labs, Kyoto*—Pictures of facial expressions from the Ekman and Friesen’s (1976) set were submitted to a principal component analysis (PCA) of the gray-scale values of the images’ pixels. The results of the PCA were subjected to a series of linear discriminant analyses, which revealed three principal findings: (1) PCA can capture effectively the visual information relevant to different facial expression categories, (2) the first two canonical discriminant functions for facial expression resemble continuous two-dimensional models of emotion concepts (e.g., Russell, 1980), and (3) the PCs critical for facial expressions are largely different from those critical for facial identity. The latter result suggests that, contrary to current thinking, the visual representation of facial identity and facial expression could be stored within the same perceptual system.

**SOCIAL FACTORS AND MEMORY ERRORS**  
**Beverly Hills, Friday Afternoon, 3:00–4:40**

*Chaired by James S. Nairne, Purdue University*

**3:00–3:15 (223)**

**Interviewer Feedback and False Memory for Knowingly Confabulated Events.** MARIA S. ZARAGOZA, KRISTIE E. PAYMENT, & SARAH B. DRIVDAHL, *Kent State University*, & JENNIFER K. ACKIL, *Gustavus Adolphus College*—Previous studies of eyewitness suggestibility have focused on situations where misinformation is explicitly provided by the interviewer. However, in many real-world therapeutic and investigative interview contexts where suggestive interviewing is of concern, the nature of the suggestive questioning is to press people to provide details of events they do not remember or never experienced. Two experiments assessed whether participants would develop false memories for events they earlier had been forced to confabulate. The influence of interviewer feedback on the development of false memory for knowingly confabulated events was also assessed.

**3:20–3:35 (224)**

**Repeated Imaginings Affect Veridical and False Memories for Dyadic Action Events.** DAVID G. PAYNE, LISA ROSENFELD, TALI DITMAN, GREGORY BENOIT, & VANESSA CALABRESE, *SUNY, Binghamton*—Recent studies show that repeated imaginings can lead people to falsely remember events that never occurred (e.g., Goff & Roediger, 1998). The present study examined the effects of repeated imaginings on memories for actions involving pairs of partic-

ipants. In the first of three sessions (separated by 1 week each), participants performed, imagined, or heard stated simple collaborative actions (e.g., placing a video in a box). In Session 2, participants imagined actions performed during Session 1, as well as new, non-presented actions, 0, 1, 3, or 5 times. When tested in Session 3 on items that were not imagined in Session 2, participants rarely confused performed actions with heard, imagined, or not-performed actions. However, there was an increase in false memories for performed events associated with repeated imaginings. Thus, although memory for interpersonal action events is generally quite good, false memories can be formed through repeated imaginings.

**3:40–4:00 (225)**

**Social Contagion of Memory.** HENRY L. ROEDIGER III & MICHELLE L. MEADE, *Washington University*, & ERIK T. BERGMAN, *Pitney Bowes Technology Center*—In two experiments pairs of people (one subject, one confederate) saw a series of six household scenes and then took turns recalling items from each scene. The confederate reported a few items that had not actually appeared in the scenes. In the third phase of the experiment, the subject alone tried to recall as many items as possible from the original scene. Subjects falsely remembered items that had been suggested erroneously by the confederate. When subjects were explicitly warned that the confederate may have made mistakes in recall, this social contagion effect was reduced but not eliminated. In addition, when given a source monitoring test, subjects frequently and erroneously attributed the suggested material to having been seen in the slides. In a third experiment, this social contagion effect increased with the number of confederates’ erroneous reports previously given. Another person’s erroneous memories may be incorporated into one’s recollection of events.

**4:05–4:15 (226)**

**Wishful Thinking and Source Monitoring.** RUTHANNA R. GORDON & NANCY J. FRANKLIN, *SUNY, Stony Brook* (read by Nancy Franklin)—When attributing source, people typically rely on factors normally associated with one or another source class (e.g., sensory detail as indicating perceptual sources). Use of these empirically based factors increases the odds of accuracy. The current work examines a nonrational heuristic, wishful thinking, that also seems to guide source attribution but doesn’t appear to reflect any real-world regularities. Participants learned about two sources, an unreliable predictor (20% accurate) and a reliable predictor (80% accurate). In critical items, both made several predictions about events, each giving desirable and undesirable predictions equally often. When tested later, participants tended to misattribute the unreliable predictor’s desirable predictions to the reliable one, and to misattribute the reliable predictor’s undesirable predictions to the unreliable one. That is, without knowing what the actual outcome was of the events, people’s source attributions were guided by their desires, with performance poorer on items that had been inconsistent with desire.

**4:20–4:35 (227)**

**Cognitive Processes and Vote Overreporting in Surveys.** ROBERT F. BELLI & JOHN VAN HOEWYK, *University of Michigan*—Survey respondents consistently overreport voting, and previous attempts to reduce overreports by attacking either social desirability concerns or memory difficulties alone have not been successful. Recently, Belli, Traugott, Young, and McGonagle (1999) successfully reduced overreporting by a lengthy question that simultaneously attacks social desirability concerns, memory failure, and the source memory confusions that can result from respondents mistakenly inferring that their usual patterns of voting behavior, or their prior thoughts about voting, are diagnostic of their having voted during the last election. Following the Congressional elections of 1998, an experiment was conducted that tested a truncated version of the successful question that eliminated the memory failure and attenuated the source confusion elements. The truncated question moderately reduced overreports, but

not to the extent of the lengthy version. The overreporting of voting appears determined by multiple cognitive processes that must be treated simultaneously in order to derive success.

**ATTENTION: WHY DO VALID CUES WORK?**  
Westside, Friday Afternoon, 3:30–5:15

*Chaired by Harold Pashler, University of California, San Diego*

**3:30–3:50 (228)**

**Constancy of Location and Its Effect on Visual Selection.** PAULA GOOLKASIAN & CHRISTOPHER T. MOAG, *University of North Carolina, Charlotte*—Measures of effect size for target/distractor distance ( $0.6^{\circ}$ – $20^{\circ}$  of visual angle) and distractor compatibility help to explain reaction time performance in a series of cued attention tasks with 100% valid cuing. The studies include both covert and overt attention, and systematically vary the consistency of stimulus presentation location within a block of trials. When target and distractor letters appear at varied locations from trial to trial, distractor compatibility effects are stronger than distance effects. However, the relative importance of these two variables reverses when the presentation location of either the target or distractor letter is fixed at a constant location. Moreover, constancy of location for both target and distractor letters results in perfect visual selection. Findings identify the conditions under which space-based and object-based theories of visual selection are supported.

**3:55–4:10 (229)**

**The Locus of the Attentional Effect in Texture Segmentation.** YAFFA YESHURUN & MARISA CARRASCO, *New York University* (read by Marisa Carrasco)—We have shown that attention can enhance spatial resolution by demonstrating that attention affects texture segmentation as a function of target location: Cuing improves performance at peripheral locations, where resolution is too low for the texture scale, but impairs performance at central locations, where resolution is already too high (Yeshurun & Carrasco, *Nature*, 1998). In this study, we further examined the specific level of the attentional effect—first versus second order—by manipulating the spatial frequency of the texture. As in our previous study, precuing affected overall performance. Furthermore, the pattern of the interaction between cue-type and target eccentricity depended on the spatial frequency of the second-order filters. Precuing the target location impaired performance in a larger range of near eccentricities for the lower than the higher frequencies. These results suggest that the attentional effect reflects changes in the scale of the second order spatial filters.

**4:15–4:25 (230)**

**Endogenous Cue Utilization as Contingency Learning.** JUDITH AVRAHAMI, YAAKOV KAREEV, & ASSAF NUSBAUM, *Hebrew University of Jerusalem*—The benefits of an endogenous precue on orienting of visual attention has been demonstrated even when cue validity is less than perfect. At the same time, studies in contingency learning show that organisms, both humans and animals, do not treat a correlation as perfect (which would maximize predictions even if it is not) using probability-matching instead. In light of these findings, the present study explores the attentional strategies developed by participants who have to discover cue validity by themselves. Two experiments, in which cue validity is manipulated (between participants) from strongly negative to strongly positive, reveal how the attentional strategies, developed through experimental blocks, are affected by cue validity. Individual cluster analyses of response times shed further light on these strategies.

**4:30–4:45 (231)**

**Visual Orienting: Effects of Spatial Correspondence and Spatial Transition Cues.** ANTHONY LAMBERT & MICHELLE DUDDY, *University of Auckland*—Visual orienting was studied using bilateral

letter cues (X and T) presented at central and peripheral locations. In the *spatial correspondence conditions*, targets tended ( $p=.8$ ) to appear on the same side as one of the letters. In the *spatial translation conditions*, the bilateral letters were identical: one letter indicated that the target would probably appear on the left, the other cued the right location. In the spatial correspondence conditions, response latencies were quicker on valid than invalid trials, even at very brief (0, 33, and 66 msec) stimulus onset asynchronies (SOAs) between cue and target onset. In the spatial translation conditions, a clear advantage for valid trials was only apparent at somewhat longer SOAs (150, 300, and 500 msec). Results show that spatial correspondence between cue and target stimuli, rather than discrimination of the cue stimulus or cue eccentricity, is the critical factor mediating speed of orienting in studies of attentional precuing.

**4:50–5:10 (232)**

**Mechanisms of Perceptual Attention in Multilocation Cuing.** BARBARA ANNE DOSHER, *University of California, Irvine*, & ZHONG-LIN LU, *University of Southern California*—What are the mechanisms of spatial attention underlying precue validity effects? We answer this question within the framework of a perceptual template model (Doshier & Lu, 1999; Lu & Doshier, 1998) and an external noise plus attention paradigm for orientation judgments in 2 to 8 location displays. Attentional mechanisms correspond to behavioral signatures: External noise exclusion produces cuing effects in high external noise and stimulus enhancement produces cuing effects in noiseless displays. We found that external noise exclusion was the primary mechanism of cue validity effects, with large effects in high-noise displays. Stimulus enhancement coexisted as a secondary mechanism in noiseless displays for a subset of observers and display conditions. Contrast threshold ratio tests ruled out attentionally mediated changes in gain control. Similar results were observed for four-alternative and two-alternative orientation discrimination. We concluded that precues allow observers to reduce noise and focus on the target in the precued location.

**PSYCHOLINGUISTICS: WORDS**  
Century, Friday Afternoon, 3:25–5:30

*Chaired by Keith Rayner, University of Massachusetts, Amherst*

**3:25–3:40 (233)**

**Naming Single Words in an Alphabetic Script: Orthography to Semantics to Phonology.** BAHMAN BALUCH, *Middlesex University*, & DEREK BESNER, *University of Waterloo* (read by Derek Besner)—The question of how skilled readers of an alphabetic script read single words aloud has been dominated by (1) the debate as to whether there are one or more nonsemantic ways of converting print to sound and (2) the debate between those who advocate localist representations and those who prefer a parallel distributed processing framework. Perhaps because of this, remarkably little work addresses the issue of whether intact skilled readers of an alphabetic script ever utilize the orthography to semantics to phonology pathway. We report evidence that they do, even for high-frequency words.

**3:45–4:00 (234)**

**The Production of Nouns and Verbs.** PATRIZIA TABOSSI & SIMONA COLLINA, *University of Trieste*—The study investigates semantic and syntactic factors in the production of nouns and verbs in Italian using the picture–word interference paradigm. This paradigm has recently been employed to explore lexical access in language production. However, while the issues addressed are of great theoretical relevance, the empirical evidence is still rather sparse and contradictory. Semantic and syntactic effects have been found at early stages in the production of nouns in some studies but not in others. Semantic effects have also been reported in the production of verbs, but access to verb syntactic features has not been explored so far. The

aim of the study is to clarify and extend the available evidence, testing whether and under what conditions early semantic and syntactic effects can be obtained in the production of both nouns and verbs. The results are discussed in light of the current model of language production.

**4:05–4:20 (235)**

**Morphological Similarity and Orthographic Similarity Contrasted: A Cross-Task Comparison.** LAURIE FELDMAN, *SUNY, Albany, and Haskins Laboratories*—Psycholinguists debate whether all morphologically related word forms, or only those forms that are irregular with respect to either form or meaning, are stored in the mental lexicon. When regularity is defined with respect to form, we can ask whether irregular forms that undergo a change in spelling (and sometimes pronunciation) in the past tense such as FALL–FELL are represented differently from regular forms such as LIST–LISTED. I will present the results of a study that asks whether the magnitude of facilitation among morphological relatives is sensitive to the degree of form overlap. Pairs such as LIST–LISTED will be contrasted with pairs such as FALL–FELL and BUY–BOUGHT. I compare morphological facilitation with the effect of shared form for LIST–LISTEN, FALL–FILL, and BUY–BALANCE type pairs. Morphological and form similarity will be contrasted in the lexical decision task with and without a mask and in the naming task.

**4:25–4:45 (236)**

**Recognizing Underlying and Surface Form in English Place Assimilation.** DAVID W. GOW, JR., *Massachusetts General Hospital and Salem State College*—Phoneme monitoring and form priming techniques were used to examine the effects of English place assimilation on lexical activation in the processing of continuous speech. The results of six experiments are presented, suggesting that listeners selectively access the underlying form of potentially ambiguous modified words and use assimilation to anticipate their assimilated context. These results prompt a reconsideration of representational and inferential accounts of modified word recognition, and suggest that the speech signal encodes both modified and unmodified place of articulation. I will discuss possible implications of this dual encoding for categorical perception, phonological representation, and the processes of mapping between the speech signal and the lexicon.

**4:50–5:05 (237)**

**Speech Errors, Music Errors, and Planning Constraints.** CAROLINE PALMER, PETER Q. PFORDRESHER, & DANIELLE BRINK, *Ohio State University*—Dell, Burger, and Svec (1997) proposed a serial order model of sentence production that predicts an increase in relative proportions of anticipatory speech errors with decrease in overall error rate (general anticipatory effect) and a decrease in speech rate (anticipatory rate effect); these predictions were confirmed in studies of tongue-twisters. We report studies of piano performance errors (finger fumblers) that replicate the general anticipatory effect but fail to replicate the anticipatory rate effect. Instead of decreasing the anticipatory proportion of errors, faster production rates reduced the scope of planning, or how far into the future and the past performers have access to sequence information. We conclude that speech and music reflect similar influences of practice on future-oriented planning. We suggest that metrical frames influence the scope of planning in music performance similar to how structural frames influence scope in sentence production.

**5:10–5:25 (238)**

**Syllable Production Across Languages.** PADRAIG G. O'SEAGHDHA, *Lehigh University*, ROSA SANCHEZ-CASAS, *Universitat Rovira i Virgili*, YUAN WANG, *Lehigh University*, JOSÉ MANUEL IGOA, *Universidad Autónoma de Madrid*, & JULIO SANTIAGO, *Universidad de Granada*—The status of syllable units and their liaison with other lexical units in production is likely to vary across languages. We deploy repetition of pairs of related words (sharing segments and/or syllables) or unrelated words to explore the coordination of segmental and syllable units in word-form encoding. In English, repetition of related monosyllables and polysyllables causes similar difficulties in segment selection, suggesting that syllables are secondary, perhaps computed units. Syllables are more prominent units in other languages, such as Chinese and Spanish. In Mandarin Chinese, whole syllables appear to compete directly for selection in word-pair repetition. Thus, syllables may be represented in a lexical hierarchy, mediating between word and segment units. We also report a direct test of syllable representation in Spanish by crossing first syllable and word frequency in related and unrelated bisyllable pairs. We outline an account of syllable representation that addresses language variation.

## POSTER SESSION II

California Showroom, Friday Evening, 5:30–7:00

## • PSYCHOPHYSICS •

(239)

**Two-Dot Masking Under Divided Attention.** TODD A. KAHAN, *University of Southern Mississippi*, KATHERINE M. MATHIS, *Millsaps College*, & CHRISTOPHER WARD & YOLANDA CRUMP, *University of Southern Mississippi* (sponsored by W. Trammell Neill)—Recently Enns and Di Lollo (1997; Di Lollo & Enns, 1998) have reported a “four-dot” masking effect which only occurs under divided attention conditions. A theory of object substitution was proposed to explain this effect (Enns & Di Lollo, 1997). We report data from a series of experiments examining masking under divided attention; a “two-dot” masking effect is reported. Discussion focuses on how these data impact a theory of object substitution.

(240)

**Measurement of Pitch and Loudness: A Multidimensional Generalization of Fechner’s Method.** DAVID N. LEVIN, *University of Chicago* (sponsored by James T. Townsend)—This paper describes an experimental procedure for deriving psychophysical scales on multidimensional stimulus manifolds. The observer takes a simple multiple choice test on perceptual analogies. In each question, the subject determines whether two stimuli are related to one another in the “same or different” way as two other stimuli. Multidimensional scale functions can be derived from such observer-determined stimulus analogies in the same manner as Fechner derived a one-dimensional psychophysical scale from Weber’s JND measurements. The new method was applied to derive pitch and loudness scale functions on the two-dimensional manifold of tones with various frequencies and intensities. The resulting scale functions are in good agreement with other investigators’ data on (1) equivalent loudness relations and (2) the frequency and intensity dependence of both pitch and loudness JNDs. The new method is general enough to be applicable to a variety of other auditory and/or visual stimuli that form multidimensional manifolds.

(241)

**Age-Related Development of Multidimensional Judgment Strategies in Psychophysics.** PETRA HAUF & VIKTOR SARRIS, *Goethe University* (sponsored by Friedrich Wilkening)—The age-related development of multidimensional judgment strategies was tested by the use of a stimulus generalization paradigm (*size* and *color* vs. *size* and *brightness*). Thereby, three types of hypothetical strategies were analyzed: judgments based on *size* only (Type I), *similarity* between test and training stimuli (Type II), and *both* dimensions (Type III). The stimuli consisted of fairy tale figures differing in size and color in one condition and in size and brightness in the other condition. A total of 144 participants of four age groups (4, 8, 12, and 18 years old) were tested individually. During discrimination training a basic categorization was learned followed by two-dimensional tests. All three judgment types appeared in all age groups in both conditions. Further, in the size and color condition, Type I increased with age, Type II decreased, and Type III remained constant and was used infrequently. In the size and brightness condition, no age-related changes were found.

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**Explicit Counting and Duration Discrimination: A Sensory Modality Effect.** SIMON GRONDIN, ISABELLE GUAY, & MÉLANIE LAPOINTE, *Université Laval*—For duration discrimination, when should one start using explicit counting to reduce variance? Regarding this question, participants discriminated empty intervals, with and without using explicit counting. The experiment includes two interval ranges, 0.8 and 1.6 sec, and three marker-type conditions, which were intervals marked by (1) two brief auditory signals, (2) two brief visual signals, and (3) one auditory signal followed by a visual

signal. In comparison with the two-auditory marker condition, the other two conditions gain benefit from explicit counting for intervals that are 200 msec shorter.

## • AUDITION •

(243)

**Adaptation Effects Indicate a Central Representation of Auditory Source Characteristics.** STEPHEN LAKATOS, *Washington State University*, KOEI KUDO, *Portland State University*, & FAIZA NOOR & CANDICE LINDSAY, *Washington State University*—Three experiments used a cross-ear adaptation paradigm to selectively adapt listeners to features of sound sources in order to determine which features might be represented at central processing levels within the auditory system. Stimuli consisted of the following seven-step continua: (1) a rod-tube continuum with tubes of varying inner diameter representing intermediate steps, with outer diameter constant; (2) a bar-plate continuum with varying width–height ratios; (3) a continuum of spectral interpolations between endpoints consisting of tubes of different material density. Similarity functions derived from pre- and postadaptation classification tasks revealed adaptation effects for all three continua. The results provide preliminary evidence that basic spatial and physical properties of auditory sources are represented categorically at a central level.

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**Auditory Apparent Motion Between the Components of Complex Tone Sequences.** OTILIA M. BLAGA, KIM-PHUONG LE VU, & THOMAS Z. STRYBEL, *California State University, Long Beach*—Previously, we determined that auditory apparent motion (AAM) could be heard between two low-frequency sine waves as long as the frequencies fell within the same critical band. Here we investigated whether the critical-band requirement applied to AAM produced with harmonic and inharmonic tone complexes. Participants heard a sine-wave target, followed by a sequence of two complex tones, timed to produce AAM. Participants reported whether the target tone was present in the complex-tone sequence, and whether it moved. Each tone complex consisted of two harmonic (e.g., 225 + 1125 Hz) or inharmonic (e.g., 225 + 1131 Hz) frequencies. The harmonic relationship between the stimuli was also manipulated. Participants reported AAM of the target tone most often when at least one tone in the second stimulus was in the same critical band as the target. They also reported more AAM when the target tone was the lowest tone in the complex. Harmonicity did not affect AAM.

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**Dual Mechanisms in Dynamic Loudness Detection.** JOHN G. NEUHOFF, *Lafayette College*—In a natural listening environment, almost all sounds change in loudness. Some sounds, such as speech, exhibit rapid changes in loudness in a short period of time. Other changes in loudness, such as those produced by auditory motion, can change more gradually. In three experiments listeners were asked to detect rising or falling intensity change as quickly as possible. For any given sound, rising loudness was always detected sooner than falling. For short rapid changes, rising intensity broadband noise was detected sooner than rising intensity tones. However, for longer slower changes, rising intensity tones were detected sooner than rising intensity noise. The findings suggest different neural mechanisms for processing different types of loudness change and may have implications for speech processing theories and the perception of auditory motion.

## • TOUCH •

(246)

**Activation of SII During Passive Tactile Pattern Discrimination Using MEG.** CATHERINE L. REED, *University of Denver*, & ERIC HALGREN, CATHERINE P. RABELL, R. H. DHOND, & KIM PAULSON, *University of Utah*—Secondary somatosensory cortex

(SII) has been implicated in animal ablation and patient lesion studies for the processing of tactile object information. In this study, we delivered patterned pneumatic stimulation to normal subjects' palms. Subjects participated in two tasks: In one task subjects distinguished between two patterns. In a second task the same subjects ignored the somatosensory stimulation. We measured neural activity using a whole-head magnetometer with 306 channels and coordinated it with structural MRI. The initial somatosensory response peaks at approximately 40 msec and is well modeled by an equivalent current dipole (ECD) located in contralateral primary somatosensory cortex (SI). A second source of activation occurs at approximately 220 msec, and the ECD is located in contralateral SII. When dipoles for the pattern discrimination task are subtracted from the "ignore" task, only the SII dipole remains, suggesting that the SII dipole is related to tactile pattern discrimination.

(247)

**Cross-Modal Interaction Between Vision and Touch.** GAIL MARTINO & LAWRENCE E. MARKS, *John B. Pierce Laboratory and Yale University*—At each moment, we experience a melange of information from our senses. Despite this diversity of information, we can focus on inputs from one modality and "reject" inputs from another. Does input from a "rejected" sensory modality modulate one's ability to make decisions about a selected one? In vision and hearing, the answer is "yes." Making decisions about a selected (attended) modality can be influenced by information from the unselected (unattended) one, showing that vision and hearing interact cross-modally. In this study, we test whether mechanisms proposed to explain cross-modal interaction in vision and hearing apply also to vision and touch. Using a selective attention task, we (1) demonstrate cross-modal interaction between vision and touch, and (2) show that the relatedness of the cross-modal combination of attributes predicts when cross-modal interaction will occur. Results favor a view that similar mechanisms govern cross-modal interaction across sensory modalities.

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**Components of Priming in a Haptic Selective Attention Paradigm.** NOELLE C. CHIANG & EMILY W. BUSHNELL, *Tufts University*, & SOLEDAD BALLESTEROS, *Universidad Nacional de Educación a Distancia*—Previous research has demonstrated robust haptic priming when subjects repeatedly identify single objects by touch. We investigated haptic priming in a selective attention paradigm involving multiple objects. During study, subjects lifted different common-place objects with the two hands simultaneously but were instructed to name only the object in either the right or the left hand. They also read the names of other unhandled objects. Reaction times in a subsequent speeded identification test were fastest for the objects both handled and named during study, slowest for novel objects, and intermediate for objects just handled and for objects just named during study. These results suggest both a semantic and a perceptual component for haptic priming. Additional analyses suggest that the perceptual component may be contingent on experiencing the object with the same hand during the study and test phases.

• PERCEPTION •

(249)

**Two Roll-Tilted Inducing Lines Average Their Influences on the Orientation of Visually Perceived Vertical (VPV).** LEONARD MATIN & WENXUN LI, *Columbia University*—The roll tilt of one 64°-long line (25° hor ecc) in the frontoparallel plane viewed in total darkness induces a change in VPV (4.9°-long test line: 0° hor ecc in the frontal plane) that increases with roll tilt magnitude and grows with line length along a negatively accelerated exponential. (The frame in the classical "rod-and-frame" is not required.) Roll tilting one 64°-long inducing line by  $\pm 13^\circ$  induces a roll tilt of  $+6^\circ$  in the orientation of VPV. Roll tilting two 64°-long lines at bilaterally symmetric locations by the same or different amounts over the  $\pm 13^\circ$  range

results in a VPV that is roll tilted by the average of the VPV settings for the two lines measured separately (49 inducing line roll tilt combinations; 6 subjects). Individual lines also influence visually perceived eye level (VPEL); parallel pairs generate large VPV effects but no VPEL effects; bilaterally symmetric pairs generate large VPEL effects but no VPV effects.

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**Frame of Reference for Orientation in Visual Search.** SHUJI MORI, *Toyama Prefectural University*—In visual search, a line of unique orientation is preattentively detected among lines of other orientations. In this study, six experiments were conducted to investigate whether and how the detection of line orientation would be modulated by the orientation of reference frame, which was induced by a frame surrounding each line, a frame covering an entire set of lines, or a pictorial background. The results showed that the searches for vertical and tilted lines were dramatically affected by the orientation of the frame surrounding each line. When the frame orientation was the same as the target orientation, the search became much slower than when no frame was presented. Similar results were obtained when the frame had an incomplete (subjective) contour, and it had a slightly different orientation from the target. However, neither the frame surrounding an entire set of lines nor the pictorial background changed the search performance.

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**Ideomotor Phenomena: How Intention and Perception Induce Involuntary Action.** SARA DEMAEGHT, LOTHAR KNUF, & WOLFGANG PRINZ, *Max Planck Institute for Psychological Research, Munich*—Ideomotor phenomena are involuntary movements induced by the contents of an observed scene. They typically occur while observing the action of a person or the movement of an object. Two possible induction mechanisms are proposed: (1) perceptual induction (i.e., induced action mirrors the perceived action) and (2) intentional induction (i.e., induced action reflects the action needed to produce the intended goal). Our experimental paradigm was similar to a billiards game, in which an aiming task and a tracking task are performed in successive blocks. A first experiment demonstrated that subjects who observe the effects of an illusory participant's movements perform movements themselves that are compatible with both types of induction. A second experiment demonstrated that intentional induction is not the result of intentional inertia due to recently performed voluntary actions. In short, ideomotor action not only seems to be guided by perception, but it is influenced by intention as well.

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**Tri-Modal Extinction: Competition Across Visual, Tactile, and Auditory Modalities.** SHARMA K. HENDEL & BRENDA C. RAPP, *Johns Hopkins University*—We present data from two neurologically impaired subjects who exhibited tactile/tactile extinction: G.A.S. and S.L.H. often failed to detect tactile stimulation to a contralesional finger when presented with a competing tactile stimulus to an ipsilesional finger. Both subjects also showed tactile extinction when the competing ipsilesional stimulus was either visual or auditory. The visual/tactile extinction was modulated by the distance of the visual stimulus to the ipsilesional hand. Similar results have been taken as evidence for cross-modal integration within a hand-centered spatial frame of reference. However, we also describe other visual/tactile and auditory/tactile extinction effects that cannot be explained in this way. For example, auditory/tactile extinction depended on the type of auditory stimulus presented (tone vs. word) rather than the location of presentation. Our findings indicate that the integration of information across modalities occurs at various levels within the cognitive system.

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**Time Course of Spatial Memory Distortions.** STEFFEN WERNER, *University of Göttingen*, & JÖRN DIEDRICHSEN, *University of California, Berkeley*—Three experiments investigated memory dis-

tortions for the location of a dot in relation to two reference points. In Experiment 1, subjects reproduced a dot location from memory. Their performance showed a complex but interindividually homogeneous pattern of distortions. Analysis of the data using the Huttenlocher, Hedges, and Duncan (1991) model of spatial distortions yielded a good fit for systematic biases but not for variable error. Experiments 2 and 3 investigated the time course of spatial memory distortions. Using a visual discrimination task, we mapped the emergence of spatial biases within the first 800 msec after stimulus offset. A bias was detectable as early as 50 msec after presentation. This time course might reflect the fast decay of accurate spatial information in the perceptual system and the immediate formation of an enduring spatial memory representation that encodes spatial information in terms of the perceived structure of space.

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**Attention-Facilitated Fading of Negative Afterimages.** LIANG-GANG LOU, *University of Hong Kong*—Previous studies demonstrated a facilitative effect of attention on fading of a constant stimulus from awareness in peripheral vision (Lou, 1999). To explore similar effects on afterimages and to rule out possible involvement of eye movement, a set of new observations was conducted. Observers kept fixating a display composed of two superimposed geometric line figures in distinct colors. Thirty seconds later, the entire display turned gray and observers were instructed to attend to one of the afterimage figures. The attended afterimage faded from awareness first, even when the observers had received instructions that biased them to believe the opposite outcome. Unlike the previous finding, attention seemed to facilitate the fading regardless of the retinal eccentricity of the negative afterimage. These findings support the view that voluntary object-based attention can either undergo adaptation itself and/or expedite lower level sensory adaptation.

• ATTENTION •

(255)

**Reduction of Interference From Task-Irrelevant Information With Concurrent Perceptual Load in a Patient With Frontal Lobe Damage.** TAKATUSNE KUMADA, *National Institute of Bioscience and Human-Technology*, & GLYN W. HUMPHREYS, *University of Birmingham*—We examined effects of interference from task-irrelevant information in a patient with frontal lobe damage (F.K.), using reverse-Simon tasks; F.K. responded to the location of a word (LEFT or RIGHT) while ignoring the word meaning. When the location was incompatible with the word meaning, F.K. showed a large interference effect. When noninformative distractors (e.g., XXXX) were presented as a perceptual load in the display, the size of interference effect reduced as a function of the number of distractors. RT distribution analyses revealed that the reduction of interference was due to increased correct responses in the fast end of the distribution. This is consistent with perceptual load leading to early visual selection (Lavie, 1995). These results suggest that F.K. is intact in processing the location and meaning of words, but his frontal lobe damage impairs the control of attentional resources to the task-relevant information.

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**Validity Effects With Offset and Onset Distractors and Targets.** GARVIN CHASTAIN, *Boise State University*, & MARYLOU CHEAL, *Arizona State University*—Offset or onset targets were presented following either offset or onset distractors to determine whether validity effects would be stronger with distractors and targets of the same type than if they were of different types, in consonance with predictions based on attentional set for target type (Folk, Remington, & Johnson, 1992). However, in contrast to those predictions, validity effects were significant and approximately equal for all distractor- and target-type combinations. Thus being “set” for an onset target did not prevent capture by an offset distractor, and vice versa. Targets were E or H,

appearing among nontargets E, P, and b, in order to avoid any potential for a singleton detection strategy (Bacon & Egeth, 1994). These results were interpreted as showing that attention automatically is drawn by the appearance of a new object, whether it is produced by an onset or by an offset.

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**The Spatial Distribution of Inhibition of Return.** JAY PRATT & PATRICK J. BENNETT, *University of Toronto*—Previous findings regarding inhibition of return (IOR) showed that it is not strictly localized to cued locations but may extend to surrounding locations. To determine the spatial distribution of IOR, a series of experiments used 4 cue locations and varied the number of target locations (121 or 441), presence of placeholders at the cue locations, and stimulus onset asynchrony (SOA) (100, 200, 400, or 800 msec). With the placeholders present, IOR was restricted to the cued location and the expected pattern of early facilitation and late inhibition was found. Without placeholders, the spatial distribution of IOR was much broader, and inhibition occurred at both short and long SOAs. A systematic effect of the cue also was found in the other three uncued quadrants of the display. These experiments measure the spatial distribution of IOR with unprecedented resolution and show that the time course of inhibition depends strongly on the placeholders.

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**Elimination of Semantic Effects When Processing Local Form Information.** JANICE E. MURRAY & CRAIG JONES, *University of Otago*—Previous matching studies have shown that when processing of form is required, attention to a local part of a visual display results in automatic processing of semantic information derived from global shape (Humphreys & Boucart, 1997). This global dominance effect was replicated in an experiment in which participants attended to a single line segment inside a picture of an animal or a vehicle, and then decided which of two pictures in the target/distractor display that followed contained a line that matched the first in orientation. The semantic relations among the pictures were manipulated, and the expected semantic interference effects were observed. However, there was no evidence of any semantic processing when the line to be matched in the target/distractor display was embedded in letters inside the pictures. This suggests that attentional priority can be given to local information to the exclusion of global-shape information under certain conditions.

(259)

**A Cross-Modal Attentional Blink Without Task Switching.** KAREN M. ARNELL & JULIE M. LARSON, *North Dakota State University*—Previous experiments on cross-modal attentional blinks (ABs) have shown contradictory findings. Potter, Chun, Muckenhoupt, and Banks (1998) suggested that all findings demonstrating cross-modal ABs were an artifact of task switching, where attention was reconfigured between processing the two targets, and that this reconfiguration mimicked the AB. In the present experiment, the first target (T1) could be either visual or auditory, and the second target (T2) could be either visual or auditory. T1 and T2 modality were independent, and varied randomly trial to trial, so that the modality of each target on each trial was always unpredictable. Significant ABs were found in both within-modality T1–T2 conditions and in the auditory T1–visual T2 cross-modal condition. Results support the existence of both within-modality and central limitations on stimulus consolidation.

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**Repetition Blindness and Intrusion Errors.** JUAN BOTELLA, *Universidad Autónoma, Madrid*, MARIA ISABEL BARRIOPEDRO, *European University, Madrid*, & MIGUEL A. RUIZ, *Universidad Autónoma, Madrid*—From a model for the production of intrusions in Lawrence’s task based on a double route—one of successful focalization and the other of sophisticated guessing—it is predicted that, on

interfering in the focalization process, the hit rate will decrease but the pattern of intrusions will not present great changes. If any change should occur, it would consist in a slightly earlier origin of the intrusions. These predictions are tested by impairing the focalization process through the production of the repetition blindness effect and the use of the procedure employed by Kanwisher (1991, Experiment 6).

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**Factors That Influence the Choice of Strategy in Conjunction Search.** KENITH V. SOBEL, *Vanderbilt University*, & KYLE R. CAVE, *University of Southampton*—In conjunction searches, subjects try to find a target that is defined by a combination of two features from among several distractors. One set of distractors has one of the target's features, and the rest have the other feature. Some previous experiments have shown that subjects limit their search to those elements with a particular feature (target–feature strategy). In other experiments, subjects apparently determine the smaller of the two groups of distractors and search among this smaller group (smaller group strategy). Our experiments provide some evidence for both of these strategies, and indicate that the choice of search strategy is determined more by the relative discriminability of the relevant features than by the subjects' goals or instructions.

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**Inhibitory Control and Task Switching.** MARK E. FAUST & JOSEPH V. WILKINS III, *University of South Alabama*—Switching from one cognitive task to another often leads to a performance decrement in the second task compared with performance for the second task only. Although task switching costs may arise as a result of the time and effort required to reconfigure the cognitive system to perform the second task, task switching costs may also arise as a result of interference from the first task. On this view, an important determinant of efficient task switching is inhibitory control over processes associated with the first task. To test this hypothesis we assessed between-task interference effects by having participants alternate word selection criterion while naming words. The results indicate that specific aspects of the previous selection task (e.g., word color) can affect the efficiency of the current selection task (e.g., category membership) in a task switching paradigm, and that task switching paradigms may be useful as tests of inhibitory cognitive control.

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**The Role of Position Cuing in Short-Term Color Priming.** BRIAN A. GOOLSBY & SATORU SUZUKI, *Northwestern University*—Previous work by Maljkovic and Nakayama (1994) has demonstrated that shape discrimination on an oddly colored item (in a visual search display) is speeded in the subsequent trials in which the same target–distractor color combination is used. The present study investigated their suggestion that this facilitation is primarily due to the fact that observers had to attend to color to find the target. In Experiment 1, half the stimuli were preceded by a 100% valid cue that identified the target location (the position cue reduced RT to be similar to the RT for a single target display). Although observers need not use color to find the target in the cued trials, the priming effect persisted, suggesting that conscious use of color is not necessary for the priming. The results from Experiments 2–4 suggest that the priming occurs automatically when the color information is useful for distinguishing the target.

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**Does Unattended Information Facilitate Change Detection?** DANIEL SMILEK, JOHN D. EASTWOOD, & PHILIP M. MERIKLE, *University of Waterloo*—It is often difficult to detect a change between two alternating visual displays when a brief temporal interval separates successive presentations of the displays. To assess whether unattended visual information plays a functional role in directing attention to the location of such changes, observers searched for the location of a single changed item in pairs of displays consisting of 4, 7, 10, 13, or 16 letters or digits. Each change involved either a three-

feature or a two-feature change. The slopes of the search functions for locating the larger three-feature changes were shallower than the slopes of the search functions for locating the smaller two-feature changes. These results suggest that unattended visual information accumulates in memory and plays a functional role in guiding attention to the location of changes between successive displays.

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**Components of Task Priming in Task Switching.** PADMANABHAN SUDEVAN, JOHN HOLMES, TARA HOFKENS, ELIZABETH HORSWILL, & NATASHA RUETH, *University of Wisconsin, Stevens Point*—We have been studying task switching using a new technique that uses an interpolated task prime between the two tasks in order to overcome the adverse effects of switching. We report new work in which we study the components of such priming. In the first experiment, we studied consistent mapping of target stimuli to responses in pairs of tasks. We found, surprisingly, that response times showed a pattern very similar to that observed with distinct primed tasks such as odd–even or consonant–vowel classifications, although error rates were higher. We further explored the implications of this finding by using varied mapping of target stimuli to responses, and found similar results. We discuss the implications of these findings for strategy in task switching.

• HUMAN LEARNING/MEMORY •

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**The Name Game: Applied Retrieval Practice.** PETER E. MORRIS, *Lancaster University*, & CATHERINE O. FRITZ, *Bolton Institute*—In medium-sized groups such as classes, it is often desirable that the members become acquainted with one another. To this end, various methods of introducing group members are often used with only anecdotal evidence for their effectiveness. Bjork advocates one introductory method, the Name Game, based on the principles of retrieval practice. We compared two versions of the Name Game with a widely used introductory method—pairwise introductions—and found that the Name Game participants were much better at remembering other's names after 30 min, 2 weeks, and 11 months. In a second experiment, we tested the contribution of retrieval practice by comparing two versions of the Name Game with a procedure that matched them for number of repetitions and time spent on the task. Again the Name Games were much superior. Results are discussed in terms of applications in classrooms and other medium-sized groups.

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**Part Set Cuing With Coherent, Interrelated Materials.** CATHERINE O. FRITZ, *Bolton Institute*, & PETER E. MORRIS, *Lancaster University*—The part set cuing effect, the failure of cues that are members of the study set to facilitate recall, continues to resist a definitive explanation. Our approach to understanding the phenomenon is to take the effect to its limits by observing recall of stimuli that were presented in a coherent context, testing with and without part set cues. Surprisingly, a failure to facilitate was observed when participants were asked to recall information from expository text passages. Recall of objects presented as line drawings in a room context was also examined. Implications for understanding the part set cuing effect and for academic assessment are discussed.

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**Elimination of the Word Length Effect by Irrelevant Sound Revisited.** S. TREMBLAY, W. J. MACKEN, & D. M. JONES, *Cardiff University*—The “word length effect” refers to the tendency for lists of long words to be recalled less well than lists of short words. Theoretical and empirical objections are raised to a recent claim that irrelevant speech eliminates the word length effect (Neath, Suprenant, & LeCompte, 1998). A first experiment using a within-subjects design of adequate power ( $N = 65$ ) fails to replicate the recent finding, showing instead that the word length effect is not differentially elim-

inated by speech as opposed to tones. In a second experiment, the effect of change (repeated vs. changing sounds) is shown to be additive to the effect of word length for both speech and nonspeech. Irrelevant speech and irrelevant tones have comparable effects on lists of short words or lists of long words. This pattern of results is at variance with the feature model (e.g., Nairne, 1990) and consistent with the O-OER model (Jones, 1993).

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**Specifying the Locus of Divided Attention Effects at Retrieval.** MORRIS MOSCOVITCH & MYRA FERNANDES, *University of Toronto, Mississauga*—Previous research suggests that dividing attention during retrieval impairs free recall for words if the distracting task also involves memory for verbal material. The purpose of this study was to determine more precisely the locus of this effect. Experiment 1 tested whether interference would be maintained even when the distracting task did not involve memory but still involved verbal material. We found that verbal distracting tasks that required animacy or syllable decisions, but no memory load, interfered with retrieval as much as the same distracting tasks with a memory load. Experiment 2 tested whether interference was associated with the semantic or phonemic aspect of word processing in the distracting task. We found that semantic decisions about pictures did not interfere with free recall, but that phonemic decisions about nonwords, which had no semantic content, did interfere. These results suggest that the locus of the interference effect at retrieval is at the phonemic (or phonological) level.

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**Communicative Assumptions and the Malleability of Memory: Reducing the Effect of Misleading Postevent Information by Retrospective Source Invalidation.** GERALD ECHTERHOFF & WILLIAM HIRST, *New School for Social Research*—Loftus and colleagues reported that people's recollections of an event can be influenced by misleading postevent information (MPI), a result often interpreted as arising from source attribution difficulties. Our research investigated the communicative conditions that affect the accuracy of source attributions by drawing on Grice's principles of conversation. According to the Gricean maxim of quality, people have the default assumption that the communicator is truthful. Our hypothesis was that when people are given information that invalidates the source of MPI after having received MPI, they discard the default assumption that the maxim of quality is respected and resist the influence of MPI to a larger degree than when they keep the default assumption. Results of an experiment showed that the MPI effect was significantly reduced (from 41.2% to 11.6%) when the source was characterized retrospectively as a person who would hardly deliver a truthful description of the event to be remembered.

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**Response-Effect Learning Explains Serial Learning Under Implicit Learning Conditions.** MICHAEL ZIESSLER & DIETER NATKEMPER, *Humboldt University, Berlin* (sponsored by Peter A. Frensch)—Three experiments provide converging evidence that serial learning in a serial reaction task (Nissen & Bullemer, 1987) is based on response-effect learning. Under implicit serial learning conditions, participants learn the relations between their responses and the next stimuli. In Experiment 1, we varied the stimulus sequence and the response-stimulus relations. Despite identical response sequences, we found different serial learning effects that depended on the complexity of the response-stimulus relations but not on the stimulus-stimulus relations. In Experiment 2, transfer of serial learning from one sequence to another was found if both sequences had identical response-stimulus relations. Reaction times increased if the response-stimulus relations of the transfer sequence were more complex, even if the response sequence was not changed. Experiment 3 shows that a pure variation of the stimulus sequence had no effect on serial learning if the response-stimulus relations and the response sequence were held constant.

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**Source Monitoring and Choice: Do Our Decisions Seem to Get Better As We Age?** MARA MATHER & MARCIA K. JOHNSON, *Princeton University*—Participants were given several two-option choices, and then asked to review how they felt about their decisions, to review the details of their decisions, or to do an unrelated task. When later asked to attribute features to the previous options, in each condition older adults (64–83 years) attributed significantly more positive and fewer negative features to their chosen options than to foregone options. Younger adults' (18–22 years) attributions were as choice-supportive as those of older adults in the affective review condition, but were less so in the other conditions. This overall age difference was present even when older and younger adults were equated for source monitoring and recognition accuracy. This study suggests that as we age, our tendency to distort memory in favor of the options we choose increases. In addition, it suggests that affectively reviewing choices increases younger adults' tendency toward choice-supportive memory.

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**Children's Early Learning of Geometry.** PATRICIA BAGGETT, *New Mexico State University*, & ANDRZEJ EHRENFEUCHT, *University of Colorado, Boulder*—Teaching geometry in the early grades stresses that children recognize shapes, and not that they make measurements, draw, or construct objects, which require motoric actions. Several teachers in a school district in the southwest United States used materials in their classrooms that teach geometry through measurements in standard units and drawings and constructions using rulers, compasses, and protractors. Children's skill learning was evaluated by the quality of their work, and their understanding was evaluated through write-ups they were asked to do after finishing their tasks. Most of the materials used were very advanced for their grade level. The poster will show some materials, children's work, and their write-ups. The data indicate that advanced skills and understanding of geometry can be acquired earlier than is usually assumed, when geometry is taught as a process of construction, rather than recognition, of shapes and objects.

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**Exemplar-Based Learning and Its Transfer.** VERED YEHENE & JOSEPH TZELGOV, *Ben-Gurion University*—Memory-based approaches to automaticity argue that the representation underlying skilled performance is based on an exemplar learning mechanism, and thus it does not predict transfer of *old* tasks to *new* stimuli (e.g., Logan, 1988). The present study analyzes the components of an exemplar-based mechanism in performing *new* tasks on *old* stimuli. During training, subjects practiced performing a lexical decision task with the episodic priming paradigm. Thus, they practiced associating prime-target pairs taken from originally unrelated categories (e.g., Mexico–Forehead). After the learning phase, two different transfer tests were conducted. Results exemplify what components were attended in the learned exemplars, and which of them underlie automatic performance in the new task.

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**ERPs Reveal Sensory Signatures for True but Not False Memories.** MICHAEL A. STADLER, PETER M. WESSELS, & MONICA FABIANI, *University of Missouri, Columbia*—Using the Deese (1959)/Roediger and McDermott (1995) paradigm, lists of associatively related words were presented to one or the other visual hemifield for study. At test, studied words, related but nonpresented lures, and appropriate control items were displayed at fixation for recognition judgments. The hit rate for the studied words and the false alarm rate for the nonpresented lures were equally high (about 70%), whereas the false alarm rate for control items was comparatively low (about 20%). For studied items, event-related potentials (ERPs) recorded at test were lateralized according to the side of presentation during study, which suggests that processing of the item during study

left a “sensory signature” associated with the hemifield that first processed the item. ERPs were not lateralized in this fashion for the nonpresented lures, which was expected because nonpresented items should not, of course, leave any sensory trace.

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**Memory for Temporal Order.** ELKE E. VAN DER MEER, FRANK KRÜGER, & ANTJE NUTHMANN, *Humboldt University, Berlin*—The knowledge-based memory for temporal order of events was examined in semantic priming (Experiment 1) and fore-information with relation recognition tasks (Experiment 2). An identical set of variations was used in each task: the stimulus onset asynchrony (SOA) (200 vs. 1,000 msec) and the direction of the temporal order between prime or fore-information and target (prospective vs. retrospective). Response latencies, error rates, and pupillary responses served as dependent variables. A positive priming effect was observed with a 200-msec SOA (Experiment 1), suggesting that temporal order of highly typical event sequences (scripts) is stored in memory and is automatically activated. Retrospective items took longer to process with both tasks. These results converge with other studies in demonstrating that the temporal dimension in semantic memory is directional—that is, it emphasizes future time. Compared with RTs the pupillary responses reflect the time course of ongoing processes as well as the difficulty of the task with a greater sensitivity. The implications of our results for the representation of temporal order information in knowledge-based memory (Anderson, 1983, 1996; Friedman, 1990; Freyd, 1987, 1992) are discussed.

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**Adaptation to Auditory Distractors in a Cross-Modal, Color-Word, Interference Task.** EMILY M. ELLIOTT & NELSON COWAN, *University of Missouri, Columbia*—The effect of recent learning and memory on selective attention was examined using a cross-modal, Stroop-like task with acoustic distractors. The goal was to discover what conditions are best for the formation and use of a neural model of distracting sounds to facilitate selective attention, as reflected in reaction times. In one experiment, practice with the distractors was examined, and, in four additional experiments, color-naming trials were immediately preceded by preexposures to sounds that were different, similar, or identical to the auditory distractor. A robust cross-modal Stroop-like effect was replicated in five experiments. Practice and preexposure stimuli were shown to act in two ways: (1) by allowing the participant to learn to ignore classes of distracting stimuli and (2) by allowing the participant to avoid attentional distraction at the time of color naming. However, only the first specifically influenced the Stroop-like effect, presumably because it occurs outside of attentional control.

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**The Acquisition of Automatic Response Biases Through Stimulus-Response Association and Categorization.** YVONNE LIPPA, *Max Planck Institute for Psychological Research, Munich, and Indiana University*, & ROBERT GOLDSTONE, *Indiana University*—Two experiments explored whether spatially neutral stimuli acquire the ability to automatically elicit spatial responses. In Experiment 1, participants associated line drawings with either left or right keypresses. Subsequently, the pictures were used in a Simon task, wherein participants made left and right keypresses according to the color of the picture, ignoring its shape. Participants responded more quickly when the keypress previously associated with the picture matched, rather than mismatched, the response required by the picture’s color. In Experiment 2, participants learned response categories that grouped spatially ambiguous line drawings together with pictures of left- and right-pointing arrows. A subsequent Simon task again yielded compatibility effects, indicating that the spatially ambiguous pictures inherited the response biases of the other objects in their category. Thus, responses directly associated with shapes, and indirectly associated with shapes by category membership, are both automatically triggered even when the responses are irrelevant and inappropriate.

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**The Effect of Attentional Resources of Reading on Prospective Memory.** RICHARD L. MARSH, *University of Georgia*, & JASON L. HICKS, *Louisiana State University*—In the course of everyday cognition, people are often reminded of intentions that they formed at some earlier point in time. The demands of ongoing activities, among other variables, would seem to dictate to what extent these intentions are brought to mind or cued by environmental events. In fact, our previous work has suggested that noticing an event as relevant to an intention can require significant attentional resources (Marsh & Hicks, 1998). In this study we varied people’s level of engagement in reading stories (i.e., reading load). Embedded in the texts were event-based prospective cues to which people should have responded. Our working hypothesis was that more engaging texts would result in less noticing and worse prospective memory performance because of the greater attentional demands involved in reading such texts. The opposite pattern of results was obtained. The theoretical ramifications of these findings are discussed.

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**Long-Term Recall and Recognition Failure for Previously Performed Roles.** HELGA NOICE, *Elmhurst College*, & TONY NOICE, *Indiana State University*—Four experiments demonstrated remarkable long-term recall of previously performed roles by professional actors despite interference from learning many new roles. The first experiment, using a lexical decision task and a fill-in-the-blank task, found that discrimination and recall were perfect after a 3-month interval. The second, using a standard recognition task and a fill-in-the-blank task, found nearly perfect memory after a 12-month delay. Only after a 20-month delay were enough participants off-ceiling to permit contingency analysis, which revealed a positive relationship between recognition and recall (as predicted by the Tulving–Wiseman function). The final experiment found extraordinarily rapid relearning of a monologue after a 7-year delay, although pretesting had found the material to be completely unavailable. The results of all four experiments are discussed in the context of Bahrick’s (1984) permastore theory and Reyna and Brainerd’s (1992) notion of verbatim storage.

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**The Role of List Strength, Structure, and Presentation Modality in Recollective Experience Accompanying False Memory.** KATHARINE KRAUSE SHOBE, *Yale University*, & JOHN F. KIHLSSTROM, *University of California, Berkeley*—When people study a list of semantic associates, they are likely to falsely remember a critical nonpresented word that guided construction of the study list. Three experiments looked at the Deese false memory effect by examining false recall followed by recognition, recognition by confidence ratings, and recollective experience. Experiment 1 showed that false memory was greater with auditory than with visual presentation during study. Experiment 2 revealed that false recognition was greater after blocked than after random presentation; however, false recall only showed an increase in the blocked condition when word associates were presented prior to unrelated words. Experiment 3 demonstrated that word lists consisting of strong as opposed to weak associates produced more false memory. Moreover, as the study list strength decreased, the proportion of *remember* responses decreased while *feel* responses increased.

• RECOGNITION MEMORY •

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**Generating False Memories: Conscious or Nonconscious Spread of Activation During Study.** LORI BUCHANAN, NORMAN BROWN, & CHRIS WESTBURY, *University of Alberta*—We test the assumption that false memories in the Deese/Roediger and McDermott (1995) paradigm arise via conscious generation of the target item during study (cf. Underwood, 1965). Two hundred and fifty-six subjects made frequency judgments about words presented during study. In

one condition, subjects saw the study items for 2,000 msec each; in a second, the study items were presented at a rapid serial visual presentation (RSVP) of 72 msec per item. The testing phase was constant across conditions. Frequency judgments of nonpresented targets and absolute false alarm rates in the RSVP condition exceeded the same in the 2,000-msec condition. Test conditions were identical, thus implicating study manipulations as the source of this increase. These data are inconsistent with Underwood's hypothesis that false recognition arises as a consequence of conscious generation of target during the study phase. Rather, they support an unconscious spreading activation account of false memories.

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**The Discrepancy-Attribution Hypothesis and Familiarity, Part II.** BRUCE W. A. WHITTLESEA & LISA D. WILLIAMS, *Simon Fraser University*—Besides the perception of discrepancy, people can also experience their processing as being coherent or incongruous. We believe that these three states are the fundamental categories of subjective experience: Unconscious attribution about the source of these states is the source of a variety of human subjective experience. We have investigated the source of feelings of pleasantness and interest-iness, as well as feelings of familiarity. We demonstrate how variations in task and context affect the perception of discrepancy, coherence, and incongruity, and how those perceptions produce various subjective feelings.

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**Two Effects of Word Frequency: Recollection and the Mirror Effect.** PATRICK O. DOLAN & DAVID A. BALOTA, *Washington University*—A two-list "exclusion" test was used to investigate the impetus for the low-frequency word advantage in recognition memory tasks. Participants studied two unique lists of low- and high-frequency words and at test were required to identify words from one particular list among lure words, including words from the other study list (words to be "excluded"). A dual process account of recognition memory posits that context-free familiarity is in opposition to context-specific recollection for the to-be-excluded study list. False alarm rate to these items under a short (800-msec) versus a long (2,300-msec) response deadline indexes the relative amount of familiarity and recollection (respectively) for low- and high-frequency words. Results suggest that low-frequency words are associated with an increase in both familiarity and recollection.

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**A Comparison of Spontaneous and Implanted False Memories in Children.** LILIAN M. STEIN, *PUCRS*—Children's memory falsification was studied comparing spontaneous and implanted false memories under similar conditions, by introducing a new experimental paradigm. Children first studied sentences about everyday events. Either in the same day or a week later, misinformation was presented by replacing some of the original sentences with misleading ones. Children's memory was assessed by both an immediate and a one-week delayed forced-choice recognition test. Results indicated that children's memories were susceptible to the effects of misinformation. The comparison between spontaneous and implanted false memories yielded the following results: (1) Memory accuracy was greater in the immediate test; (2) misinformation effect was greater with delay; (3) implanted false memories were preserved across a one-week forgetting interval better than spontaneous false memories. Fuzzy-trace theory provided explanations that could account for the data by assuming that different classes of memory representations about experienced events—verbatim and gist—are retrieved on memory tests.

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**Is Object Representation Structural or Holistic?** FIONA N. NEWELL, *University of Durham*, & SHIMON EDELMAN, *University of Sussex*—Most theories of object representation can be classified as either structural or holistic. We tested the predictions of these current

theories in three experiments, using a priming paradigm. The structural description theories predict priming by "disembodied" parts or geons, whereas the holistic theories predict priming that depends on location of parts. We used a four-AFC classification task. Stimuli were composed of two out of four possible parts. The prime could be (1) identical to the stimulus, (2) identical only in the location of parts, (3) identical in parts but with different locations, or (4) altogether different. Both location and part identity effects were significant. In Experiment 3, we included a location-neutral prime condition which also proved significant. Our findings are not entirely compatible with either the structural or the holistic theories of representation. We propose a hybrid theory, within which conjunctions of shape and location are explicitly represented.

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**Qualitative Differences and the Mirror Effect: Support for Two Memory Influences.** STEVE JOORDENS, *University of Toronto*, & WILLIAM E. HOCKLEY, *Wilfrid Laurier University*—We demonstrate how qualitative differences can be used to support the contention of two different influences underlying performance in recognition memory. The experiments focus on the mirror effect—the finding that more memorable stimulus classes show an advantage over less memorable stimulus classes both in terms of hit rates and false alarm rates. Across a number of experiments we demonstrate that manipulations assumed to decrease the amount of recollection eliminate or even reverse the hit rate portion of the mirror effect while leaving the false alarm portion intact. Moreover, this occurs when the critical distinction between conditions is created during the test phase, or manipulated during the study phase. These results are completely consistent with a two-factor theory of recognition memory in which the two factors are familiarity and recollection.

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**Effects of Brief Encounters With Words Continue to Exist at Least for 10 Weeks.** TAKAFUMI TERASAWA, *Okayama University*—On the basis of an interpretation of the word frequency effect in recognition memory, we can predict long-lasting effects of a minor encounter with words on recognition memory performance. The experiment examined how performance in a recognition experiment (Session 2) was affected by a prior incidental study session 10 weeks earlier (Session 1). In Session 1, participants judged whether each presented word was a word or a nonword at the rate of 1 sec per word. The words can be classified into several item sets according to the number of presentations. In Session 2, the experimental group studied a list of words and completed a recognition test for that list. The list consisted of those words that had been presented in Session 1 and new words. The analyses of false alarms in the test compared with that of control groups who attended only Session 2 showed an effect of a single encounter in Session 1.

• IMPLICIT MEMORY •

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**Intact Involuntary Retrieval of Conceptual Information in Old Adults Depends on Associative Strength and Level of Processing.** CHRISTINA RAMPONI, *City University, London*, ALAN RICHARDSON-KLAVEHN, *Westminster University, London*, & JOHN M. GARDINER, *City University, London*—We examined whether involuntary priming on incidental conceptual memory tests is impaired in old adults. Experiment 1 compared old and young on incidental free-association and intentional cued-recall tests with identical associate cues. Level-of-study processing (graphemic, phonemic, semantic) and normative association strength of word pairs (strong, weak) were manipulated. For both strong and weak pairs, the intentional test showed a standard level-of-processing effect in young and old and impaired performance in the old. For strong pairs, the incidental test showed no priming advantage for semantic over phonemic processing and no impairment in the old. For weak pairs, the incidental test showed a priming advantage for semantic over phonemic

processing and impaired priming in the old. Graphemic processing reduced priming across the board. Experiment 2 suggested that these dissociations and associations between intentional and incidental tests neither reflected baseline differences between strong and weak pairs nor response-bias differences between tests.

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**Interindividual Differences in Implicit Versus Explicit Learning: Evidence From a Twin Study.** MICHAEL R. WALDMANN, *University of Göttingen*—Very little is known about interindividual differences in implicit versus explicit learning. Results of a large twin study conducted at the Max Planck Institute for Psychological Research will be presented in which approximately 300 monozygotic and dizygotic twins between the ages of 65 and 85 years participated. Implicit and explicit learning was assessed with a serial reaction time task, in which participants tracked a sequence of positions that followed a complex rule (second-order conditional), and an artificial grammar learning task. The study allowed us to trace the developmental course of implicit and explicit learning in elderly people, to analyze interindividual differences in implicit and explicit learning, and, most importantly, to estimate the contribution of genetic and environmental factors to interindividual differences (heritability analysis).

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**Levels-of-Processing and Priming Effects in Stem Completion Are Independent.** TERRENCE M. BARNHARDT, *University of Texas, Arlington*—The effects of levels of processing (LOP) (pleasantness judgments vs. counting enclosed spaces), response deadline (3.8, 3, 2.4, 2, 1.6, 1.3, 1, and 0.8 sec), number of alternative solutions (>10, 2–4, and 1), frequency of the nontarget alternative solutions (high vs. low), and subjects' level of memorial awareness (unaware, aware, or intentionally retrieving; assessed by a posttest questionnaire) on an oral stem completion test were examined. Priming effects were independent of LOP effects. Priming depended upon deadline, number of solutions, frequency, and awareness. The LOP effect depended on frequency and an interaction of solutions and awareness: The LOP effect increased as the number of solutions decreased in unaware subjects, whereas the LOP effect was rather stable across solutions in aware subjects. Finally, the correlation between priming and LOP was non-significant ( $r=.048$ ). Although inconsistent with the notion that LOP effects are attributable to contamination by explicit memory processes, the data support the notion of an automatic contribution of semantic processing to stem completion tests.

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**Parallel Relationships Between Conscious and Unconscious Processes in Memory Misattribution.** ETSUKO T. HARADA, *Hosei University*—Experiments were conducted to investigate whether there was an interaction between conscious recollection and memory misattribution based on automatic retrieval, using a task of subjective evaluation of computer-synthesized speech. In order to clarify the relationship of the two memory processes, clearness of speech at the learning phase was systematically manipulated by covering speech with three levels of noise: In the learning phase, subjects heard two-noun phrases with no, low, or high noise, whereas in the test phase, they listened to all phrases with low noise. The first two experiments showed no influence from explicit memory on the magnitude of memory attribution, either after semantic learning tasks (Experiment 1) or perceptual learning tasks (Experiment 2), although subjects showed the existence of explicit memory for the presented phrases (Experiment 3). Results supported the independence of conscious and unconscious memory processes, and also implied that implicit memory is goal dependent.

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**Visual–Auditory Cross-Modal Priming for Natural Events.** ANTHONY J. GREENE, *University of Georgia*, & LISA S. R. LASHELL & RANDOLPH D. EASTON, *Boston College*—Modality

specificity in priming is taken as evidence for independent perceptual systems. However, where appropriate, perceptual systems might share like information (Easton, Greene, & Srinivas, 1997). To test this, we assessed priming for visual and auditory events, within- and across-modalities. On the auditory priming test, visual study resulted in priming that was comparable to within-modal priming. On the visual priming test, auditory study resulted in no priming. The results were not attributable to recognition memory contamination. The priming results show that visual study facilitates identification on both visual and auditory tests, but auditory study facilitates performance only on the auditory test. Ecological considerations suggest that visual perception might inform and constrain auditory processing, whereas auditory perception corresponds to too many potential visual events as to usefully inform and constrain visual perception.

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**When Is Voice Priming Specific and When Is It Abstract?** BARBARA A. CHURCH & BRADLEY NEADERHISER, *SUNY, Buffalo*—Two experiments examined the specificity of memory for unfamiliar voices using an implicit and an explicit measure. Experiment 1 looked at the specificity of the representation after exposure to only one word said by the voice. Results showed a facilitation of perceptual discrimination performance (voice priming) and a very large reduction in both priming and recognition memory when the word said by the voice changed between study and test. Experiment 2 examined the specificity of the memory after exposure to five different words spoken by each speaker. The words were presented during the study phase either blocked by speaker or in a random fashion. Results, in the random condition, replicated the results of Experiment 1. However, there was no specificity effect in the blocked condition, suggesting the abstraction of general information about voice with variable experience. Findings are discussed in terms of connectionist accounts of learning.

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**Strength of Association and Overlapping Associates in List- and Sentence-Based Cued Recall.** NANCY R. GEE, *SUNY, Fredonia*—Two experiments are presented that examine the relationship between the strength of association and the number of overlapping associations shared by the cue and the target in a cued recall task. In the first experiment, subjects studied the items in a list-learning paradigm, whereas in the second experiment subjects studied the items in the context of sentences. The results indicated that performance was facilitated when the direct connection between the cue and the target was strong and when the cue and the target shared many overlapping associates. Additionally, these two variables interacted such that the effect of overlapping associates was more apparent when the direct connection between the cue and the target was weak relative to when it was strong. These results were consistent across both experiments. Predictions based on two different interpretations of spreading activation and two different versions of the PIER model will be evaluated.

• LETTER/WORD PROCESSING •

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**Orthographic Cues to Lexical Stress in Words With Variable Orthography.** JOANNA A. MORRIS, *Hampshire College*, & MICHAEL H. KELLY, *University of Pennsylvania*—Low-frequency words in English show a regularity effect in that regular words show advantages in naming and lexical decision tasks over irregular words. We have shown that the regularity effects found in the domain of segmental phonology can be extended to the domain of lexical stress. Disyllabic words whose spellings are consistent with their stress are easier to process than words whose spellings are misleading about stress. We conducted both a naming and a lexical decision experiment using words with two alternative spellings, one consistent and one inconsistent with the word's stress pattern. We predicted that subjects

would be faster and more accurate in both the naming and the lexical decision tasks on words spelled in a manner consistent with their prosody.

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**Graded Semantic and Phonological Effects in Lexical Processing: Implications for Morphology.** LAURA M. GONNERMAN, *Carnegie Mellon University*, ELAINE S. ANDERSEN & MARK S. SEIDENBERG, *University of Southern California*, & DAVID C. PLAUT, *Carnegie Mellon University* (sponsored by David C. Plaut)—Psycholinguistic investigations of morphological processing have focused on two major questions: (1) Are complex words decomposed in lexical access or in storage and (2) What are the roles of semantic and formal (phonological or orthographic) factors in morphological processing? These questions stem from a dictionary-like metaphor of the mental lexicon, in which words are listed either as decomposed or as whole forms. We present evidence from a series of cross-modal lexical decision experiments demonstrating graded priming effects as a function of degree of semantic and phonological similarity. Moreover, similar priming effects hold for items that are semantically and phonologically similar but morphologically unrelated. The results are awkward for accounts in which morphological decomposition is an all-or-none phenomenon, but follow naturally from a distributed connectionist perspective. On this account, morphology is not an independent component of the language system but, rather, characterizes the regularities in the learned mapping between semantics and phonology.

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**Consistency, Regularity, and Frequency Effects in Naming Chinese Characters.** CHIA-YING LEE, *Chung-Cheng University*, & ERICA CHUNG-I SU, DAISY L. HUNG, & OVID J. L. TZENG, *National Yang-Ming University*—Experiments on regularity and consistency effects in naming Chinese complex characters suggest that Chinese readers utilize a sublexical phonological processing strategy to read low-frequency complex characters. However, other studies suggest that the sublexical “phonological” route is nothing more than decomposing the phonetic radical of a complex character and using it access to its corresponding representation in the lexicon. In this study, subject’s naming performance on two sets of Chinese complex characters was used to differentiate these different accounts. The results of naming first set of characters replicated previous findings and suggested the effect of regularity could be separated from the effect of consistency. However, the phonetic radicals in the second set of characters were not legal Chinese characters and could not be pronounced alone; they also had no semantic representation. The significant consistency by frequency interaction was found for this set of characters. These results cannot be explained by the strategy of sublexical decomposition and suggest that Chinese readers do engage sublexical phonological processing in reading low-frequency complex characters.

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**Chocolate Dandy Bars Can Make You Fat: Semantic Context and Repetition Blindness.** ALISON L. MORRIS & CATHERINE L. HARRIS, *Boston University*—Recent investigations of the effects of sentence context on word recognition in RSVP support a two-stage modular interactive model of lexical access, in which the first stage is stimulus driven and produces multiple weighted candidates that interact with contextual information in a second stage. We investigated the timing of this second stage by examining the effects of sentence context on repetition blindness (RB). Since orthographic RB leads to deficits in lexical access, any factor that influences it must also occur during the same time frame. Subjects viewed RSVP sentences with leading context designed to induce misreading of the first critical word. When subjects misread *chocolate dandy bars* as *chocolate candy bars*, RB for a subsequent word *can* was increased. In contrast, when subjects misread *prevent forest fires* as *prevent forest fires*, RB

for a subsequent *fires* was decreased; correct reading of the sentence resulted in significant RB for the repeated *fires*.

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**Bigram Manipulation Effects in Lexical Decision.** CHRIS WESTBURY & LORI BUCHANAN, *University of Alberta*—We report the results of two lexical decision experiments designed to examine the effects of two-letter pair (bigram) frequencies within word and nonword strings. In Experiment 1, we demonstrate a disadvantage for high minimal bigram over low minimal bigram words, but only for high-frequency words. In Experiment 2, we show that manipulating the minimal bigram frequency in the nonwords only (keeping the words constant) has significant effects on LD RTs for words. Again, high-frequency words show a specific bigram-frequency disadvantage, but only when embedded in a background of nonwords with high minimal bigram frequencies. In contrast, low-frequency words showed a disadvantage most strongly when embedded in a background of nonwords with low minimal bigram frequencies. Results are discussed in terms of sublexical processes for high- and low-frequency words.

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**Item-Level Analyses of Lexical Decision Performance: Results From a Mega-Study.** DAVID A. BALOTA, MICHAEL J. CORTESE, & MAURA PILOTTI, *Washington University*—Thirty young and 30 older adults made lexical decisions to 2,903 single syllable words, and 2,903 length-matched single syllable nonwords. Independent groups of younger adults rated the words according to their subjective estimates of the words being read, heard, written, said, or encountered. The results of regression analyses indicated that the predictive power of traditional familiarity ratings on lexical decision performance encompassed both imageability and log frequency, whereas the predictive power of the new subjective estimate primarily encompassed log frequency. Coltheart’s *N* was positively related to nonword response latencies, and negatively related to word response latencies. In contrast to the 7.3% of variance accounted for in naming performance by log frequency in these same items (reported by Spieler & Balota, 1998), log frequency accounted for 26% of the variance in lexical decision performance. Item RTs and accuracy levels for both young and older adults are available on request.

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**The Interaction Between Semantic and Phonological Processes in Reading Aloud.** MICHAEL J. CORTESE, DAVID A. BALOTA, & JASON M. WATSON, *Washington University*—Two naming experiments addressed the interaction between semantic and phonological processes in younger adults, healthy older adults, and individuals with dementia of the Alzheimer’s type. Previous studies have shown relatively intact semantic/associative priming in individuals with Alzheimer’s disease, but an increased susceptibility to make regularization errors. Experiment 1 crossed prime associative relatedness and target orthographic-to-phonological regularity. In Experiment 2, regular and irregular words served as targets, but relatedness was varied such that a prime was related to a lure word (e.g., *tie-soot*, *tie* being related to *suit*, which is the regularization of *soot*). Preliminary results show that semantic/associative priming increases across age and dementia, but the effect of orthographic-to-phonological regularity decreases. The results are discussed in terms of contemporary models of word recognition.

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**Strategy Effects in Naming: A Modified Deadline Approach.** THOMAS M. SPALEK & STEVE JOORDENS, *University of Toronto, Scarborough*—In the past, naming has been conceptualized as a relatively pure measure of lexical access. However, recent findings by Lupker, Brown, and Columbo (1997) have shown that context can play a role in the naming task. Specifically, they found that if a mixture of slow and fast items was presented, the fast items were slowed and the slow items were sped up relative to when they were presented by

themselves. Therefore, naming is not as pure of a measure as had previously been assumed. The present work will investigate what happens to the frequency effect when the items are either sped up or slowed down. The results of human data will be supplemented by the results of Monte Carlo simulations to extend the Lupker et al. (1997) findings, and to modify the deadline model that they had put forth to account for their results.

• PSYCHOLINGUISTICS •

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**Conceptual Access in Bilingual Translation.** NATASHA TOKOWICZ & JUDITH F. KROLL, *Pennsylvania State University*—Most models of bilingual representation assume that words in the two languages access the same meaning. However, the observation that some types of concepts are translated more quickly than others suggested that word meaning is only partially shared across languages (De Groot, 1992). In the present study, we examined the effects of two aspects of concept representation on bilingual translation: word concreteness and number of translations. In Experiment 1 we failed to replicate past findings of a concreteness effect in bilingual translation using words that primarily had a single translation equivalent. In Experiment 2 we found that the time to translate concrete words was uninfluenced by the number of translation equivalents, whereas the time to translate abstract words was longer when additional translation equivalents were available. The implications of these results for models of bilingual language processing will be discussed.

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**On the Road to Two Routes: Accessing Gender in Spanish.** TAMAR H. GOLLAN, *University of California, San Diego*, MANUEL PEREA, *University of Valencia*, & AARON BAUER, *University of California, San Diego* (sponsored by Manuel Perea)—We assessed the ability of native Spanish speakers to access the grammatical gender of transparently marked (e.g., *casa*) and opaque (e.g., *leche*) nouns, and compared subjects with extended immersion in a primarily Spanish speaking environment (Spaniards) to those immersed in a primarily English speaking environment (Latin Americans). Both subject groups demonstrated strong effects of gender marking transparency. However, the Spaniards also showed a robust interaction with word frequency, whereas the Latin Americans demonstrated much less evidence of lexical involvement. A further difference between groups was that the Latin Americans (but not the Spaniards) demonstrated a robust gender by transparency interaction, suggesting greater reliance on a nonlexical route to gender. Untimed word translation and gender decisions also suggested that the acquisition of word meaning precedes the acquisition of grammatical gender. We interpret these findings within a framework based on dual-route and connectionist interpretations of the frequency by regularity effect previously discussed in the word recognition literature.

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**Working Memory and Writing: How Do They Relate?** LUCILE CHANQUOY, *Université de Montpellier*, & GUY DENHIÈRE, *Université de Provence and CNRS*—This research analyzed the relations between working memory spans and several writing tasks in third and fourth graders. First, working memory spans were measured with three tests: a reading span test, a speaking span test, and a writing span test. Second, writing measures were obtained through four tasks: two narrative texts to write down, and a dictation and grammar exercises. For these tasks, the dependent variables were the number of words and clauses, a measure of quality, and a percentage of errors. For both levels, significant correlations between working memory spans and written measures appeared. The stronger correlations were noticed between reading spans and narrative measures. Precise relationships between working memory spans and the quality of writing also clearly appeared. The increase of the working memory span

and/or the automatization of some writing processes would therefore be linked to an increase in writing expertise and, thus, quality.

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**Sequential Activation Processes in Producing Words and Syllables: Evidence From Picture Naming.** JULIO SANTIAGO, *Universidad de Granada*, DONALD G. MACKEY, *UCLA*, ALFONSO PALMA, *Universidad de Granada*, & CHRISTINE RHO, *UCLA* (sponsored by Deborah M. Burke)—This study examines picture naming latencies for predicted effects of two word retrieval factors: onset complexity and number of syllables. In Experiment 1, naming latency was longer for depicted words with two syllables (e.g., *demon*) than one syllable (e.g., *duck*), and longer for words beginning with consonant clusters (e.g., *drill*) than single consonants (e.g., *duck*). Experiment 2 replicated these results and showed that vowel nucleus and coda complexity did not interact with onset complexity and did not affect naming latency. Moreover, effects of onset complexity and number of syllables were additive and unrelated to word frequency, articulatory factors, or picture complexity. These results comport with evidence from speech errors and metalinguistic tasks and with predictions of the node structure theory of language production, but do not support production theories that do not predict special processing difficulty for words with complex onsets and multiple syllables.

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**ERP and RT Evidence for Inhibition Between Alternative Meanings of Ambiguous Words.** DOROTHEE J. CHWILLA & HERMAN H. J. KOLK, *Nijmegen University NICI* (sponsored by Wido La Heij)—We investigated the effects of multiple primes that converged onto the same semantic representation (e.g., LION–STRIPES–TIGER) or diverged onto different semantic representations (e.g., KIDNEY–PIANO–ORGAN). Balota and Paul (1996) showed that inhibition of alternative meanings of ambiguous words only occurs if participants are “forced” to select one meaning of the ambiguous word. In a relatedness judgment task, we replicated their RT inhibition effect and extended this inhibition effect to ERPs—that is, for ambiguous stimuli the facilitation for two related primes was smaller than the sum of the facilitation of two single related primes. In contrast, for unambiguous stimuli, additivity was found for RT, whereas for ERPs, an overadditive priming pattern was observed. The fact that the ERP inhibition effect was more robust in a relatedness judgment task than in lexical decision (Chwilla & Kolk, 1998) indicates that readers have at least some control about a given processing pathway (lexical vs. semantic).

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**Gender Interference in Speech Production: The Case of German.** NIELS O. SCHILLER & ALFONSO CARAMAZZA, *Harvard University*—Two picture-word interference experiments investigated the role of grammatical gender in noun phrase production in German. In the first experiment, participants named pictures in the singular or in the plural with their determiners. Naming latencies were longer when picture name and distractor word did not have the same gender than when they agreed in gender. However, this was only the case in the singular, where different determiners mark the different genders, but not in the plural, where all three genders take the same determiner. Therefore, the interference may occur at the level of determiner selection, rather than at the level of gender selection. This hypothesis was confirmed in a second experiment in which adjective–noun phrases were produced. Picture naming latencies were just as long when picture name and distractor word had the same gender than when they had different genders, both in the singular and in the plural.

(310)

**Gender and Number Agreement in Sentence Comprehension in Spanish.** MANUEL CARREIRAS & ENRIQUE MESEGUER, *Universidad de la Laguna*—An experiment examined the processing of subject–verb agreement in sentence comprehension in Spanish. Eye

movements were recorded while participants read sentences that contained a complex noun phrase, composed of two noun phrases, followed by a copulative verb and a predicate (e.g., *The name of the child was German....*). The verb and the adjective always agreed with the first noun phrase. The gender and/or the number of the second noun phrase could match or mismatch that of the first noun phrase. The results showed that a mismatch of gender and/or number of the second noun phrase increased the reading time of the verb and following regions. The effects of gender and number mismatch did not interact. The results suggest that readers compute immediately and separately number and gender agreement relations.

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**“Priming” Does Not Prime “Priming.”** MATTHEW J. TRAXLER & DONALD J. FOSS, *Florida State University*—Lexical priming effects have been attributed to spreading activation in the lexicon, message-level influences, or some combination of the two. Three self-paced reading experiments investigated the source of priming effects in sentence comprehension. In the first two experiments, sentences containing strong associates of previously encountered words were read more slowly than sentences containing no such associates. In the third experiment, repeated words were read more slowly than nonrepeated words. We propose that in normal language comprehension, mental models, rather than schemas or scripts, enable facilitated processing of words. Spreading activation does not influence access or integration.

• DEVELOPMENTAL/AGING: MEMORY •

(312)

**Superior Performance in Older Adults Resulting From Cognitive Control and Working Memory Impairments.** TODD S. BRAVER, DEANNA M. BARCH, & BETH A. KEYS, *Washington University*—The effects of context processing on cognitive control were examined in a version of the continuous performance test. Participants were required to make a target response to a specific probe (X) when immediately preceded by a valid cue (A), and a nontarget response in all other cases. A long delay (5 sec) between the cue and probe ensured that the context provided by the cue be actively maintained in working memory. Target (AX) trials occurred with high frequency, producing both expectancies following the cue and response biases to the probe. Older adults ( $N=81$ ) showed specific deficits on “BX” trials, in which context maintenance is required to inhibit the response bias, but performed significantly *better* than younger adults ( $N=175$ ) on “AY” trials, in which context-based expectancies impair performance. These results support the hypothesis that age-related deficits in cognitive control result from a failure to actively maintain context information.

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**Age and Individual Differences in Working Memory: Individuals With Larger Spans Show Larger Interference Effects.** LISA A. JENKINS, *University of North Carolina, Wilmington*, & JOEL MYERSON & SANDRA S. HALE, *Washington University*—Visuospatial memory span was assessed with and without secondary tasks in young and older adults. A single secondary task produced a 2-item decrease in span for young adults and a 1.3-item decrease in span for older adults, whereas a double secondary task produced a 3.5-item decrease in span for young adults and a 2.2-item decrease in span for older adults. Surprisingly, neither young nor older adults’ interference effects were correlated with the time spent performing either the single or double secondary task. Within each age group, subjects with *larger* spans showed *larger* interference effects. Results support a model of age and individual differences in working memory proposed by Jenkins, Myerson, Hale, and Fry (1999).

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**Age-Related Changes in Memory Function Under Interference Conditions.** DARLENE FLODEN, DONALD T. STUSS, & FER-

GUS I. M. CRAIK, *Rotman Research Institute* (sponsored by Endel Tulving)—This research addressed the inconsistency in previous reports concerning age-related changes in performance on a well-known short-term memory test with interference, the Brown–Peterson task. Specifically, do older adults show a disproportionate decrease in recall accuracy as a function of delay length and, if so, does this reflect an age-related difference in rate of forgetting from primary memory or the influence of impaired secondary memory processes at longer delay intervals? A variation of the task was developed to control for extraneous factors, such as task difficulty and amount of interpolated stimuli, that may have confounded the results of previous Brown–Peterson studies of aging. The results indicate that aging is not associated with an accelerated rate of forgetting. Rather, the increased slope of the forgetting function is attributable to age-related deficits in secondary memory, possibly arising from frontal dysfunction.

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**The Density Theory of Aging.** PATRICK CONLEY & CURT BURGESS, *University of California, Riverside*, & CATHERINE DECKER, *Chaffey College*—Three experiments using the HAL model of memory demonstrated a relationship between age and density in a high-dimensional semantic space. Using corpora of text gathered from younger and older adults, HAL demonstrated the same preservation of priming between older and younger adults as seen in previous studies (Howard, 1998). However, the results provided evidence that age and representational density are linked in the HAL model. Age was operationalized in HAL in two ways: external, with older and younger adults providing different text corpora for analysis, and internal, with greater information added to the HAL model representing greater experience. Both increasing the information available to HAL and providing the model with text generated by older adults resulted in denser representations in semantic space. We hypothesize that density in semantic space may provide a model for effects commonly detected in aging.

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**Relationships Between Memory and Personality in Adults Aged 67–95.** BEAT MEIER, PASQUALINA PERRIG-CHIELLO, & WALTER J. PERRIG, *University of Bern* (sponsored by Walter J. Perrig)—In this study the relationship between personality and memory in a sample of 281 healthy adults 67–95 years of age is examined. Neuroticism and extraversion versus introversion were assessed with a standardized personality inventory, and their influence on semantic and episodic memory was investigated. For data analysis, a quasi-experimental and a regression-analytical approach in which the effects of age, gender, and education were taken into account were applied. Both analyses support the hypothesis that personality traits should be considered as determinants of cognitive performance. Results revealed that, in general, lower neuroticism and higher extraversion are associated with better memory performance in older adults. The relevance of these findings for theories of memory and personality is discussed.

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**Age Differences in Recognition for Both Spoken Targets and Distractors.** PATRICIA A. TUN, GAIL C. ROSS, & ARTHUR WINGFIELD, *Brandeis University*—When younger adults (ages 17–19) and older adults (ages 67–81) recalled spoken target sentences heard in quiet or with to-be-ignored distracting speech in the background, older adults’ recall for target material was impaired more than the young by the background speech. However, in a later recognition test, the younger adults were more likely than older adults to correctly recognize material from the distracting speech. These findings suggest that younger adults’ greater processing capacity permits them to accurately store more information about both targets and to-be-ignored material than do older adults. We interpret these data in terms of disinhibition and capacity theories of cognitive aging.

## • SOCIAL-PERSONALITY PROCESSES •

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**Salience of Components in the Perception of Anger Expression.** NANCY ALVARADO & KIMBERLY A. JAMESON, *University of California, San Diego* (sponsored by John Wixted)—This study explores whether meaning is decoded from facial expressions in terms of additive combinations of components or as integral patterns. It tests the salience of specific movement cues (action units) in the categorization of anger expressions. In Study 1, triad and paired-comparison similarity data were analyzed using consensus analysis, multidimensional scaling, and a numerical scaling model. Task invariance, as evidenced by reciprocal meaning between label and expression across tasks, was found for only the expression most closely matching Ekman and Friesen's hypothesized anger expression. Specific movement cues did not systematically relate to specific anger-term labels, although they were related to categorization decisions and consensus. In Study 2, a speeded-response delayed matching-to-sample task showed cognitive interference for only those expressions containing the hypothesized anger components, not expressions containing partial sets of movement cues. Taken together, these results support decoding of expressions as patterns rather than components.

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**College Students' Perceptions of Hillary Clinton's Marital Relationship.** HELEN SWANSON, CHERYL BECKER, BETH WINGE, & TAMMY SMITH, *University of Wisconsin, Stout*—We assessed whether college students perceived Hillary Clinton as an enabler of the President's marital infidelity or as a benevolent public servant and spouse, during December 1998, just weeks before the decision favoring impeachment. Participants were 79 females and 76 males at an upper midwestern state university. A 2 (gender)  $\times$  3 (scale) mixed design MANOVA showed a main effect for scale [ $F(2,306) = 123.53, p = .001$ ], with no gender differences. A Newman-Keuls test showed differences between all means, with enabling (2.99,  $SD = 1.10$ ), detached (3.87,  $SD = 1.20$ ), and benevolent (4.9,  $SD = 1.02$ ) ratings in ascending order on a scale of 1 (*strongly disagree*) to 9 (*strongly agree*). A self-projective measure showed majority support for immediate or eventual divorce in said situation. Results are interpreted using Godfrey and Lowe's (1975) model regarding the influence of intrinsic versus extrinsic motivation on victim devaluation.

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**Incriminating Pretrial Publicity and Inadmissible Testimony Influence Mock Juror Verdicts.** GARY J. GARGANO & CATHERINE MCKEEVER, *Saint Joseph's University*—Previous research shows that "mock juror" verdicts are influenced by inadmissible testimony (Sue, Smith, & Caldwell, 1974). The present study investigates whether incriminating pretrial publicity will also affect mock juror verdicts. Participants read a newspaper account of an armed robbery that mentioned incriminating evidence found in the suspect's residence. Participants then read a transcript of the court trial. The incriminating evidence was mentioned, not mentioned, or ruled inadmissible in the transcripts. Following a short retention interval, participants were asked to render a verdict based only on the evidence presented in the transcripts. The results indicated more guilty verdicts were given when the testimony was mentioned, regardless of whether it was ruled admissible or inadmissible. In addition, when the testimony was not provided in the transcript, nearly half of the guilty verdicts were based solely on the evidence mentioned in the pretrial publicity. The findings suggest that pretrial publicity and inadmissible testimony both influence mock juror verdicts.

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**On-Line Processing of Stereotypes During Spoken Language: A Moment-to-Moment Processing Approach.** ROBERTO R. HEREDIA & TRACIE L. BLUMENTRITT, *Texas A&M International University*—Why is it that everyone thought about the Middle East during the

Oklahoma City bombing? This study explores the processing of stereotypes during on-line sentence comprehension. Participants listened to stereotyped target words embedded in sentences (e.g., Pete realizes the importance of assuring that *terrorists* do not have access to airports or any other type of security system) and then made lexical decisions to targets related to the literal meaning (e.g., *bomb*) and to the figurative interpretation of the stereotype (e.g., *arab*). Critical targets were presented at prime offset. Facilitative priming was found, but only for the target related to the literal interpretation of the stereotype. The figurative related target was no different than an unrelated control. The view that stereotypes are a special case of figurative language is examined. The results are discussed in terms of current models of language processing and social cognitive models of how stereotypes are processed.

## • INDIVIDUAL DIFFERENCES •

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**Memory Capacity, Processing Speed, and Fluid Intelligence: Is Working Memory Capacity =  $g$ ?!** ANDREW R. A. CONWAY, *University of Illinois, Chicago*, NELSON COWAN, *University of Missouri, Columbia*, & MICHAEL F. BUNTING, DAVID THERRIAULT, & SCOTT MINKOFF, *University of Illinois, Chicago*—The relationship between working memory capacity, short-term memory capacity, processing speed, and fluid intelligence was investigated using a latent variable approach. One-hundred twenty subjects performed multiple measures of working memory capacity, including reading span, operation span, and counting span; multiple measures of short-term memory capacity, including simple word span with a fixed or free pool of words with or without concurrent articulation; multiple measures of processing speed, including digit-symbol substitution, letter and pattern comparison, and digit copying; and two measures of fluid intelligence—Raven's Progressive Matrices and Cattell's Culture Fair Test. Results demonstrate a very strong relationship between working memory capacity and fluid intelligence. Furthermore, results indicate that processing speed does not predict fluid intelligence. We suggest that "complex" span tasks, such as reading span, operation span, and counting span, tap a general working memory capacity that is strongly related to, if not isomorphic to, controlled attention and Spearman's  $g$ .

## • HUMAN PERFORMANCE •

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**Concurrent Temporal and Spatial Learning in a Serial Reaction Time Task.** JACQUELINE C. SHIN & RICHARD B. IVRY, *University of California, Berkeley*—In a serial reaction time task, the series of events simultaneously defined spatial and temporal sequences. The two sequences were either of equal length and thus could be integrated, or of unequal length. By randomizing the events along the dimensions independently, learning was assessed. Although the spatial sequence was learned regardless of whether the temporal sequence was of equal or unequal length, temporal learning was only observed when the two sequences were of an equal length, allowing integration. Furthermore, spatial sequence learning was greater in the presence of the temporal sequence relative to a condition in which the timing was random. This effect is attributable to either perceptual-motor scheduling or the use of temporal information to disambiguate context. Temporal information appears to be an integrated part of the representations of actions, and unlike other dimensions, cannot be learned independently from the action.

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**Improving Pilot/ATC Voice Communication in General Aviation.** O. VERONIKA PRINZO, *FAA/Civil Aeromedical Institute*, & DANIEL G. MORROW, *University of New Hampshire*—The influences of air traffic control (ATC) instructional format and message length on pilot read-back of ATC messages were investigated.

Following familiarization training, 24 general aviation pilots were asked to read back ATC instructions during simulator flights. Altitude and radio frequency instructions were presented orally either in grouped format (“forty-one-hundred”) or sequentially (“four-thousand-one-hundred”). Short and long messages (3, 5 speech acts) were counterbalanced according to phase of flight. Limited evidence was found that the grouped format improved read-back performance. However, altitude and radio instructions presented in grouped format did generate fewer requests for clarification. Message length had a more clear-cut influence; read-back errors and requests for clarification increased with message length.

(325)

**Imagining Physically Impossible Transformations: Geometry Is More Important Than Gravity.** SARAH H. CREEM, *University of Virginia*, MARYJANE WRAGA, *Harvard University*, & DENNIS R. PROFFITT, *University of Virginia*—Spatial updating refers to our ability to keep track of positions of objects after real or imagined movement. We have shown that it is easier for observers to update displays after imagining themselves rotating to a new position than after imagining the objects rotating. The present studies asked observers to imagine self-motions that defied the laws of gravity. They were asked to imagine rotating around a four-object array or to imagine the rotation of the array itself. The self-movement involved physically impossible rotations such as lying prone and walking on the wall. When an orthogonal relationship (real or imagined) remained between the self and observer, updating after self-rotation was easier. When this relationship was not preserved, the self-advantage was lost. These results suggest that imagined self-transformations rely on self-to-object relations that preserve our everyday experience with transverse rotations, rather than internalized principles of gravity.

(326)

**The Role of Optic Flow in Human Path Integration.** ANDREW DUCHON, MELISSA BUD, WILLIAM H. WARREN, & MICHAEL J. TARR, *Brown University*—Studies of the blind and blindfolded sighted find that these subjects can use nonvisual (e.g., vestibular and proprioceptive) information to find their way “home” after walking two legs of a triangle. While roughly accurate, there are systematic errors in their paths. We examined the role of visual information in this task. Subjects used a joystick to guide themselves in a virtual reality environment that had a floor only, a wall only, or both. All visible surfaces were highly textured in order to provide optic flow information. Performance with a floor only was more inaccurate, and with a wall only, more variable. Overall, however, biases were similar to those from previous studies. Further studies will have subjects wear a head-mounted display and physically walk through a large virtual environment. In this set-up, we can examine all combinations of visual and nonvisual information in this task.

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**Synchronization Error: An Error in Time Perception.** ANDREAS WOHLSCHLÄGER, *Max Planck Institute for Psychological Research, Munich*—When synchronizing finger taps with regular clicks, the tap leads over the click. On the basis of the idea that the emptiness of the interval between two clicks (ISI) might distort time perception, we investigated whether structuring the ISI has an influence on this negative synchronization error (NSE). In Experiment 1, we added a rhythm to the clicks. In Experiment 2, 10 additional clicks were added per ISI at random points in time. Experiments 3 and 4 investigated whether structuring the ISI by performing additional movements also reduces NSE. The more contact-free in-between taps subjects performed, the more NSE was reduced. In summary, results showed that structuring the ISI by adding auditory signals or limb movements leads to a reduction of the asynchrony. The main problem in synchronization is to estimate the time elapsed since the last click. We argue that structuring the ISI improves the perception of elapsed time.

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**Reaction Time Distribution and the Locus of Processing Variability in the Simon Task.** GREGORY STEVENS & SYLVAN KORNBLUM, *University of Michigan*—Distributional analysis of RT in Simon tasks has been proposed as a measure of the time course of that effect (DeJong, Liang, & Lauber, 1994). We show that the slope of the plots produced by this analysis varies greatly and systematically depending on (1) whether variability originates in the stimulus identification, the response selection, or the motor execution process, and (2) whether one assumes discrete or continuous processing. Our results, which are supported by simulations, imply that caution must be exercised when interpreting distributional analysis plots as measures of time course.

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**Delayed Auditory Feedback: Evidence for a Critical Interval Shift.** STEVEN A. FINNEY, *Ohio State University*—Impairment under delayed auditory feedback (DAF) has been reported in tasks such as speech, tapping, and music performance, with qualitatively similar impairment in each. One characteristic of the DAF effect in adult speech is maximal impairment at a delay near 200 msec (the “critical interval”), with less impairment occurring at shorter or longer delays. There are, however, conflicting data about whether or not this critical interval is affected by performance rate. The current research investigated rhythmic tapping under DAF, and unequivocally established that the critical interval in this task is affected by tapping rate, with a longer delay causing maximal impairment at slower tapping rates. These results are compared with the data reported for speech, and discussed from the perspectives of feedback control, entrainment, and Mackay’s (1987) node structure theory.

• ANIMAL COGNITION •

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**Spatial Learning in Short-Beaked Echidnas (*Tachyglossus aculeatus aculeatus*).** DARREN BURKE & RAELEEN QUINCE, *University of Wollongong*—Echidnas are important subjects for comparative studies of spatial learning because they are phylogenetically and neuroanatomically unusual, and because their food (ants and termites) occurs in stable, spatially isolated clumps, potentially providing selection pressure for an ability to be able to remember and relocate food-rich locations. As a preliminary investigation of this, two echidnas were tested for their ability to use landmark configurations to specify the location of a food dish. In Experiment 1, only a configuration of small, discrete, moveable landmarks specified the location of the correct dish. This led to no evidence of learning after 70 trials, so in Experiment 2 the landmarks did not move between trials. This produced strong evidence of learning the correct location. When a stable baseline of zero errors was reached, the experimental enclosure was altered to determine what information the echidnas were using to do the task.

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**View-Dependent Scene Recognition in Pigeons.** JENNIFER E. SUTTON & WILLIAM A. ROBERTS, *University of Western Ontario*—The current research investigated pigeons’ generalization over novel views of an array of 3-D objects. The array was photographed at a constant height from 24 different viewpoints rotated in depth (every 15°). Pigeons were trained using a successive discrimination procedure to discriminate one viewpoint of the array (S+) from a different arrangement of the same items (S-) and were then tested with the entire set of 24 S+ viewpoints. Response latencies and peck rates to test stimuli were consistent with a view-dependent theory of object and scene recognition and showed a pattern similar to data obtained by Diwadkar and McNamara (1997) with human subjects in a comparable task.

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**Behavioral Decisions for Managing Social Distance and Aggression in Polar Bears (*Ursus maritimus*).** AISLINN L. KELLY

& MICHAEL J. RENNER, *West Chester University*—Although polar bears (*Ursus maritimus*) are typically solitary in the wild, captive bears are typically socially housed. We report behavioral evidence about decisions used by bears for managing this situation, and whether proximity leads to aggression. Two female polar bears were observed at the Philadelphia Zoo for over 100 h; the samples represented all times of day that bears spent in the enclosure (off-exhibit time is spent apart, in separate indoor dens). Location and behavior were recorded once per minute for each bear. When either bear changed locations, she more frequently moved away from the other bear than toward, resulting in increased interindividual distance. Although the bears spent a relatively low proportion of the time occupying the same zone within the enclosure, proximity did not routinely lead to overt aggression. These data indicate that polar bears make behavioral decisions to manage social distance, resulting in minimization of aggression.

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**Judgments of Numeric Symbols and Quantities by Macaques.** JONATHAN P. GULLEDGE, DAVID A. WASHBURN, & DUANE M. RUMBAUGH, *Georgia State University*—In this series of experiments, rhesus monkeys responded either to quantities of computer-generated dots or to Arabic numerals. In the first study, five monkeys learned to select the larger of two dot arrays or the larger of two Arabic numerals, even though the animals were reinforced regardless of their selection. On novel presentations of mixed-stimulus trials (e.g., four dots vs. the numeral 5), the monkeys were significantly accurate in selecting the larger quantity, even on the first presentation of each possible pair. Subsequently, this finding was replicated with a naive monkey that was reinforced with a single pellet only on dot-dot trials solved correctly. These results, plus the animals' responses to equal quantities (e.g., six dots and the numeral 6) suggest a number concept for these symbols that cannot be explained on the basis of hedonic value of the stimuli, prior learning of a matrix of relative values, or specific reinforcement.

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**Simultaneous Temporal and Spatial Processing.** JONATHON D. CRYSTAL, *University of Georgia*, & BENJAMIN J. MILLER, *College of William & Mary*—The experiments investigated simultaneous temporal and spatial processing. A food tray was embedded in each wall of a square box. A fixed-interval schedule was active at one location on each trial. The active location moved clockwise across trials. The sequence of fixed intervals (60, 30, 30, and 60 sec) was repeated throughout 35- to 40-min daily sessions. In Experiment 1 ( $n=7$  rats), response rates increased at appropriate locations and times. However, spatial and temporal errors occurred. Response rates failed to superimpose when plotted in proportional time units. To investigate the failure of superposition, a penalty was added in Experiment 2 ( $n=6$ ). The number of food pellets per trial was contingent on few responses at incorrect locations to reduce spatial and/or temporal errors. Spatial, but not temporal, errors occurred, and the data superimposed. These data suggest that simultaneous temporal and spatial errors, but not spatial errors alone, interfere with scalar timing.

• ANIMAL SENSORY PROCESSES •

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**Stimulus Size and the Pigeon's Ability to Recognize Objects.** JESSIE J. PEISSIG, MICHAEL E. YOUNG, & EDWARD A. WASSERMAN, *University of Iowa*, & IRVING BIEDERMAN, *University of Southern California*—It is important for adaptive behavior that organisms recognize objects at different distances despite the attendant size changes of the retinal image. Pigeons were trained with four objects: an arch, a barrel, a brick, and a wedge. The birds learned to make a different response for each of the objects. One group of pigeons was trained with five depth rotations of each object and a second group was trained with a single depth rotation. After

achieving a high level of accuracy, birds were tested with several different sizes of one of the training rotations: three larger sizes and three smaller sizes that differed from the original by 25%, 50%, and 75%. The pigeons' performance indicated a systematic recognition decrement as the objects varied increasing amounts from the original training size.

• CATEGORIZATION •

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**Abstraction of Distributionally Defined Categories and Grammatical Rules.** REBECCA L. GOMEZ, *Johns Hopkins University*, & ROGER W. SCHVANEVELDT, *New Mexico State University*—We investigated conditions promoting abstraction of distributionally defined grammars. Strings were generated by the grammar,  $S \rightarrow (aXbY \text{ or } bYaX)$ , where  $a$ ,  $X$ ,  $b$ , and  $Y$  were instantiated by distinct characters—for example,  $a \rightarrow (R, C)$  and  $X \rightarrow (N, B, T, L)$ . Frequency of particular pairings was manipulated during training. Some possible pairs were not presented at all. Subsequently, some learners judged whether pairs conformed to the rules (rule test). Others received recognition instructions (memory test). Accepting grammatical unstudied pairs (GUPs) as legal implies induction of distributional categories and/or grammatical rules. The basis of induction is further clarified by the memory test. Correctly judging GUPs as new implies that induction is an independent process, whereas false recognition of GUPs implies that grammatical structure affects memory of instances. Our experiments suggest that any induction requires some preexisting structure. With complete category structure, induction overrides memory for specific instances. With partial structure, induction and memory are independent processes.

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**Lexical and Relational Priming in Conceptual Combination.** CHRISTINA L. GAGNÉ, *University of Western Ontario*—The data demonstrate two ways in which a recently encountered combination (e.g., *oil moisturizer* or *surgery treatment*) influences the interpretation of a similar combination (e.g., *oil treatment*). First, it increases the availability of the lexical entries for the modifier and head noun. Second, when the prime and target combinations share the same modifier, the prime combination increases the availability of the relation used to interpret the target combination. For example, the relation "noun USES modifier" is more easily selected when *oil treatment* has been preceded by a combination (e.g., *oil moisturizer*) using the same relation than when preceded by a combination (e.g., *oil accident*) using a different relation. However, only lexical priming is observed when the head noun is in common. The data are consistent with the view that relational information is associated with the modifier and not with the head noun.

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**Variability Along Relevant Dimensions in Classification.** ARTHUR B. MARKMAN & W. TODD MADDOX, *University of Texas, Austin*—Research demonstrates that people have difficulty learning to classify multidimensional objects when there is irrelevant variation along the relevant components. For example, observers had difficulty learning to classify objects when the number of legs was relevant for accurate classification, and the shape of the legs varied across trials (Yamauchi & Markman, in press). We explore the influence of relevant dimension variation in the same task (e.g., variation in leg length when leg length is relevant). Research suggests classification tasks with relevant dimension variation can be learned straightforwardly (e.g., Ashby & Maddox, 1992). Nonetheless, in a classification task with an exception feature structure, relevant dimension variation made classification learning difficult. This difficulty had two primary sources: (1) determining the perceptual boundary between values characteristic of one category and another, and (2) dealing with the larger number of potential exemplars as the number of possible manifestations of a feature increases.

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**Cue Competition and Salience in Probabilistic Categorization Learning II.** STEPHEN E. EDGELL, WILLIAM P. NEACE, & ANDREW S. LAJOIE, *University of Louisville*—Earlier work in a probabilistic category learning task found highly different levels of utilization for different cue dimensions across conditions of which cue was relevant, when only one of three cue dimensions was relevant. Cue dimensions and values were discovered that gave equal utilization in that task. However, work we presented last year showed that when cue dimensions compete, complex salience effects are again present. The present work extends that finding of salience effects to both the interaction of cue representations and response names and to cues that are names of actual symptoms, which is a representation being used more extensively by researchers employing this paradigm.

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**Category Discriminability, Base-Rate, and Payoff Effects in a Simulated Medical Diagnosis Task.** JEFFREY L. DODD & W. TODD MADDOX, *University of Texas, Austin*—Human categorization performance was explored in a simulated medical diagnosis task. Three category discriminabilities ( $d' = 1, 2.2,$  and  $3.2$ ) were combined factorially with four payoff conditions and one base-rate condition. A within-subjects design was used, and all analyses were performed at the single-observer level using a series of nested decision-bound models (Ashby, 1992; Maddox & Bohil, 1999). The optimal decision criterion from signal detection theory was identical across conditions. Observers' decision criteria were closer to optimal in  $d' = 2.2$  than in the other  $d'$  conditions, and were closer to optimal when base-rates, as opposed to payoffs, were manipulated. In addition, decision crite-

ria values were closer to optimal in zero cost than in nonzero cost conditions (i.e., when an incorrect response led to a decrease in reward). Finally, some interesting interactions between  $d'$  and base-rate/payoff condition were observed.

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**Gender Identification of Domestic Cat Faces: Perceptual Learning of a Natural Categorization Task.** PAUL C. QUINN, *Brown University*, & VANESSA PALMER & ALAN M. SLATER, *University of Exeter*—Three experiments examined whether human observers could identify the gender of domestic cats depicted in individual color photographs. In Experiment 1, observers performed at chance with full-face close-ups of the cats. Experiment 2A revealed that even with gender identification training on a broad set of face close-ups, observers were unable to reliably identify the gender of a set of test faces. However, Experiment 2B showed that gender identification training with the most accurately identified faces from Experiment 1 was successful in raising gender identification of the test faces above chance. Experiment 3 extended this facilitative effect of gender identification training to a population of animal care workers. The findings indicate that with appropriate training, human observers can identify the gender of domestic cat faces at an above-chance level. A perceptual category learning account emphasizing on-line formation of differentiated male versus female prototypes during training is offered to explain the findings.

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**Research Support From the National Science Foundation.** JOE YOUNG & FRED STOLLNITZ, *National Science Foundation*—Information about the various programs of the NSF will be available.

## CATEGORIZATION II

Pacific Palisades, Saturday Morning, 8:00–10:00

Chaired by Diane J. Schiano, Interval Research Corp.

8:00–8:20 (343)

**Orientation to Meaning Suppresses Explicit Knowledge of Surface Cues in Category Learning.** LEE R. BROOKS, *McMaster University*—People had less explicit knowledge of the surface features that they learned to use for identification when they were oriented toward meaningful interpretation of the stimulus items. This was demonstrated for both artificial animals and sets of adjectives presented as personality descriptors. In neither case were prior concepts responsible for the learned category discrimination. This lack of explicit knowledge about surface cues is similar to that produced by diverting attention to the use of items, previously reported. Both operations (diverting attention to use and orientation to meaningful interpretation) are argued to be characteristic of everyday learning but not of most artificial learning tasks.

8:25–8:40 (344)

**The Consistent Contrast Principle in Learning Variable Categories.** DORRIT BILLMAN, *Georgia Institute of Technology*—Much natural concept learning involves learning subcategories of a general kind. In this type of learning, the relations among contrasting categories are very important. We investigate one relational principle, *consistent contrast*. In consistently contrasting categories, the same attributes are relevant across categories. If dogs eat bones and bark, monkeys eat bananas and chatter, and horses eat grass and neigh, these categories contrast consistently. In inconsistently contrasting sets of categories, different, distinctive attributes are relevant for different categories. In our previous studies, all members of a category shared the same relevant values (consistently or inconsistently assigned); consistency strongly facilitated learning. Now our participants learned categories in which the relevant attribute values could be only imperfectly predicted and each category had some distribution across relevant values of an attribute. We report effects of consistency of the attribute distribution across contrasting categories, extending our findings to variable categories.

8:45–9:05 (345)

**Conceptual Basis of Function Learning and Extrapolation.** JEROME R. BUSEMEYER, *Indiana University*, & MARK MCDANIEL, *University of New Mexico*—One important way that concepts are used is to learn *functional relationships* between continuous variables and make predictions about one variable on the basis of another. There are innumerable examples that we encounter every day, such as predicting job performance on the basis of intelligence, anticipating mood level on the basis of stress intensity, forecasting interest rates on the basis of unemployment rate, and so on. The purpose of this article is to provide a foundation for a more formal, systematic, and integrative approach to function learning that parallels the existing progress in category learning. First we review some basic findings concerning function learning that must be addressed by any candidate theory. Next we review several potential models of function learning and describe how each model addresses these basis issues. Third we present new rigorous tests of the competing models. Finally, we form conclusions about the essential ingredients that need to be included in future models of function learning.

9:10–9:30 (346)

**Context, Not Frequency, Determines Categorical Structure.** CURT BURGESS & KEVIN LUND, *University of California, Riverside*—The most basic premise of the HAL memory model is that the context in which a word is learned determines its meaning. We show that two methodologically different learning mechanisms (global co-occurrence in the HAL model and a simple recurrent network) generate similar structural knowledge when provided with the same language

input. This provides convergent evidence that context provides the constraints necessary for semantic and grammatical knowledge acquisition. Some have made simplistic claims about co-occurrence statistics, arguing that contextually driven learning models are simply sensitive to frequency information that only appears to capture representational structure (e.g., Fodor & Pylyshyn, 1988). We developed a completely frequency-controlled HAL model and show, in a series of experiments with categorization data (Elman, 1990), motion verb data (Audet & Burgess, 1998), and proper name data (Conley & Burgess, 1998), that the role of frequency in ultimate knowledge structure is negligible.

9:35–9:55 (347)

**Comparing Computational Models of Categorization: The Complete Solution.** IN JAE MYUNG, SHAOBO ZHANG, & MARK A. PITT, *Ohio State University*—Most quantitative methods of selecting among computational models of cognition are heuristic in nature, lacking a well-developed theoretical framework within which to conceptualize the selection problem. We show that differential geometry provides a unified and easily interpretable framework. Foremost among its advantages is a reconceptualization of the problem as one of counting probability distributions. This naturally leads to a measure of a model's geometric complexity, which is sensitive to the model's functional form (i.e., how parameters are combined) and number of parameters. The superiority of this method is demonstrated by comparing model recovery performance of many selection methods in the context of prototype and exemplar models. The generality of the method will be demonstrated in the fields of psychophysics and information integration.

## ATTENTION I

Plaza, Saturday Morning, 8:00–9:35

Chaired by Philip M. Merikle, University of Waterloo

8:00–8:20 (348)

**Brain Basis of Reorienting Visual Attention When Targets Appear in Unexpected Locations.** CATHERINE M. ARRINGTON, *Michigan State University*, ANDREW R. MAYER, *Medical College of Wisconsin*, THOMAS H. CARR, *Michigan State University*, & STEPHEN M. RAO, *Medical College of Wisconsin* (read by Thomas H. Carr)—Brain activation involved in deploying and reorienting visual attention was measured using event-related functional magnetic resonance imaging while 12 perceivers engaged in a cued letter discrimination task. Methodology and trial design allowed for direct comparison of activity associated with validly cued and invalidly cued trials. All areas of activation that differentiated between these two conditions resulted from greater activity during the invalid trials. This outcome suggests that all brain areas involved in attentional orienting and task performance in response to valid cues were also involved on invalid trials, plus additional regions recruited when a perceiver needed to recover from invalid cuing and reorient attention to a target that appeared at an uncued location. The areas of activation specific to attentional reorientation were strongly right-lateralized. They included regions of temporal and parietal cortex already implicated in visual attention by lesion studies, as well as prefrontal regions that might subserve control processes.

8:25–8:40 (349)

**Expectancy for Relevant and Irrelevant Stimulus Location in a Serial RT Task.** ERIC SOETENS, WIM NOTEBAERT, & ANNEMIE MELIS, *University of Brussels*—In two-choice serial RT tasks with long response–stimulus intervals, higher order sequential effects typically display a cost–benefit pattern, which has been explained as subjective expectancy. The more a repetition of the previous stimulus is expected on the basis of the preceding higher order sequence, indicated by relatively fast reactions, the less an alternation is expected,

indicated by relatively slow reactions (and vice versa). This pattern has been observed repeatedly in earlier studies with spatial position of the stimulus as relevant dimension. We demonstrate that such expectancy pattern does not unfold for color or form. The cost–benefit pattern does appear for an irrelevant spatial stimulus position in a typical Simon task with color as relevant dimension, and is identical for corresponding and noncorresponding stimuli. The results support the earlier claims that subjective expectancy is an automatic process, and that it does not affect the Simon effect.

#### 8:45–9:05 (350)

**Attention Fine-Tunes Perceptual Templates in Spatial Cues.** ZHONG-LIN LU, *University of Southern California*, & BARBARA ANNE DOSHER, *University of California, Irvine*—We characterize perceptual templates of human observers in a spatial cuing paradigm in which the observer is either precued or postcued to a form discrimination task at one of four locations. Modeling the human observer within a noisy perceptual template model (PTM); (Lu & Doshier, 1997), we estimate the perceptual templates employed by the observer in the precued and postcued conditions by systematically measuring threshold signal contrasts when the target forms are embedded in low-pass or high-pass random noise with a range of manipulated cut-off frequencies. Spatial precuing significantly improved performance in all conditions. The data are well accounted for by a PTM, with both stimulus enhancement and external noise exclusion as attentional mechanisms of the precue advantage. Moreover, the perceptual template at the precued location is better tuned (better matched to the frequency characteristics of the stimulus) than for the postcued locations.

#### 9:10–9:30 (351)

**“High-Priority” Stimuli and Visual Attention.** HAROLD PASHLER & CHRISTINE R. HARRIS, *University of California, San Diego*—People sometimes spontaneously notice their own name and other emotionally charged stimuli in unattended visual or auditory channels. Previous literature paints a confusing picture of whether, and how, processing of these materials might be special. Suggestions include (1) that high-priority stimuli might automatically grab or hold attention, (2) the existence of biases toward such stimuli, and (3) the absence of capacity limitations in identifying them. To test these possibilities, we compared high-priority and control stimuli in the role of either target or distractor using a number of different attention designs, including speeded visual search and detecting targets in rapid streams of successively or simultaneously presented items.

### HUMAN LEARNING AND MEMORY Santa Monica, Saturday Morning, 8:00–9:50

Chaired by Thad A. Polk, *University of Michigan*

#### 8:00–8:15 (352)

**Lexical Neighborhood Effects on Serial Recall of Nonwords.** STEVEN ROODENRYS & MELINDA HINTON, *University of Wollongong*—Two experiments are reported examining the contribution of long-term phonological knowledge to the immediate serial recall of nonwords. Gathercole, Frankish, Pickering, and Peaker (1999) showed that serial recall of CVC nonwords is better for those composed of more common phoneme combinations (high biphone frequency) than those composed of less common combinations (low biphone frequency). They attributed this effect to a process in which decayed short-term memory traces are reintegrated using knowledge of the sublexical structure of English. The first experiment manipulated biphone frequency while controlling for the number of lexical neighbors and found no effect of biphone frequency. The second experiment manipulated the number of lexical neighbors while controlling biphone frequency and found a significant difference. We argue that the reintegrative process operating on nonwords retrieved from short-term memory is influenced by the activation of lexical rather than sublexical information.

#### 8:20–8:35 (353)

**Coactivation of Semantic and Arithmetic Knowledge.** AN T. TRAN & MIRIAM BASSOK, *University of Washington* (read by Miriam Bassok)—Bassok, Chase, and Martin (1998) found that when people construct word problems, they tend to systematically align semantic relations between objects with particular mathematical relations. Specifically, people tend to add taxonomically related objects (e.g., tulips + daffodils) and divide thematically related objects (e.g., tulips/vases). To examine whether such “semantic alignments” are automatic, we adapted Lefevre and Kulak’s (1994) number-matching task in which subjects were briefly exposed to a digit pair (e.g., 3+5) followed by a single digit probe. In rejecting probes that did not match either number in the digit pair, subjects took longer to reject a sum probe (e.g., 8) than a neutral probe (e.g., 9). Using this task, we examined whether automatic activation of addition facts (e.g., 3+5 = 8) is stronger when the addends are aligned with taxonomically related objects (e.g., 3 tulips + 5 daffodils) than with unrelated objects (e.g., 3 tulips + 5 cars).

#### 8:40–9:00 (354)

**The Role of Neural Habituation in Serial Position Curves.** SVERKER SIKSTRÖM, *University of Toronto* (sponsored by Bennett B. Murdock)—Habituation is the basic phenomenon that repeated presentation diminishes responses. It is characterized by the property of stimulus specificity and rate sensitivity. The habituation model is suggested in which the representation of context in episodic memory becomes habituated during encoding and it is applied to serial positions effects. The primacy effect is predicted because the context becomes habituated during encoding and it is predicted to be rate sensitive when plotted against time. For fast presentation rates, a minimum performance is predicted at the end of the primacy. The long-term recency effect is predicted because the recovery from habituation is rate sensitive. The model also makes predictions regarding frequency effects and is supported by new data. Furthermore, older items in short-term memory are predicted to be retrieved before newer items—consistent with data on immediate free recall.

#### 9:05–9:20 (355)

**Item and Order Information in Subject-Performed and Experimenter-Performed Tasks.** JOHANNES ENGELKAMP, *University of the Saarland*, & DORIS DEHN, *Technical University of Berlin*—A series of experiments was conducted to investigate memory for subject-performed tasks (SPTs) and for experimenter-performed tasks (EPTs) from the perspective of the item-order hypothesis. It is assumed that SPTs provide better item information than EPTs and EPTs better order information than SPTs when EPT/SPT is a between-subjects variable, and further, that order information of EPTs decreases to the level of SPTs when EPT/SPT is a within-subjects variable. Consequences of these assumptions for order reconstruction (as index of order encoding), for recognition memory (as index of item encoding), and for free recall (as index of item and order information) were experimentally tested. A further assumption tested in a series of experiments was that order information is generally confined to short lists and does not contribute to free recall of long lists.

#### 9:25–9:45 (356)

**Spatial Representations From Description and Taction.** AMY LYNNE SHELTON, *Stanford University*, & TIMOTHY P. MCNAMARA, *Vanderbilt University* (read by Timothy P. McNamara)—This project investigated the acquisition of spatial knowledge from nonvisual modalities. Participants were seated in front of an array of seven objects and were required to either describe or reconstruct (using only tactile and proprioceptive feedback) the array from a point of view that differed by 0°, 45°, 90°, 135°, or 180° from the view they could see. Subsequent judgments of relative direction were more accurate for imagined headings corresponding to visually perceived, described, and reconstructed views than for imagined headings corresponding to novel views. In scene recognition,

participants who described the layout were able to recognize visually perceived views faster than described and novel views. However, participants who reconstructed the layout tactilely were able to recognize reconstructed views faster than visually perceived and novel views; these participants had better visual memory for a view they had never seen than for a view they had studied visually for several minutes.

#### LETTER/WORD PROCESSING: REPETITION/PRIMING EFFECTS

Beverly Hills, Saturday Morning, 8:00–9:50

Chaired by Greg B. Simpson, University of Kansas

8:00–8:20 (357)

**What Can Form Priming Tell Us About the Morphological Organization of the Lexicon?** RAM FROST & TAMAR KUGLER, *Hebrew University of Jerusalem*—Form (orthographic) priming in visual masked presentation is a robust and reliable experimental finding in alphabetic orthographies. We examined form priming in Hebrew. In contrast to English, form priming was not obtained, and words having similar sequences of letters did not prime each other. Reliable priming effects, however, were found even with minimal orthographic overlap, when primes and targets were morphologically related. These results suggest that words in the Hebrew lexicon are organized according to a morphological, not an orthographic principle. We conclude that a general theory of visual word recognition needs to consider first the morphological structure of the language.

8:25–8:40 (358)

**Priming Complex Words: Evidence for Supralelexical Representation of Morphology.** JONATHAN GRAINGER, *CNRS and Université de Provence*, & HÉLÈNE GIRAUDO, *Université de Provence*—Effects of morphologically related primes were examined in a series of masked prime experiments. Suffixed word targets showed similar degrees of facilitation from suffixed word primes and free root primes. On the other hand, prime words containing a pseudoroot did not produce significant facilitation. Furthermore, the printed frequency of derived word primes was shown to influence the size of priming effects. We argue that these data support a supralelexical account of morphological representation.

8:45–9:05 (359)

**Morphological Priming and Semantic Relatedness: A Connectionist Account.** JAY RUECKL, *University of Connecticut and Haskins Laboratories*—Short-term priming varies with the semantic relatedness of morphologically related primes and targets at relatively long SOAs (e.g., 250 msec). However, at short SOAs semantic relatedness has little or no effect. A recurrent connectionist network trained to map letter strings onto semantic representations exhibits this same pattern of behavior. Analyses reveal that the interaction of relatedness and SOA is brought about by processes at two time scales. At the faster scale, morphological relatives have cooperative and competitive effects on the trajectory of the network through its state space. At the slower scale, morphological regularities influence the learning process that organizes the layout of the attractors in this space.

9:10–9:30 (360)

**Are Nonsemantic Morphological Effects Incompatible With a Distributed Connectionist Approach?** DAVID C. PLAUT & LAURA M. GONNERMAN, *Carnegie Mellon University*—From a distributed connectionist perspective, morphology is a characterization of the learned mapping between surface forms of words and their meanings. Performance on lexical tasks should thus be sensitive to graded effects of both semantic and formal similarity. Although there is evidence for such effects, there are also demonstrations of morphological effects in the absence of semantic similarity, predominantly in morphologically rich languages. To evaluate whether such

findings are incompatible with a connectionist account, we carried out simulations in which a set of morphologically related words varying in semantic transparency were embedded in either a morphologically rich or impoverished artificial language. We found that morphological priming increased with degree of semantic transparency in both languages. Critically, priming extended to opaque items only in the rich language. Such priming arises because the processing of all items, including opaque forms, is influenced by the degree of morphological organization of the entire system.

9:35–9:45 (361)

**Familiarity, Lexical Decision, and the Neighborhood Size Effect.** MANUEL PEREA & EVA ROSA, *Universitat de Valencia*—Lexical decisions on low-frequency words are typically faster when the word has many orthographic neighbors than when the word has only a few neighbors. In contrast, increasing the number of neighbors of a nonword slows down correct responses to these nonwords. It could be argued that these neighborhood size effects are not indexing the speed of lexical access but, rather, are reflections of a different, task-specific process (e.g., a visual familiarity assessment). Case alternation is supposed to reduce the familiarity of the stimuli. If familiarity is partly responsible for the neighborhood size effect, the *N* effect for words should be greatly reduced with mixed-case stimuli, as we actually observed (Experiment 1). However, this is not the whole story: When items were presented in different size (in lowercase letters), the neighborhood size effect was reduced for nonwords, but it was unaffected for words (Experiment 2).

#### JUDGMENT/DECISION MAKING: PROBABILISTIC JUDGMENT

Westside, Saturday Morning, 8:00–10:25

Chaired by William M. Petrusic, Carlton University

8:00–8:20 (362)

**On the Perception of Variability.** YAAKOV KAREEV, SHARON ARNON, & REUT ZELIGER, *Hebrew University of Jerusalem*—Ever since the days of Francis Bacon, it has been claimed that people perceive the world as more regular (or less variable) than it actually is. Such misperception could explain a host of vexing behaviors; however, evidence in support of this claim has been indirect, and an explanation of its causes lacking. We first suggest that working-memory capacity, limiting the size of the sample people can consider, could serve as such a mechanism. This is so since the sampling distribution of sample variance is downward attenuated, and the more so the smaller the size of the sample. The results of four experiments show that people are sensitive to variability, use sample variance, uncorrected, where estimates of population variance are required, and indeed perceive variability to be smaller than it actually is. Surprisingly, such biased perception can be shown to improve performance in a number of important situations.

8:25–8:45 (363)

**Averaging Dependent and Independent Probability Judgments.** DAVID V. BUDESCU & TIMOTHY R. JOHNSON, *University of Illinois*, & THOMAS S. WALLSTEN, *University of North Carolina*—Wallsten, Budescu, Erev, and Diederich (1997) developed a general framework for assessing the quality of aggregated probability judgments. One of the most powerful predictions that can be derived from their model is that, under some reasonable conditions, the average of conditionally pairwise independent judgments grows increasingly diagnostic of the true event state as the number of judgments being averaged increases, and becomes perfectly diagnostic in the limit. We report results of simulations and reanalyses of some empirical data sets pertaining to this prediction. The results document, under a variety of conditions, the diagnostic value of the average judgment for a finite number of judgments, their rate of convergence to perfect di-

agnostic value, and the detrimental effect of conditional dependence among individual judges on the diagnostic value of the average judgment. Implications of these results are discussed.

#### 8:50–9:10 (364)

**Intuitive Bayesian Updating.** X. T. WANG, *University of South Dakota*—In a series of experiments, Bayesian updating was examined using a new empirical paradigm that allows a participant to update Bayesian probability through multiple trials and to stop sampling whenever she/he is ready to make a judgment. The variables in the experiments included problem domains (detecting a fake coin vs. detecting a criminal), real-time constraints (hands-on vs. imaginary), and the base rate of a target in a population. The results showed that the use or disuse of base rate information, indicated by the number of self-determined sampling trials, was a nonlinear and categorical function of base rate with different threshold points for different tasks. Social variables affected the response criterion of the participants but had little effect on their sensitivity to the base rate information. These findings suggest that humans possess a rich array of intuitive and satisficing heuristics to make judgments under uncertainty.

#### 9:15–9:35 (365)

**On the Use of Inconclusive Information in the Generation of Subjective Probabilities.** JOSEPH V. BARANSKI, *Defence and Civil Institute of Environmental Medicine, Toronto*, & WILLIAM M. PETRUSIC, *Carleton University*—This study examined how people use inconclusive information when forming subjective probability (SP) assessments using a medium-fidelity naval threat assessment simulation. In the present context, inconclusive information refers to data that are relevant but do not clearly support a decision alternative. On each of 36 trials, subjects interrogated 10 pieces of information (e.g., speed, direction, bearing) about “targets” in a radar space. The amount of hostile [ $n(H)$ ], peaceful [ $n(P)$ ], and “inconclusive” [ $n(I)$ ] information was factorially varied across targets. The best empirical fit to the data was provided by a variant of support theory,

$$SP(H) = \frac{n(H)'}{n(H)' + n(P)'}, \text{ with } n(H)' = n(H) + \frac{1}{2}n(I), \text{ and}$$

$$n(P)' = n(P) + \frac{1}{2}n(I),$$

where  $SP(H)$  denotes the subjective probability that a given target is hostile. Importantly, systematic deviations from the model’s predictions imply that inconclusive information “dilutes” subjective probabilities. We compare this “dilution effect” with related phenomena in the social cognition and judgment/decision making literatures.

#### 9:40–10:00 (366)

**Ending the Tyranny of the Point-Null Hypothesis.** LESTER E. KRUEGER, *Ohio State University*—Few believe the point-null hypothesis is ever true, which makes its acceptance very problematic. To solve that problem, it is proposed that we (1) shift from the point null to a null range (bounded by a just nontrivial difference, or  $jnd$ ); (2) base the alternative hypothesis likewise on the  $jnd$ ; (3) properly define (and thereby control!) beta (by distinguishing it from the true “region of doubt” in the rejection region); and (4) set beta at .05 (just like alpha), so that, with the proper data, the null-range hypothesis could be accepted (i.e., alternative hypothesis rejected) at the .05 level even when power is low ( $< .80$ ). Plausibility measures would still be available in the form of exact probability values ( $p, q$ ). Limitations (e.g., the lack of error terms, alpha and beta) in other plausibility measures (e.g., 95% confidence intervals; likelihood ratios) will be discussed.

#### 10:05–10:20 (367)

**When Data Are Manipulated: The Traces Left by Naive Statistical Expectations.** GIL KALAI & MAYA BAR-HILLEL, *Hebrew University*, & BRENDAN MCKAY, *Australian National University* (read by Maya Bar-Hillel)—In 1994, *Statistical Science* published the

results of experiments that purported to offer extremely strong statistical evidence proving the existence of a secret code in the Book of Genesis. This alleged code became known as The Bible Code, made famous by a 1997 bestseller by that name. McKay, Bar-Natan, Bar-Hillel, and Kalai (1998, 1999) offered their own statistical—and other—evidence that The Bible Code is just the cleverly disguised result of data tuning. We show how taking into account the psychology of the code researchers explains some surprising statistical features of their reported experimental results (surprising even assuming a genuine code). Using the notion of naive statistical expectations (e.g., Tversky & Kahneman, 1971), we show how results that are surprising from the statistical viewpoint may be just what one expects if the erroneous but common statistical intuitions of the data tuners is taken into account.

### 3-D/MOVEMENT PERCEPTION I Century, Saturday Morning, 8:00–9:50

Chaired by Geoffrey P. Bingham, *Indiana University*

#### 8:00–8:20 (368)

**Heading From Optic Flow: A Resolution of the Rotation Problem.** WILLIAM H. WARREN & LI LI, *Brown University*—Perceived heading (direction of self-motion) is accurate during actual eye or head rotation. During simulated rotation, heading is accurate at low rotation rates (Warren & Hannon, 1990) but not at high rotation rates (Royden, Crowell, & Banks, 1994): Observers perceive a curved path of self-motion rather than a straight path. This suggests that extra-retinal information is necessary to determine heading. However, these studies used minimal random-dot displays. In experiments with complex texture-mapped scenes, we found that heading judgments are accurate when both (1) dense motion parallax and (2) trackable reference objects are present. This is consistent with a result from Cutting et al. (1997). We conclude that instantaneous heading during rotation can be determined from motion parallax alone and integrated over time with respect to reference objects, thereby specifying the observer’s path. Thus, both retinal flow and extra-retinal solutions are sufficient to determine heading, but neither is necessary.

#### 8:25–8:40 (369)

**The Visual Perception of Global 3-D Shape.** J. FARLEY NORMAN, *Western Kentucky University*, & JAMES T. TODD, *Ohio State University*—Research on the perception of 3-D shape has often focused on local aspects of surface structure. Observers are typically asked to compare relative depths, orientations, or curvatures of local regions on an object’s surface. In the present experiments, observers viewed stereoscopic smoothly curved objects that were transformed versions of a single “base” object. They were required to discriminate between two types of shape deformation. One transformation changed the relative magnitude of the preexisting surface relief, without affecting the sign of curvature. The other possible transformation, in contrast, altered both the sign and magnitude of curvature. Although the metric differences among the objects to be discriminated were equated in both conditions, observers’ thresholds were significantly lower when the objects had different signs of curvature. These findings suggest that metrical aspects of 3-D surface structure (e.g., magnitudes of curvature) are less perceptually salient than are more qualitative aspects (e.g., convexity vs. concavity).

#### 8:45–9:00 (370)

**The Role of Experience in Event Perception.** THOMAS F. SHIPLEY & LESLIE R. COHEN, *Temple University*—Point-light displays of human motion are uniquely salient for most viewers. The ease and rapidity with which such figures are detected has led people to theorize that special processing may be involved, that we use our own motor system to visually pick out human motion. Under what circumstances may experience facilitate the perceptual organization of complex events? Two studies examine the potential contribution of learning.

The first compares the performance of experts (seal trainers and dog trainers) as they describe and detect point-light seals and dogs engaged in a variety of typical motions (crawling, swimming, walking, and jumping). In the second study, subjects watched point-light displays of coordinated action from sporting events. Familiarity was manipulated by inverting the display. Experience appears to play a role in the segmentation of dynamic displays—we recognize coordinated action in the absence of all other cues to the identity of objects.

9:05–9:20 (371)

**Perceiving Directions of Illumination.** JAMES T. TODD, *Ohio State University*, & J. FARLEY NORMAN, *Western Kentucky University*—In the literature on perceived shape from shading, it is often argued that human observers are biased to assume an overhead direction of illumination. Although numerous examples have been presented that purport to demonstrate this phenomenon, it is a common occurrence in natural vision for nonoverhead directions of illumination to be perceived correctly. In the present experiments, observers were shown randomly shaped shaded objects and were asked to discriminate whether the direction of illumination was to the right or left of a pre-defined standard direction. Discrimination thresholds for this task could be as small as 4°, depending on the observer and the specific viewing conditions, and there were no indications in the data that overhead illuminations are preferred over other possible directions.

9:25–9:45 (372)

**Baseball Outfielders Can Use Group Center-of-Attention as a Guide to Fly Ball Destination.** MICHAEL K. McBEATH & SHANNON E. MORGAN, *Arizona State University*—Past research on how baseball outfielders navigate to the destination of fly balls has principally examined only the use of the optical ball trajectory. The present study investigates whether fielders may also utilize the direction that the other fielders face. In two experiments, observers looked at pictures or videotapes of various ball trajectories and fielder arrangements from the perspective of a left fielder, and estimated the destination of fly balls. Pictures showed the half-way point, and videos the first half of the trajectory. On each trial the ball was either present or absent, and the direction that other fielders oriented was either consistent or inconsistent with the actual path of the baseball. The results confirm that the direction other fielders face influences accuracy of estimates. The findings support the idea that fielders can discern and utilize the group center-of-attention defined by the composite body orientations of other visible fielders.

#### ANIMAL LEARNING AND BEHAVIOR

Pacific Palisades, Saturday Morning, 10:10–12:00

Chaired by Michael F. Brown, *Villanova University*

10:10–10:25 (373)

**Learning to Anticipate Food: Knowing When to Fold.** KAREN L. HOLLIS, KRISTEN S. LANGWORTHY, MARY C. ROMANO, ALLYSON M. EATON, & LISA A. BLOUIN, *Mount Holyoke College*—Outside of the breeding season, when many territorial animals live together in groups, competition for food results in the formation of dominance hierarchies. Dominant individuals garner more food for themselves by bullying subordinates; however, subordinates capture some of the food by relying on what behavioral ecologists call “sneaky” tactics. For example, subordinates sometimes hover in the background, and quickly capture food before dominant animals appear to notice that food has arrived. Intrigued by the idea that such strategies rely on associative learning, we explored this possibility in male blue gouramis, freshwater tropical fish. Our research suggests that dominant and subordinate males can learn to anticipate the arrival of food and that learning reduces competition. In addition, learning enables subordinates to rely on defensive tactics that increase the amount of food that they obtain, but at the same time avoid retaliation that more offensive tactics elicit from dominant males.

10:30–10:45 (374)

**Emotion in Reptiles and Birds, but Not in Amphibians.** MICHEL CABANAC, *Université Laval*, ARNAUD CABANAC, *University of Tromsø*, CÉCILE BERNIERI, *Université Laval*, & SEIKA AIZAWA, *University of NARA*—Lizards (Iguanidea and Teiidea) but not frogs (*Rana sp.*) become feverish and tachycardic when handled. If, as hypothesized, emotion emerged in phylogeny between amphibians and reptiles, all animals above amphibians should possess emotion. The present work verified that a tortoise (*Clemmys insculpta*) and a bird (*Gallus domesticus*) also responded with emotion to simple handling. When handled, the animals raised their body temperature by 4°C (tortoises) and 0.5°C (birds); the birds also vasoconstricted peripherally. Handling, therefore, caused an emotional fever in reptiles and birds. This fever was inhibited in birds and lizards after i.p. salicylate. Tortoises were equipped with an electrocardiogram radio transmitter and their heart rate was recorded telemetrically. During a 1-min handling, their heart rate rose from 28 to 40 bt/min. This tachycardia persisted several minutes, then heart rates returned to baseline in 10 min. These results are compatible with the hypothesis that reptiles and birds experience emotion.

10:50–11:00 (375)

**Exposure to a Synthetic Predator Odor (TMT) Disrupts Working Memory.** JON L. WILLIAMS & KATHERINE J. HLADKY, *Kenyon College*—Previous research has established that rats exposed to natural predator odors show freezing, analgesia, and poor working memory. Recently, we found that trimethylthiazoline (TMT), a synthetic odor compound isolated from the feces of the red fox, is also capable of eliciting freezing and opioid analgesia. This experiment examined the effects of TMT on working memory. Rats were initially given water-reinforced training on a position-alternation task in a T maze involving no-delay (0-sec) and 30-sec delay trials. After 13 daily sessions, separate groups were given a 30-min exposure to a hedonically neutral odor (citronella), a low level (i.e., amount) of TMT, or a high level of TMT. A low level of TMT, in contrast with the control odor, significantly disrupted alternation only for the 30-sec delay trials, whereas a high level of TMT interfered with alternation for both sets of trials. The future implications of this unique predatory stressor on memory are discussed.

11:05–11:20 (376)

**Ondansetron Interferes With the Establishment and the Expression of Conditioned Disgust Reactions: A Rat Model of Nausea.** LINDA PARKER & CHERYL LIMEBEER, *Wilfrid Laurier University*—Conditioned disgust reactions displayed in the taste reactivity test are exclusively produced by treatments that elicit nausea. The present experiments demonstrated that pretreatment with the anti-nausea agent ondansetron interfered with the establishment of conditioned disgust reactions (Experiment 1) and interfered with the expression of previously established conditioned disgust reactions (Experiment 2). Ondansetron selectively interfered with conditioned nausea as reflected in conditioned disgust reactions, because it did not modify the unconditioned disgust reactions elicited by unpalatable quinine solution (Experiment 2). Although ondansetron blocked the expression of the selective taste reactivity reaction of conditioned disgust, it did not modify the nonselective reactions of conditioned taste or place avoidance (Experiment 3). The results suggest that conditioned disgust reactions reflect conditioned nausea in rats that is attenuated by pretreatment with the anti-nausea agent ondansetron.

11:25–11:35 (377)

**Conditioned Affiliative Behavior in Mongolian Gerbils: Role of Female Sexual Receptivity.** RONALD P. VILLARREAL & MICHAEL DOMJAN, *University of Texas, Austin* (read by Michael Domjan)—Female gerbils are sexually receptive only for about 24 h after parturition. Previous studies have shown that affiliative behavior can become conditioned in both males and females during the postpartum estrous period. The present experiments demonstrated that affiliative behavior that is conditioned while females are in estrus transfers to subsequent nonestrous periods. Conditioned affiliative behavior can

also become established during the nonestrous phase in both males and females, and this conditioned responding transfers to subsequent estrous periods. These results have implications for the role of learning in pair-bonding and for the functional significance of Pavlovian conditioning in the organization of social behavior.

#### 11:40–11:55 (378)

**Intermodal Blocking in Honeybees.** P. A. COUVILLON & M. E. BITTERMAN, *University of Hawaii*—Previous experiments with free-flying honeybees showed blocking in intramodal compounds (of two colors or two odors) but not in intermodal (color–odor) compounds. A reasonable interpretation of these results is that component-independence is subverted by afferent interaction, which tends to be greater in intramodal than in intermodal compounds. That heteromodality per se is not critical is shown in new experiments with targets distinguished by color, odor, or an adjacent (visual) landmark. In color-landmark training, blocking is reciprocal (color blocks landmark and landmark blocks color). In odor–landmark training, although landmark fails to block odor, odor does block landmark (intermodal blocking). Such lack of reciprocity, which has previously been reported in overshadowing experiments both with rats and honeybees, as well as in blocking experiments with rats, is compatible with the assumption that the components of a reinforced compound compete for attention rather than for associative strength.

### SOCIAL-PERSONALITY PROCESSES AND INDIVIDUAL DIFFERENCES Plaza, Saturday Morning, 9:45–11:30

*Chaired by Richard A. Carlson, Pennsylvania State University*

#### 9:45–10:00 (379)

**Learned Interpretation of Emotional Ambiguity.** ANDREW M. MATHEWS, *MRC Cognition and Brain Sciences Unit*—Differences in anxiety levels are associated with congruent biases in the interpretation of emotionally ambiguous information, but it is unclear how such biases are acquired, or if they are the cause of congruent mood changes. In initial experiments, threatening or nonthreatening meanings of emotionally ambiguous homographs were primed by solving valenced word fragments. A lexical decision task then revealed increased accessibility for emotionally congruent meanings, including those of a new set of homographs. In further experiments, texts describing emotional events were resolved in a negative or positive manner. Later ambiguous texts were then interpreted congruently, as shown by endorsement of recognition items disambiguated in a positive or negative direction. Anxious mood also changed congruently, but only when biased personal emotional meanings had been actively generated. Thus, repeated access to emotional meanings led to interpretative bias, but mood state changed only when this bias was actively deployed.

#### 10:05–10:15 (380)

**Public Eyewitness Confidence Judgments Can Differ From Those Held Privately.** JOHN S. SHAW III, *Lafayette College*—Research on the eyewitness confidence-accuracy relationship has concentrated primarily on events that occur between encoding (at the crime scene) and the final memory test (at trial). However, normative influences may also affect a witness's confidence ratings during courtroom testimony. Two experiments examined the proposition that normative pressures to be a "good witness" can cause eyewitnesses to give higher confidence ratings in court than they would in private. Participants either answered recognition questions about previously studied faces or provided details about a simulated robbery. Participants shared half of their answers and confidence ratings with 3 other participants and kept the other half of their responses private. The public–private manipulation interacted with question type (e.g., fact questions vs. inference questions) in affecting confidence ratings, but had no impact

on response accuracy. The results are interpreted in terms of how normative influences can impact a witness's public confidence ratings.

#### 10:20–10:35 (381)

**Perspective-Taking Ability Is Distinct From Mental Rotation Ability.** MARIA KOZHEUNIKOV & MARY HEGARTY, *University of California, Santa Barbara* (read by Mary Hegarty)—We developed a psychometric test of perspective-taking ability in which people are shown a 2-D array of objects, take a perspective within the array, and point to an object within the array. The test had an internal reliability of .83. Consistent with experimental studies of perspective taking, pointing accuracy decreased with the angular deviation of one's imagined heading (perspective) from the orientation of the array and with the angular deviation of pointing direction from one's imagined heading. In a factor analysis, perspective-taking tests loaded on a different factor from mental rotation and spatial visualization tests, and on the same factor as self-report sense of direction. The Guilford–Zimmerman spatial orientation test loaded on both factors.

#### 10:40–11:00 (382)

**Effect Size Bias From Reliable Error in Observational (Nonexperimental) Research.** WILLIAM TERRIS, *De Paul University*—The nature of error that biases effect size statistics in observational (non-experimental) research is examined. Most variance in X (independent variable of typical observational psychology study is unique variance, but unique variance (or any error) is shown to be never in X of ordinary true experiment. For this and other discussed reasons, we conclude that all unique variation in X is error that biases usual effect size statistics ( $\bar{X}_{diff}$ ,  $b_{YX}$ ,  $r_{XY}$ , etc.) from observational studies toward zero. Most unique variation in X is reliable and undetectable and varies from 0% to  $1 - \rho^2_{XY}$  in typical observational study. Therefore, effect size statistics from these studies are likely to be biased and often invalid as estimators of true parameter, but nevertheless are useful for prediction and control. Thus, observational research may be reliable, replicable, and useful and have apparent theoretical significance but provide only an illusion of scientific effect size knowledge.

#### 11:05–11:25 (383)

**Cognitive Design Systems for Individualized Item Generation During Testing.** SUSAN E. EMBRETSON, *University of Kansas*—This paper shows how a cognitive design system approach permits cognitive ability items to be written on line to be maximally diagnostic for each person. Adaptive testing of cognitive abilities, in which maximally diagnostic items are selected for each individual, is now state of the art in measurement. Items are selected during computerized testing sessions according to mathematical models of item performance. However, the cognitive design system approach permits measurement to move a step further; new items are written during testing for specific sources and levels of information processing complexity. On-line item generation according to cognitive principles is demonstrated for the abstract reasoning test (ART). ART contains matrix completion problems to measure general intelligence. It is shown that items are reliably generated by a computer program to target sources and levels of cognitive complexity. High levels of prediction for the properties of newly generated items is supported.

### RETRIEVAL PROCESSES

Santa Monica, Saturday Morning, 10:10–12:00

*Chaired by David G. Payne, SUNY, Binghamton*

#### 10:10–10:30 (384)

**Getting the Facts Straight: Evidence for Inhibitory Processes That Resolve Interference in Propositional Retrieval.** MICHAEL C. ANDERSON & T. BELL, *University of Oregon*—Two experiments are reported that show that (1) retrieving propositions from long-term memory (e.g., recalling "The ant is crawling on the rock" given "Ant

crawling r\_\_\_” as cues) is accomplished, in part, by inhibitory processes that suppress interfering propositions (e.g., “The ant is crawling on the couch”); (2) this suppression causes a long-lasting recall deficit for inhibited propositions; and (3) inhibition of the concepts in a proposition generalizes to other propositions in which those concepts take part. The generalized inhibition observed here replicates similar phenomena observed by Anderson and Spellman (1995) and extends those findings to propositional memory. These findings are not easily explained by existing models of propositional retrieval (e.g., ACT-R) that emphasize traditional associative interference processes, but are consistent with a general role of inhibitory control in the resolution of retrieval interference.

#### 10:35-10:50 (385)

**Retrieval-Induced Forgetting: The Role of Item Similarity.** KARL-HEINZ BÄUML & ARMIN HARTINGER, *University of Regensburg*—We report on two experiments designed to examine the role of item similarity in retrieval-induced forgetting. Subjects studied categorized item lists with each category consisting of four exemplars, two from one semantic subcategory and two from another. When each item was displayed together with its category label (Experiment 1), the item belonging to the same subcategory as a retrieval-practiced item showed about the same amount of forgetting as the items belonging to the category’s other subcategory. However, when each item was displayed with both its category and its subcategory label (Experiment 2), thus enhancing the similarity between a subcategory’s items, the forgetting of the item belonging to the same subcategory as the retrieval-practiced item disappeared. These results suggest that, depending on the items’ processing, item similarity may reduce and even eliminate retrieval-induced forgetting.

#### 10:55-11:15 (386)

**Memory Control Processes: A Role of Familiarity in Recall.** KEVIN MURNANE & KENNETH MALMBERG, *University of Maryland*—The results of several experiments show that the time spent searching memory in a cued recall task is affected by the familiarity invoked by the retrieval cue. Familiar cues produce longer search times. However, the extra time spent searching memory does not improve memory performance. These results are discussed in terms of a general framework for modeling the control processes that govern the use of memory. Implications of the results for theories of interference are also discussed.

#### 11:20-11:30 (387)

**Does Retrieval Practice Influence Directed Forgetting?** BARBARA H. BASDEN, DAVID R. BASDEN, & EMILY MORALES, *California State University, Fresno*—Anderson, Bjork, and Bjork’s (1998) concept of retrieval-induced forgetting has been proposed as an explanation of retrieval inhibition in directed forgetting. In their experiments (that did not involve directed forgetting), retrieval-induced forgetting found support in the finding that repeated retrieval of some of the items within a set inhibits the retrieval of the remaining items within that set. The implication is that, in directed-forgetting experiments, repeated retrieval of the to-be-remembered items should inhibit retrieval of to-be-forgotten items. Our experiments were conducted to test this implication of retrieval-induced forgetting.

#### 11:35-11:55 (388)

**Divided Attention at Encoding and Retrieval: Assessment of Attentional Costs.** MOSHE NAVEH-BENJAMIN & JONATHAN GUEZ, *Ben-Gurion University*—Recently, Craik, Govoni, Naveh-Benjamin, and Anderson (1996) and Naveh-Benjamin, Craik, Guez, and Dori (1998) have cast doubt on the view that encoding and retrieval processes in human memory are similar by demonstrating notable differences between the two. Divided attention at encoding has been shown to significantly reduce memory performance, whereas divided attention at retrieval affected memory performance only minimally. This immunity at retrieval was associated with a significant secondary task cost. In this work we further investigated this symme-

try, employing a cued-recall task and a multimeasure approach, with accuracy, latency, and attentional costs as three measures of performance. The results yielded a complex pattern comprising both similarities and differences between encoding and retrieval. Simultaneous inspection of the different measures of performance was instrumental in identifying three major types of retrieval (unsuccessful, slow, and fast), as well as different phases of the retrieval process.

### PSYCHOLINGUISTICS: WORD MEANING Beverly Hills, Saturday Morning, 10:00–12:05

*Chaired by Alexander Pollatsek, University of Massachusetts, Amherst*

#### 10:00–10:15 (389)

**Quality Lexical Representations (Not Suppression) Are Central to Reading Skill.** CHARLES A. PERFETTI & LESLEY A. HART, *University of Pittsburgh*—According to one hypothesis, reading comprehension problems are localized in a faulty suppression mechanism (Gernsbacher, 1990). In another, skill variations arise from the quality of lexical representations (Perfetti, 1992). Experiments using nonhomographic homophones (e.g., *gate–gait*) in tasks of “meaning fit” support the second account. At intermediate (450-msec) SOAs, both skilled and less skilled adult readers had difficulty rejecting critical foils in meaning fit judgments (e.g., *gait–fence*). But at long SOAs (2,000 msec), neither skill group had difficulty. At short (150-msec) SOAs, only skilled readers had difficulty. Furthermore, for skilled readers, only the low-frequency member of the homophone pair (*gait*) produced difficulty, whereas for less skilled readers, only the high-frequency member (*gate*) did so. The overall pattern of results is not as well handled by a suppression mechanism as by variability in the quality of lexical representations (triples of orthography, phonology, meaning) that must be activated in reading.

#### 10:20–10:35 (390)

**Homograph Disambiguation and the Processing of Related Materials.** DAVID S. GORFEIN, *University of Texas, Arlington*—Several theories suggest that the selection of a meaning for a homograph (disambiguation) will result in the suppression or inhibition of associates to the homograph that are unrelated to the meaning selected. One theorist (Gernsbacher, 1990) posits an additional facilitatory process wherein associates related to the selected meaning are potentiated. The research reported employs a relatedness decision task to evaluate these positions. Gorfein and Amster (this meeting, 1998) have shown that having decided that BAT is related to HITTER made it easier to decide that BAT was related to BASEBALL and more difficult to decide that BAT was related to BLIND even over widely separated trials. Continuing the BAT example, the present studies report the outcome of trials in which, having decided that BAT was related to HITTER, the participant is subsequently confronted with a related meaning pair BASEBALL–UMPIRE or with a pair DRACULA–VAMPIRE, unrelated to the selected meaning of BAT.

#### 10:40–10:55 (391)

**Inhibition of Nonantecedents Following Anaphoric Reference.** STEPHEN DOPKINS, *George Washington University*, & JOHANNA NORDLIE, *New York University*—Following the processing of a noun anaphor, antecedent and nonantecedent nouns become respectively more and less accessible (Gernsbacher, 1989). The results of several experiments offer some clues as to the nature of the nonantecedent effect. It evidently reflects the presence of an active source of inhibition rather than the simple withdrawal of focus. The inhibitory process is related closely enough to the facilitatory process that their opposing effects are aggregated when applied to the same target. But the inhibitory process does not enable the facilitatory process by freeing up needed resources. The inhibitory process operates at a reasonably low level, with lexical items rather than discourse entities as its targets. It does not seem to abide by the predictions of either the spreading activation or the retrieval view of priming.

11:00–11:15 (392)

**Summation of Priming for Ambiguous Words in the Cerebral Hemispheres.** MIRIAM FAUST & ALON KAHANE, *Bar-Ilan University*—Previous research has demonstrated right hemisphere (RH) superiority for the summation of priming from several single-word primes. The present study included two lexical decision experiments that investigated the ability of the RH and the LH to benefit from three centrally presented single-word primes followed by a laterally presented ambiguous target word. The priming words were homogeneous (i.e., all three words related to the dominant or to the subordinate meaning of the target) or heterogeneous (i.e., two words related to the dominant meaning and one to the subordinate meaning of the target), or vice versa. Results indicated that the LH benefits more from homogeneous primes, mainly when they are related to the dominant meaning of an ambiguous target word, whereas the RH benefits more from heterogeneous primes, which enable the summation of priming from different meanings of the ambiguous words. These findings were more pronounced for long SOAs.

11:20–11:35 (393)

**Global Lexical Co-Occurrences and the Acquisition of Word Meanings.** PING LI, *University of Richmond*—High-dimensional semantic space models such as HAL (Burgess & Lund, 1997; Lund & Burgess, 1996) suggest that the computation of multiple lexical co-occurrences in large-scale text corpora can lead to accurate and faithful representation of the meaning of words. In HAL, global lexical co-occurrence is a measure of a word's total experience in the context of other words before and after it (i.e., what words co-occur and how frequently, in a moving window of variable size). In this study, we explored the role of global lexical co-occurrence in children's acquisition of word meanings. We analyzed the 3.8 million word corpus in parental/caregivers' speech in the CHILDES database with respect to several parameters: the size of the corpus, the size of the moving window, and the number of co-occurring words. Results indicate that use of global lexical co-occurrence information allows the learner to derive accurate representation of word meanings.

11:40–12:00 (394)

**Instantiating Hierarchical Semantic Relationships in a Connectionist Model of Semantic Memory.** GEORGE S. CREE & KEN MCRAE, *University of Western Ontario* (read by Ken McRae)—Past models of semantic memory have transparently represented hierarchical relationships as distinct levels of nodes connected by "isa" links. We present a connectionist model in which basic-level (*dog*) and superordinate-level (*animal*) concepts are represented over the same set of semantic features. Semantic feature production norms were used to derive basic-level representations and category membership for 181 concepts. The model was trained to compute distributed patterns of semantic features from word forms. Whereas a basic-level word form mapped to a semantic representation in a one-to-one fashion, a superordinate word form was trained by pairing it with each of its exemplars' semantic representations with equal frequency (typicality was not built in). This training scheme mimics the fact that people sometimes refer to an exemplar with its basic-level label, and sometimes with its superordinate label. The model is used to simulate human data from typicality, category verification, and superordinate-exemplar priming experiments.

## ATTENTION II

Westside, Saturday Morning, 10:40–12:00

Chaired by Paula Goolkasian, *University of North Carolina, Charlotte*

10:40–10:55 (395)

**Is Limited-Capacity Attention a Primary Determinant of Repetition Blindness?** JUNG-OH KIM, *Seoul National University and University of Massachusetts, Amherst*, & KYOUNGYONG KIM, *Seoul National University*—In an attention-limited condition, a re-

peated item is less accurately reported than a nonrepeated item (repetition blindness, e.g., Kanwisher, 1991; Kanwisher, Driver, & Machado, 1995). RB has been explained as arising from lack of attention to a repeated item. No RB task has made it clear whether a repeated input is fully attended or not. To examine a limited-capacity interpretation of RB, we modified Posner's validity task and used two target sets, HMN and EOS. All experiments showed a robust validity effect. The valid and invalid conditions showed RB in Experiments 1 and 2. The valid condition in Experiment 3, however, did not show any RB, whereas the invalid condition did. When location markers were displayed with targets, both conditions did not show any RB in Experiment 4. The results are not consistent with the limited-capacity interpretation of RB.

11:00–11:15 (396)

**Yes, Virginia, There Is Stroop Facilitation.** D. STEPHEN LINDSAY, *University of Victoria*—Stroop facilitation (faster color naming on congruent color names than on control items) is usually attributed to convergence of the influences of automatic word-reading processes and intended color-naming processes. Colin MacLeod and co-workers have proposed that there is no such convergent facilitation, and that Stroop facilitation reflects occasional inadvertent word-naming responses on congruent words. In support of this argument, they reported that color naming was no faster on congruent color-related words (e.g., "sky" in blue) than on nonword control items ("xxxx" in blue). This finding is ambiguous, because convergent facilitation from congruent color-related words would likely be offset by the interfering influence toward saying the color-related word (e.g., "sky"). In the present experiments, color naming was faster on congruent color-related words than on matched color-unrelated control words (e.g., "win" in blue). This facilitation effect cannot be accounted for by inadvertent word naming, and instead appears to reflect convergent facilitation.

11:20–11:35 (397)

**Part-Based Attentional Selection.** SHAUN P. VECERA, *University of Iowa*, & MARLENE BEHRMANN, *Carnegie Mellon University*—Recent empirical results suggest that there is a decrement in dividing attention between two objects, compared with focusing attention on a single object. However, objects are composed of parts. Is there a decrement for dividing or shifting attention between the parts of an object? We addressed this question in a series of experiments. In a divided-attention paradigm (Duncan, 1984), subjects reported attributes from a single part of an object more accurately than attributes from different parts of an object. This part-based effect simultaneously occurred with an object-based effect. The part-based effect does not depend on the spatial distance between the parts. Finally, in a cued detection task (Egley et al., 1994), subjects detected targets appearing in a cued part faster than targets appearing in an uncued part, corroborating the results from the divided-attention paradigm. These results imply an attentional mechanism that can select either objects or their parts.

11:40–11:55 (398)

**Priming and Recognition for Attended and Unattended Objects at Different Delay Conditions.** SOLEDAD BALLESTEROS, *Universidad Nacional de Educación a Distancia*, JOSÉ M. REALES, *Universidad Complutense*, MARISA CARRASCO, *New York University*, & EULALIO GARCÍA, *Universidad Nacional de Educación a Distancia*—At study, observers saw outlines of two overlapping objects of different colors while they performed a speeded naming task on the green object. Test order (implicit–explicit or explicit–implicit) and delay (5 min, 1 week, or 1 month) were manipulated between subjects. Attention conditions (attended, unattended, novel objects) were manipulated within subjects. Implicit memory was assessed with a speeded picture-fragment completion task. The results indicated that priming was present for both objects, but was larger for attended than for unattended objects. In contrast, the

“old–new” recognition task showed that explicit memory was severely impaired for unattended objects. These results are consistent with previous findings we reported at this meeting 2 years ago using free recall (a conceptual test) to assess explicit memory. The effects of delay conditions on implicit and explicit tasks were also explored. The present findings make stronger our claim on the relationship between attention and both implicit and explicit memory.

### 3-D/MOVEMENT PERCEPTION II Century, Saturday Morning, 10:00–12:05

Chaired by William H. Warren, Brown University

#### 10:00–10:15 (399)

**Does the Velocity Difference or Ratio Determine Perceived Depth?** MYRON L. BRAUNSTEIN & CRAIG W. SAUER, *University of California, Irvine*, & GEORGE J. ANDERSEN, *University of California, Riverside*—We previously reported that adding object rotation to a translating 3-D scene increases perceived object depth. This may occur because perceived object depth is based on the difference between the maximum and minimum displayed velocities, without taking into account the velocity ratio (or the mean velocity). To examine the relative effects of the difference and ratio, we had observers judge the internal depths of rotating objects in a translating scene. Three levels of velocity difference and three levels of ratio were combined factorially by selecting appropriate combinations of scene translation speed and object rotation speed. For the differences and ratios studied, judged object depth was determined primarily by the difference in velocities but was also related to the velocity ratio. This result is consistent with results indicating that judged depth can be predicted from the velocity difference and results showing an influence of the ratio when the difference is constant.

#### 10:20–10:35 (400)

**Uniform-Connected Regions and Perceived Layout in Real 3-D Scenes.** GEORGE J. ANDERSEN & ASAD SAIDPOUR, *University of California, Riverside*, & CRAIG W. SAUER & MYRON L. BRAUNSTEIN, *University of California, Irvine*—Previously we have found that a uniform-connected region within a motion parallax scene can influence the perceived layout of objects in the scene. Specifically, we found that judged depth between objects was greater within the connected region and increased as increasing linear perspective information was added to the contours of the region. In the present research, we examined whether a connected region within a real scene would influence the perceived layout of objects in the scene. Observers were presented with displays of digitized images of real scenes to which a computer-generated connected region and two posts were added, and were asked to judge the perceived distance between the posts. Judged distance between the objects was greater for objects inside the connected region. The shape of the connected region also influenced the perceived distances. We will discuss the implications of this research for the perceptual analysis of scenes.

#### 10:40–11:00 (401)

**Inferring Object Shape From Motion.** BARTON L. ANDERSON & HILARY C. BARTH, *MIT*—A new class of illusory contours generated by moving images are reported. When outline figures are translated behind an invisible straight vertical occluders, vivid illusory occluding contours form that appear to deform nonrigidly. These contours were extremely robust, and form even when a different visible occluding surface is displayed concurrently. In a series of experiments, we demonstrate that the critical variable regulating the illu-

sory contour's shape is the velocity of the contour terminators. When the terminator velocity is constant, the illusory contours are simply scaled copies of each other. However, if the contour terminators have a variable velocity, then the illusory contours do not possess this scaling property. We show that the illusory contours can be modeled with mechanisms that compute the angle formed between the velocity of the contour terminators and an induced translation velocity imparted onto the illusory occluding surface.

#### 11:05–11:20 (402)

**Visible Support Surface Allows Haptic Feedback to Generalize Across Reach Space.** GEOFFREY P. BINGHAM & J. ALEX SHULL, *Indiana University*—Bingham, Zaal, Robin, and Shull (submitted) investigated the perception of egocentric distance and shape using reaching as a measure. Participants performed feed-forward reaches to place a stylus at the front, back, right, or left side of a target sphere. When participants could not touch the sphere to receive haptic feedback, both egocentric distance and shape were distorted and reaches drifted farther away in depth over trials. When haptic feedback was available, egocentric distances became stable and accurate. We now investigate the effect of a visible support surface on the generalization of haptic feedback across reach space. Participants reached to near and far targets with or without a visible support surface. They received haptic feedback from only the near or the far target. The visible support surface yielded stable and more accurate reaching to the nonfeedback target. Without the visible surface, reaches to the non-feedback target drifted.

#### 11:25–11:40 (403)

**Integrating Depth Cues During Active Control: Does Size Matter?** MARY K. KAISER & BARBARA T. SWEET, *NASA Ames Research Center*—We examined how people integrate two depth cues (relative size and binocular disparity) in an active control task. The participants' goal was to maintain a target at the same apparent depth as a standard via fore/aft joystick inputs. The target's apparent position was perturbed using pseudo-random (sum-of-sines) disturbances of the target's size, binocular disparity, or both cues in tandem. By introducing independent disturbances, we were able to measure the extent to which participants' inputs were responsive to each of the two cues (as well as identify random inputs). Preliminary analyses indicate a shift in cue utilization as a function of disturbance frequency. At lower frequencies, binocular disparity dominates; at higher frequencies (i.e., greater than 1 Hz), relative size becomes dominant. The effect of viewing distance and the dynamics of the control element (rate vs. acceleration) will also be discussed.

#### 11:45–12:00 (404)

**Perceptual Shape Distortion Under Full-Cue Viewing Is Coupled to Optical Slant.** JACK M. LOOMIS & PAVEL ZAHORIK, *University of California, Santa Barbara*—Even under full-cue viewing, 2-D and 3-D shapes are often perceived with significant distortion—the depth component is perceptually foreshortened relative to the frontoparallel components. Loomis and Philbeck (1999) hypothesized that this perceptual distortion is tightly coupled to the optical slant of the shape. In this experiment, we presented L-shaped targets at two egocentric distances, two heights above the ground and two geographical slants, all of which are determinants of optical slant. The results, for both monocular and binocular viewing, indicate that these three distal variables exert their influence on perceived shape through optical slant. Furthermore, the perceptual shape distortion is not a consequence of misperceiving the egocentric distances to the targets. Finally, the results lend further support to the idea that the perception of scale is independent of the perception of shape.

## POSTER SESSION III

California Showroom, Saturday Noon, 12:00–1:30

## • PSYCHOPHYSICS •

(405)

**Judged Synchrony/Asynchrony for Light–Tone Pairs.** STEVEN VAN DE PAR, *IPO Center for Research on User–System Interaction*, ARMIN KOHLRAUSCH, *IPO Center for Research on User–System Interaction and Philips Research Labs*, & JAMES F. JUOLA, *IPO Center for Research on User–System Interaction and Universidad Autónoma de Madrid*—A brief tone and a visible movement of a light were presented either simultaneously or with one of them leading by 50 to 350 msec in steps of 50 msec. Participants judged whether they were simultaneous, or one of them occurred first. Mean simultaneity judgments peaked in the condition in which the light preceded the tone by 50 msec, and  $d'$  was uniformly higher in the tone-first condition than when the light was first.

(406)

**Assigning Surface Attributes to Transparent Layers.** MANISH SINGH & BARTON L. ANDERSON, *MIT*—In creating the percept of transparency, human vision must decompose the light intensity at each image location and allocate the separate components to distinct layers. How does it determine when to initiate this decomposition, and how does it assign transmittance and lightness to the two layers? To address this question, observers stereoscopically viewed a small transparent disk floating in front of a sinusoidal grating. In two experiments, observers were asked to match either the perceived opacity or lightness of the transparent disk. Our results show that the opacity of a transparent surface is determined by its contrast relative to neighboring regions, and that perceived lightness is a function both of perceived opacity and whether the transparent region is lighter or darker than the surround. Whereas previous approaches have emphasized the role of luminance or lightness relationships in determining transparency, we argue for the critical role of contrast.

(407)

**Does Selective Attention Modulate the Processing of Discontinuities?** ANNE GIERSCHE, *INSERM, France*, & MANFRED FAHLE, *Zentrum für Kognitionswissenschaften*—We used a modified short-term priming task to explore the modulation in the processing of discontinuities. Two stimuli were displayed in immediate succession: they were composed of two horizontal line segments, either collinear or parallel (and connected on one side, forming a U-shape). Subjects decided whether the gap separating the two line segments was located right or left. We showed previously that RTs increase when a stimulus composed of collinear line segments is followed by a stimulus composed of parallel line segments with a gap on the same side, or the reverse. This effect is orientation and location dependent, and might rely on the modulation of the processing of line ends and virtual lines. We show here that RT variations disappear if attention is divided between several gaps. The allocation of attention on individual gaps was manipulated, and the results suggest that the modulation of the processing of discontinuities is under the control of selective attention.

(408)

**Detection of Symmetry and Repetition of Illusory Contours.** GORDON C. BAYLIS, *University of South Carolina*, JANE RAYMOND, *University of Wales, Bangor*, CHRISTOPHER GORE & NAYENA BLANKSON, *University of South Carolina*, & REBECCA SHISLER, *University of Georgia*—Illusory contours, seen when line or region terminations are aligned, may readily lead to the perception of entire regions (e.g., Kanisza triangles). Both psychophysics and neurophysiology suggests that these contours may be represented early in the visual system. Baylis and Driver (1995, *JEP:HPP*) suggested that symmetry detection occurs in an effortless manner because it uses shape

descriptions of contours derived early in vision, whereas judgments of literal repetition cannot occur in this way. Here we investigated detection of symmetry and literal repetition of contours defined by lines, illusory boundaries, or a combination of the two. Illusory contours could be judged almost as quickly as real contours. Judgments of symmetry showed a large cost of mixing real and illusory contours, whereas judgments of literal repetition did not. These results suggest that illusory contours are represented very early, but their equivalence with real contours may not be represented until later.

(409)

**Integration and Segregation of Brief Visual Displays: Masking of a Pattern by Parts of Itself.** SAMANTHA M. ZUVIC, TROY A. W. VISSER, & VINCENT DI LOLLO, *University of British Columbia*—A 5×5 square dot matrix with one missing dot was presented in two brief 12-dot frames (F1 and F2), separated by a variable interstimulus interval (ISI). To locate the missing dot, F1 and F2 had to be perceptually integrated across the temporal gap. We varied the duration of F1 and F2 both separately and jointly, and used a staircase procedure to find the critical ISI that yielded 50% correct responses. When F1 and F2 were brief (1 msec), integration occurred across ISIs as long as 100 msec. But when F1 and/or F2 were long (320 msec), observers required lengthy *negative* ISIs (100 msec) during which F1 and F2 were presented simultaneously. We account for these results in terms of two visual processes: visible persistence, which bridges the temporal gap, and backward masking, which occurs when the whole matrix is masked by the parts of itself that remain on display (i.e., F2).

(410)

**Perception of Ellipse Orientation.** BAOXIA LIU, TJEERD DIJKSTRA, & STIJN OOMES, *Ohio State University*—Perception of the orientation of objects is important in our interaction with the environment. So far, research has focused on the orientation of lines and gratings with the main result that vertical and horizontal orientations are perceived more accurately and precisely than oblique ones (oblique effect). We tested the orientation perception of ellipses with different length-to-width (aspect) ratios in various orientations. Naive subjects adjusted a broken line to match the major axis orientation of an ellipse that was placed at the center. Results show the oblique effect and, especially for the low aspect ratios (close to a circle), the sign change of biases around the vertical and horizontal reveals that the ellipse is perceived as more vertical than it actually is. We posit that the oblique effect pertains to objects instead of contours because the local contour orientation of the ellipse does not directly signal the global orientation.

(411)

**The Visuomotor System Resists the Horizontal–Vertical Illusion.** PHILIP SERVOS, *Wilfrid Laurier University*, HEATHER CARNAHAN, *University of Waterloo*, & JASON FEDWICK, *Wilfrid Laurier University*—The effect of the horizontal–vertical illusion on the visual and visuomotor systems was investigated. Subjects viewed horizontal and vertical lines in an inverted “T” stimulus and judged whether the two line segments were the same or different lengths. Subjects also reached out and grasped either the vertical or horizontal line segments of the stimulus. Perceptually subjects succumbed to the illusion, that is, they judged Ts of equal horizontal and vertical line lengths to be different, and judged Ts of unequal line lengths to be the same. However, when reaching toward these same stimuli, the size of their grip aperture was scaled appropriately for the various line lengths. Thus, although the perceptual system succumbed to the illusion, the visuomotor system did not. These results support a model proposed by Goodale and Milner (1992), which posits separate cortical pathways for visual perception and visually guided action.

(412)

**Random-Dot Stereograms Can Prime Monocular Perspective Distortions.** FULVIO DOMINI, *Brown University*, & MYRON L. BRAUNSTEIN, *University of California, Irvine*—When a random-dot

pattern representing a 3-D planar surface is shown in structure-from-motion, and two probe dots are flashed on the image plane after the motion is stopped, the perceived relative 2-D positions of the dots are distorted as if they were lying on a sustained representation of the 3-D surface (Domini & Braunstein, 1998). In a similar fashion, we studied how a stereo-specified random-dot surface could prime the perceived 2-D arrangement of monocular probe dots. Observers viewed a stereo planar surface slanted in depth about a horizontal axis for 1,000 msec, followed by a monocular image of the random-dot pattern for 0 to 600 msec, followed by two monocular probe dots superimposed on the monocular random-dot pattern for 70 msec. The results indicate that the 2-D relative positions of the probe dots were judged as if they were still perceived as lying on the 3-D surface.

• 3-D/MOVEMENT PERCEPTION •

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**Dominance of Binocular Depth Information Over Competing Kinetic Occlusion Information.** PATRICK A. CABE & PATRICK N. ABELE, *University of North Carolina, Pembroke*, & JOHN M. KENNEDY, *University of Toronto, Scarborough*—We studied competing binocular and kinetic depth information. A novel lenticular sheet material provided contradictory apparent surface layout. Kinetic occlusion indicated a target disk floating above the material's surface. But binocular information ("half-occlusion") indicated the disk was recessed into the surface. Experiment 1 verified that (1) in static monocular vision, the disk was judged coplanar with the sheet, but (2) monocularly, kinetic occlusion indicated the disk floated above the sheet, and (3) under static binocular viewing, the spot appeared recessed. With kinetic and binocular information present simultaneously, binocular effects overruled kinetic ones. In Experiment 2, we predicted the sheet material would be judged nearer when viewed through an aperture in an opaque surround. Binocular information again outweighed kinetic occlusion. In Experiment 3, observers viewed binocularly an opaque occluding stripe at varying orientations. Apparent depth judgments reliably tracked changed orientation (and hence binocular disparity), confirming the importance of binocular input.

(414)

**Exploring the Link Between Time to Collision and Representational Momentum.** ROB GRAY & IAN M. THORNTON, *Nissan Cambridge Basic Research*—Previous research has shown that when a moving object is occluded prior to collision with another stationary object, observers tend to consistently underestimate the actual time to collision (TTC). We examined whether mislocalization of the initial point of disappearance plays any role in this underestimation. To assess the contribution of mislocalization, we coupled a standard TTC paradigm with a representational momentum paradigm. Representational momentum refers to the tendency to mislocalize the stopping point of a moving object as being too far forward along an actual or implied path of motion. Using identical displays we found large representational momentum shifts and consistent underestimation of time to collision. When we modified the displays to disambiguate the point of disappearance of the moving object, representational momentum was absent or significantly reduced, and underestimates of time to collision were effectively eliminated.

(415)

**Representational Momentum in a Scene.** MARGARET P. MUNGER, BENJAMIN H. COVINGTON, JOY H. MINCHEW, & JENNIFER A. STARR, *Davidson College*—Positive memory distortions for object position have been found following implied events depicting rotations in depth, but not always for translations depicting motion in depth. In two experiments depicting either an object moving in depth or an entire scene approaching the viewer, positive memory distortions were observed for both object position and scene. Participants misremembered both the object and the scenes as closer than presented, in keeping with representational momentum. In contrast with previous work in memory

for static scenes, no boundary extension was observed, despite close-up presentation of the scene. Participants did not misremember larger boundaries, but in fact accepted as "same" more close-up views of the object. This suggests that the perceptual schema of a scene that might lead to boundary extension is sensitive to depicted movement.

(416)

**Perceived Eye Height as a Likely Yardstick for Absolute Distance Judgments.** MICHAEL J. SINAI, *Naval Postgraduate School*, TENG LENG OOI, *Southern College of Optometry*, & ZIJIAN J. HE, *University of Louisville*—In a perceptual matching task, observers estimated, with respect to the ground surface, their eye height from four vertical elevations and the horizontal distances to four targets from each elevation. Except for the control condition, in which observers stood on the ground itself, they overestimated both the distances in depth along the ground surface and their eye height judgments. The overestimation became larger with increasing elevations, and a strong correlation was found between the perceived eye height and perceived distance. This finding can be related to the proposal that the eye height to the ground surface, with either the angle of declination or texture gradient of size, is employed by the visual system to compute absolute distance on the ground (Sedgwick, 1983). We believe that the reliance on eye height, like an internal yardstick, is of ecological value since our heights often remain constant as we frequent our terrestrial environment.

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**Control of Locomotion in Nonrigid 3-D Environments.** ASAD SAIDPOUR & GEORGE J. ANDERSEN, *University of California, Riverside*—Previous research on the perception of heading from optic flow has examined conditions in which the flow field is rigid, or a single object is moving. Recently we found that observers were tolerant to nonrigid motion in detecting the direction of heading. In the present study we examined whether observers have a similar tolerance to nonrigid motion in the control of optic flow. Observers were presented flow fields simulating motion through a 3-D scene of objects. The horizontal position of observer motion was perturbed by a sum of sines function and observers were asked to null the lateral displacement. The results indicate poorer control performance occurred when the flow field was nonrigid (each object underwent a random motion). In addition, control gain and phase lag increased for nonrigid as compared with rigid flow field conditions. The importance of these results to spatial pooling models of optic flow will be discussed.

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**Predicting Outcomes of Self- and Other-Generated Throwing Actions.** GÜNTHER KNOBLICH, *Max Planck Institute for Psychological Research, Munich*—Representations guiding action planning may also be involved in action perception. If this is true, individuals should be able to correctly predict the outcome of actions and more so for self-generated actions. These hypotheses were tested in several experiments: In a first session, participants were videotaped from a lateral perspective while throwing darts at a target board. A film was prepared from these recordings. Each clip began with a person picking up a dart from a table, and ended with the last frame before the dart left the person's hand (the target board was visible). In a second session, each participant watched two films, one displaying self-generated and another displaying other-generated throwing actions. Participants predicted the landing position of the dart on the target board more accurately when the film displayed the whole person than when it displayed the moving arm and hand. Moreover, self-generated actions led to better predictions.

(419)

**Retinal Field and Heading Perception During Active Control of Yaw.** JOEL B. RICHMAN & BRIAN P. DYRE, *University of Idaho*—Previous research demonstrated that stimulation of the central visual field was necessary and sufficient for accurate heading perception.

Typically, these studies presented brief displays requiring discrete open-loop responses and controlled fixation. The present study extended this research to the context of continuous closed-loop control and free viewing. Using a yaw-control task to assess heading performance, we manipulated retinal field (central, peripheral, or both) with masks or areas of interest yoked to gaze direction so that free viewing over an area of  $90^\circ \text{H} \times 34^\circ \text{V}$  was possible. We found superior heading performance when stimulation included both the central and peripheral visual fields. Stimulation of either the central or peripheral visual fields in isolation led to moderate or worse yaw control, respectively. The central visual field thus appears necessary but not sufficient for accurate heading perception, which benefits from additional information in the periphery during active control.

• ATTENTION •

(420)

**Marking Targets and Distractors in an Odd/Even Judgment Task.** JOOYONG PARK, *Hallym University*—Visual marking refers to indicating the items that have already been processed in a display. In Experiment 1, the subjects were asked to judge whether the number of items in a display is odd or even. Positively accelerating RT functions were found as the number of items increased. In Experiments 2 and 3, subjects had to judge only for the targets, while ignoring the distractors. In Experiment 2, the targets were Os, and the distractors were Qs. The number of Os were varied from 0 to 3, and the number of Qs were 6, 12 or 18. In Experiment 3, the targets were Ts, and the distractors were rotated Ts. In both experiments, in contrast to the result from Experiment 1, either linear or negatively accelerating RT functions were observed, as the number of distractors increased. These results suggest that marking off the distractors is more efficient than marking the targets.

(421)

**Feature Integration in a Dynamic Multidimensional Situation.** JUN SAIKI, *Kyoto University*—It has been shown that visual working memory can hold information of about four perceptual objects, using either static multidimensional situation or dynamic unidimensional situation. However, in a dynamic multidimensional situation, the capacity of visual working memory is apparently well below four. Participants were shown a sequence of 10 triangular patterns composed of three colored circles with short between-frame blanks. The sequence shows rotation of the whole pattern with or without a frame violating the regular rotation. Participants had difficulty in detecting an irregularity: a switch of two colors within the pattern, even though their future locations were completely predictable. Decreasing the rotation angle per frame did improve performance, but clarification of the rotational motion by inserting achromatic linkers or by using locally moving patterns did not improve performance. Color and spatiotemporal property of objects do not seem to be coherently bound in a dynamic situation.

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**Search Asymmetry Revisited: A New Approach to Visual Search.** ROBERT RAUSCHENBERGER & STEVEN YANTIS, *Johns Hopkins University*—We conducted several search asymmetry experiments (after Treisman & Souther, 1985, Experiment 1) that yielded results that are inconsistent with the predictions of feature integration theory, guided search, and attentional engagement theory. A new account is proposed that is based on the compactness with which nontargets can be encoded in an information theoretic sense. We tested the new theory with additional search asymmetry experiments using stimuli borrowed from Garner and Clement (1963), which differ systematically in their complexity. The results were consistent with the predictions of the theory, and provide insights about the relation between visual search performance and several other phenomena, including change blindness, inattentive blindness, attentional capture by new perceptual objects, and object substitution.

(423)

**Connecting the Varieties of Attention.** MARC CARTER, *Hofstra University*, VINCENT BROWN, *Clarkson University*, & MICHAEL TUMEO, *U.S. Office of Personnel Management*—Although sometimes discussed as such, attention is probably not a unitary phenomenon, given the variety of empirical phenomena that come under the heading of selective attention, such as Stroop effects, flanker effects, location and feature cuing effects, inhibition of return, negative priming, and more. Whereas all of these selective attention phenomena almost surely involve some degree of suppression or inhibition (along with facilitation), the level at which these selective processes operate and the details of their implementation may differ, depending on the task. We explore these ideas with a general connectionist model designed to account for some of the variety of attention phenomena, and attempt to show which processes are required for different phenomena. In addition to the clearly spatial aspects of attentional selection, the model specifically attempts to account for some of the temporal dynamics of attention.

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**Spatial Frequency Affects Search Slope but Not Attentional Selection With Hierarchically Organized Stimuli.** MARVIN R. LAMB, *California State University, Hayward*—Participants searched for a target appearing in one of several hierarchically organized letter patterns. Eliminating low spatial frequencies increased search slope for global targets and decreased search slope for local targets. At the same time, attentional bias to a given level of structure was unaffected by the elimination of low spatial frequencies. The data suggest that (1) low spatial frequencies facilitate the grouping of local forms into a global configuration and (2) that spatial frequency is not the basis of attentional selection between levels of structure.

(425)

**Contingent Capture: Testing the Recovery Account.** CHARLES L. FOLK, *Villanova University*—Research using the spatial cuing paradigm indicates that an irrelevant, color-singleton precue captures spatial attention when the subsequent target is defined by the same color but not when the target is a different color. These results have been interpreted as evidence for top-down contingencies in attentional capture. An alternate, strictly bottom-up, account of these results attributes apparent top-down contingencies to differential recovery from capture, depending on whether the precue and target colors match or not. The present experiment tested this alternate account by manipulating the response compatibility of a character that appeared at the same location and simultaneous with the irrelevant precue. Compatibility effects were evident only when the precue and target color matched. These results rule out the recovery account and suggest that attentional capture is indeed contingent on top-down attentional control settings.

(426)

**High-Level Processing Constraints in Perception and Action Streams.** SOWON HAHN & GEORGE J. ANDERSEN, *University of California, Riverside*—Previous neuropsychological studies have found evidence of a dissociation between perception and action, suggesting different perceptual processing streams. In the current study we examined the dissociation of perception and action using a task-switching paradigm to determine whether this dissociation may be present in higher level processing (e.g., attention/executive function). Subjects were asked to judge the color or shape of objects. Two different response modalities were used: a judgment response (press a key to indicate color/shape) or an action response (press a key to move the object to a screen location to indicate color/shape). We obtained a larger task switching cost for between-modality than for within-modality switches. In addition, a task-switching asymmetry was found, with greater cost occurring for judgment to action switching than for action to judgment switching. These results suggest a dissociation between judgment and action processing beyond perceptual mechanisms.

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**ACT-R Does Task Switching: Effects of Foreknowledge and Foreperiod on Task-Switch Cost.** MYEONG-HO SOHN & JOHN R. ANDERSON, *Carnegie Mellon University*—Task-switching cost has been suggested to consist of lack of preparation and interference. Controlled activation (CA) may be responsible for preparation and automatic activation (AA) for interference. To examine this, foreknowledge of task transition (repeat or switch) and length of foreperiod (response-to-stimulus interval, RSI) were manipulated. Switching cost decreased as RSI increased, regardless of foreknowledge. With foreknowledge, switch RT decreased with longer RSI while repetition RT remained the same. With no foreknowledge, repetition RT increased while switch RT remained the same. Though foreknowledge resulted in benefit for both task repetition and task switch, greater switching cost was associated with foreknowledge with shorter RSIs. These results suggest that task-switching cost may reflect both CA and AA. CA may increase over time but AA may decay. An ACT-R model is proposed to explain these results on the basis of production decay and competition between productions.

(428)

**Sustained Event-Based Attending in a Time Judgment Task.** DEVIN MCAULEY, *Bowling Green State University*, & MARI RIESS JONES, *Ohio State University*—Three experiments were designed to examine the effects of large-scale contextual properties on categorical time judgments. In a baseline experiment, different groups of subjects compared standard and comparison inter-onset-time intervals (IOIs) ranging from 200 to 800 msec. Subsequent experiments placed these same standard-comparison IOIs within different session contexts that varied according to (1) number, (2) variance, (3) range, and (4) mean rate supplied by constituent IOIs within a session. Main determinants of judgment accuracy and time-order errors involved session range and rate.

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**Pitch Expectancies in Audition.** JENNIFER KIM HOFFMAN & MARI RIESS JONES, *Ohio State University*—Two experiments investigate the way attention is directed by the pitch structure of melodies. The pitch distance of a target pitch embedded within each of a set of tonal melodies was varied in order to determine listeners' ability to assess the pitch of a structurally deviant tone. All participants were exposed to sets of 9-tone familiar melodies (key of F-major) containing embedded target tones that varied systematically in pitch distance from the melodic line. Degree of listeners' exposure to melodies was also varied (one vs. four presentations). Experiments 1 and 2 differed in task requirements: Experiment 1 used a three-response choice task (the changed pitch is higher, lower, or the same as in previous cycles). Experiment 2 omitted the "same" option, reducing the number of response choices to two.

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**Attention is Mobilized by Oculomotor Preparation.** SHU-CHIEH WU & HARVEY SHULMAN, *Ohio State University*—Three experiments addressed conflicts in past research regarding whether preparation of saccadic eye movements leads to attention shifts toward the saccade target. Participants prepared saccades to an endogenously cued destination and postponed the movements until another command, presented after intervals of either 500 or 800 msec. During the preparatory period prior to the movement command, probe letters for evaluation of attention appeared at all possible saccade destinations. Evidence of saccade-related attention shifts, indicated by greater report accuracy for probes at the saccade destination, was found to depend on the interval between cues and probes, in that only long intervals revealed such effects. This dependency on proper temporal placement of probes to capture attention effects explains the conflicts in past research. Additional experiments using a go/no-go paradigm confirmed the results of whether or not saccades were executed. Findings from these experiment are consistent with a premotor account of covert attention orienting.

• COGNITION •

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**Gender Differences in Naming Speeds for Aggression Words Primed by Weapon Names.** ROBERT J. MADIGAN, CHRISTINE SEAL, SARAH LEWIS, TARIK BEL-BAHAR, & ALAN REIMAN, *University of Alaska, Anchorage*—Anderson, Benjamin, and Bartholow (1998) reported data which showed that the presentation of weapon words increased naming speeds for aggression words. Anderson et al. concluded that the weapons effect extends to semantic priming by weapon names. This study examined gender differences in this finding. Subjects were 75 male and 75 female college students who saw pairs of stimuli in which a prime word was followed by target word. Subjects read the prime word silently and the target word aloud. Prime stimuli were 12 names of weapons and 12 names of household objects. Target stimuli were 24 aggressive verbs and 72 nonaggressive verbs. Preliminary results showed a difference between men and women in that male reaction times to aggression words preceded by weapon names were faster than reaction times to aggressive words preceded by nonaggressive primes. Additional results will be presented and discussed.

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**An Alternative to the Encoding Expertise Explanation for the Cross-Race Recognition Deficit.** DANIEL T. LEVIN & ISABEL LACRUZ, *Kent State University*—Many studies show that people have difficulty recognizing faces from a race different than their own. Most researchers agree that this cross-race (CR) recognition deficit is caused by failure to generalize perceptual expertise with same-race faces to cross-race faces. Here, we argue that this explanation is incorrect, or at least incomplete. Contrary to predictions based on an encoding expertise hypothesis, we show that White subjects who are relatively poor at recognizing Black faces are paradoxically accurate at discriminating among variants of Black faces in a traditional ABX task, so long as those variants contrast in the degree to which they instantiate race-specifying information. Combined with data showing that White subjects locate and classify Black faces faster than White faces, these data suggest that the CR recognition deficit is caused by a feature selection bias in which subjects code the race of CR faces at the expense of individuating information.

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**Animation and Segmentation in Conveying Events.** JULIE BAUER MORRISON, *Stanford University*, JEFF ZACKS, *Washington University*, & BARBARA TVERSKY, *Stanford University*—Although dynamic events occur continuously in time, they are often perceived as segmented and hierarchical. This helps explain failures of animation to facilitate learning. It also suggests principles for use of segmentation and animation in the design of effective interfaces. We report experiments varying hierarchical organization and/or animation in interfaces for two tasks: one for teaching construction of an object, the other for teaching interactions of objects.

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**The Effects of Blocked and Alternating Training on Shifting Mental Set.** AKIRA MIYAKE & MICHAEL J. EMERSON, *University of Colorado, Boulder*, & PRITI SHAH, *University of Michigan*—This study examined the effects of training on shifting mental set, using the Jersild (1927) paradigm. In a pretest, college students performed simple addition or subtraction in blocks (addition only or subtraction only) or in alternation (switching between the two). They then received either blocked training (requiring no shifting) or alternating training (requiring constant shifting) that involved either the same or different operations than the pretest, before being tested again on a posttest. Although the overall task completion times decreased from pretest to posttest in all training groups, there were differential effects of training on the shifting cost, operationalized as the difference between the solution times for the blocked lists and the alternating list.

Regardless of whether the training task involved the same operations or not, the shifting cost decreased more for the alternating training group than for the blocked training group, indicating that set shifting is a separable process.

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**Spatial Orientation in Virtual Environments.** MARYAM ALLAH-YAR & EARL HUNT, *University of Washington*—Three-dimensional computer-simulated environments are used for training purposes in different settings. An important issue in using virtual environments is to understand similarities and dissimilarities between learning and orienting oneself in virtual and real environments. The present study compared patterns of reaction time obtained from orienting toward a given object and locating target objects in three different conditions—a real-world setting, a desktop, and an immersive condition. The results suggest that there is a significant difference between tasks learned in virtual environments compared with the real-world condition. Although the two computer-simulated environments produced fairly similar patterns, they both differed from the real-world environment. What is learned in the virtual environments appears more like what would be learned from a map than from an actual environment.

• PROBLEM SOLVING •

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**Them Bones: Analyzing the Expertise of Field Anthropologists.** SHARLENE D. WALBAUM, *Quinnipiac College*—Expertise consists, in part, of particular competencies that lead to superior domain-specific cognitive performance. Field anthropologists were interviewed and observed as they worked at two sites in Peru, in order to analyze their specialized competence. Both self-report and observational data indicated that fast and accurate bone identification is one important specialized skill. Field workers reported that they rely on visual cues to identify and “side” bones, but their behavior indicated a reliance on tactile cues as well. In order to examine the separate contributions of touch and vision to bone identification, two tasks were designed. They were administered to a sample of 10 field workers that included amateurs with months of experience and professionals with years of experience. Results indicated that expertise played a role in performance of these tasks and that tactile cues were at least as effective as visual ones for labeling and “siding” bones.

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**Case-Based Reasoning in Chess for Novices.** EVELYNE CAUZINILLE & ANDRÉ DIDIERJEAN, *Université de Provence* (sponsored by Guy Tiberghien)—One fundamental question in cognitive psychology is whether knowledge constructed during the analysis of examples is stored in an abstract form or whether some specificity of the examples is conserved. A related question concerns the conditions under which this knowledge can be used in a problem-solving situation. These questions are addressed in studies examining the changes that take place during the acquisition of a microexpertise in chess. The results of the first study show that subjects can store in long-term memory very specific aspects of the examples presented in the learning phase. In addition, the results show that there are prerequisites for case-based reasoning. The results of the second study show that, even when subjects are able to generalize their knowledge, they have nonetheless stored very specific parts of the source examples: the generalization process is conservative.

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**The Effects of Data Representation in a Rule Discovery Task.** SEAN C. DUNCAN & RYAN D. TWENEY, *Bowling Green State University*—The effects of varying the external representation of a science-like task was studied. By systematically modifying Wason’s (1960) rule discovery (“2-4-6”) task, we manipulated the degree of external task representation and studied its effects on hypothesis content and hypothesis-testing behavior. Previous studies (Twene et al., 1980;

Vallée-Tourangeau, 1994) have successfully shown that manipulations of the rule representation elicit differences in hypothesis-testing behavior. We extended this finding by creating problem isomorphs of the task (following Zhang & Norman, 1994; Zhang, 1997) that varied the degree to which formal elements of the task were represented graphically. Although there were few effects on overall solution efficiency, some subjects appeared to use alternative hypotheses more frequently, confirming Zhang and Norman’s finding of a “representational effect.” These subjects also tended to make more predictions that a generated triple would not fit their hypothesized rule.

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**Overcoming Mental Set Due to Domain Knowledge.** JENNIFER WILEY, *Washington State University*—Wiley (1998) demonstrated that expertise can constrain creative problem solving on a remote associates task (RAT). The present experiments investigate how fixation due to domain knowledge may be overcome. Consistent with previous studies, students with more baseball knowledge were less successful at RAT problems with an incorrect solution related to baseball. Novices given a break between solution attempts were better able to solve unsolved problems than were novices not given a break. Experts, on the other hand, benefited from a massed solution attempt more than a break. For experts, a break only helped when it included an anagram task containing words related to the RAT solutions. This suggests that in order to overcome fixation due to prior knowledge, problem solvers either need an extended period of time to get beyond the initial solutions activated by their knowledge, or “opportunistic” activation of the correct solutions. An incubation period alone does not seem to help experts escape their fixation.

• HUMAN LEARNING/MEMORY •

(440)

**Hypermnesia: Processing Versus Multiple Retrieval Cue Hypothesis.** HAJIME OTANI, *Central Michigan University*, ROBERT L. WIDNER, JR., *University of Colorado*, & CHRIS L. ENGELHARDT & VANESSA M. BARRONS, *Central Michigan University*—Hypermnesia is an improvement associated with repeated testing. We conducted an experiment to test whether the improvement is based on multiple retrieval cues or the type of processing. Participants were asked to encode single or multiple cues. They were then instructed to perform either a category sorting (relational processing) or a pleasantness rating (item-specific processing) task. We hypothesized that if hypermnesia is based on multiple retrieval cues, multiple-cue conditions should produce greater hypermnesia than single-cue condition, regardless of the type of encoding processes they engage in. The results indicated that multiple cues are important only when participants were asked to perform relational processing. Our results, therefore, supported the processing account of hypermnesia.

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**List-Method Directed Forgetting and Scores on an Adult Attention Deficit Scale.** HOLLY YETMAN, XIANGEN HU, & WILLIAM MARKS, *University of Memphis*—Successful list-method directed forgetting requires inhibiting previously relevant information that is designated as irrelevant. Individuals scoring high, medium, or low on an adult scale of attention deficit hyperactivity disorder (ADHD) were compared on list-method directed forgetting. High scorers on the ADHD scale failed to show directed forgetting after 5-min and 1-day delays, but medium and low scorers showed directed forgetting after these delays. The results partially support retrieval inhibition in list-method directed forgetting.

(442)

**Implicit Interference in Part-Set Cuing Inhibition.** KARL OSWALD, MATT SERRA, DEBORAH L. JONAS, & ANAND KRISHNA, *Duke University* (sponsored by David C. Rubin)—Three experiments

demonstrate that part-set cuing (PSC) inhibition is moderated by pre-existing semantic associative set size. Research in the “processing implicit and explicit representations” (PIER) framework demonstrates that the probability of retrieving a target item decreases as the number of automatically and implicitly activated semantic associates increases (Nelson, Schreiber, & McEvoy, 1992). Using lists of large or small associative set items, Experiment 1 showed PSC inhibition only for large set size lists. Using mixed set size lists, Experiment 2 demonstrated that this implicit interference was a function of the set size of the cues rather than the to-be-recalled items. In Experiment 3, increasing the list length elicited greater competition resulting in PSC inhibition for large and small set size lists. Results extend the competition at retrieval interpretation of PSC inhibition by exposing the influence of implicitly activated information.

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**Costs and Benefits of Intentional Forgetting.** XUN LIU, ROBERT A. BJORK, & THOMAS D. WICKENS, *UCLA*—Previous evidence indicates that there are both costs (impaired later recall of the precue, to-be-forgotten, list) and benefits (improved recall of the postcue, to-be-remembered, list) in the list method of directed forgetting. These effects are often attributed to retrieval inhibition of the List 1 episode, which impairs recall of that list, but also reduces or eliminates proactive interference from that list on the recall of List 2. Several experiments, which involved either a manipulation of retention interval or relearning of List 1, were designed to examine and, possibly, dissociate such costs and benefits of directed forgetting. The results showed that the costs of List 1 can be reduced or even reversed, while the benefits of List 2 are preserved. These findings are interpreted in the broader context of interference and facilitation mechanisms in the updating of human memory.

(444)

**Accuracy of Reconstructed Memories From Different Perspectives.** IN-KYEONG KIM, *La Sierra University*—Different perspectives affect the accuracy of memory. In this study, Nigro and Neisser’s (1983) observer mode, seeing oneself from the outside, and field mode, corresponding to the original perspective, were compared. Participants, paired with audience members, performed short plays with different emotional contents. One week later, between and within group of field and observer modes of memory, with factors of emotionality and contents, were compared. Results indicated that audience members remembered better than actors/actresses for the nonverbal and contextual parts, but not the script. Field mode of memory was more accurate than observer mode, and participants showed higher rate of vividness and stability under field mode than observer mode. Memories of emotion groups were better than the neutral group, and better with emotional congruency. There was also an effect of emotionality on observer mode of memory, when switched from field mode, suggesting the effect of asymmetry of switching the perspectives.

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**Intentional Forgetting, Inhibitory Processes, and fMRI.** ANGELA V. KNOX, ELIZABETH LIGON BJORK, ROBERT A. BJORK, & SUSAN Y. BOOKHEIMER, *UCLA*—From behavioral experiments on human memory, such as ones employing the directed-forgetting paradigm, it is clear that efficient memory functioning involves inhibitory as well as excitatory processes. In the present research, the directed-forgetting paradigm was adapted for use in the fMRI environment, with the goal of clarifying the operation of inhibitory as well as excitatory processes in memory. Subjects were scanned during all phases of the list method of directed forgetting, including the learning and recall of List 2 items following instructions either to forget or to remember List 1—that is, under conditions when inhibitory processes are presumably operating and when they are not. Results should shed light on the neural underpinnings of the inhibitory processes assumed to be involved in the varieties of goal-directed forgetting thought to be essential for the efficient operation of memory.

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**Differential Effects of Cue Dependency on Item and Source Memory.** CHAD S. DODSON, *Harvard University*, & ARTHUR P. SHIMAMURA, *University of California, Berkeley*—We investigated the cue dependency of source and item memory. Individuals listened to words spoken by a male or a female voice and were later asked to determine whether a test word was previously presented by a male, by a female, or was a new word. Cue-dependent effects were assessed by presenting test words with (1) the same voice that originally presented the word (match condition), (2) a different but familiar voice (mismatch condition), (3) a different but novel voice (novel condition), or (4) no test voice (control condition). Compared with the control condition, source recollection was facilitated in match conditions, disrupted in mismatch conditions, and not affected in novel conditions. By contrast, item recognition was not affected by the match and mismatch conditions but was disrupted by novel test voices. We propose an activation view to account for the voice match-mismatch effects observed in source recollection.

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**Distributing Working Memory Resources in Problem Solving.** MELANIE CARY, *Carnegie Mellon University*, & RICHARD A. CARLSON, *Pennsylvania State University*—We investigated how people distribute working memory demands encountered during problem solving over internal and external resources. Participants could use a computerized note-taking system while performing a complex arithmetic task. In two experiments we manipulated the costs and benefits of using external memory strategies. When more effort (higher cost) was required to take notes, participants recorded less information externally. Participants who were able to develop more effective strategies for internally managing working memory by practicing with a consistent problem structure (less benefit of note taking) recorded less information externally than participants who practiced with varied problem structures. Observations and experimental manipulations also indicate that consistencies in external information allow implicit indexing to take the place of more costly explicit indexing of recorded information. These results suggest that individuals flexibly distribute working memory demands over internal and external resources on the basis of situational cost-benefit considerations.

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**Long-Term Flashbulb Memory of Princess Diana’s Death.** SUSAN L. HORNSTEIN, ALAN S. BROWN, NEIL W. MULLIGAN, & MATTHEW E. ANSFIELD, *Southern Methodist University*—It has been suggested that flashbulb memories are so distinct that they remain accurate even years after the event. In the present study, we examined the consistency of memories concerning the death of Princess Diana. All participants ( $N = 144$ ) completed a standard flashbulb memory questionnaire one week after her death, reporting the circumstances in which they first heard the news, as well as their emotional responses. Participants were retested 3 months and 18 months after the event ( $N = 49$ ), or only at 18 months ( $N = 66$ ). Participants’ responses remained very consistent with the original description at both 3 and 18 months, and testing at 3 months did not affect consistency at 18 months. Females reported stronger emotional responses than did males, and participants assessed their original emotional responses to be less intense over time. A composite emotional rating score was positively correlated with consistency of recall.

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**Memory Distortions and the Perturbation Model.** SCOTT D. GRONLUND, *University of Oklahoma*—There are many demonstrations of memory distortions, ranging from eyewitness misidentification to repressed memories. However, theoretically integrative explanations of these type of phenomena are rare. The goal of this research is to examine one type of memory distortion, the interaction of ex-

pectations with memory, and to provide a model-based explanation of the underlying processes responsible for the distortion (the perturbation model of Estes, 1997). We adapted a laboratory-based paradigm used by Estes to examine the role of expectations in creating memory distortions. In prior work involving a no-expectation control condition, Estes found that response distributions were symmetric and well described by the perturbation model. In the present studies, we observed that the response distributions were skewed when the expectation was manipulated at storage, but not when it was manipulated at retrieval. We explored the implications of these findings for a perturbation model-based explanation.

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**Implicit False Memories: Effects of Modality Change and Additional Study on Semantic Priming.** ELINOR MCKONE & BEVAN MURPHY, *Australian National University*—McDermott (1997: *PB&R*) reported implicit false memory for nonpresented lures (*vacation*) following study of a list of semantic associates (*holiday, beach, etc.*). This was despite a perceptual stem-completion task (*vac\_\_\_*) and a study-test delay far exceeding that usual for semantic priming. Our Experiment 1 confirmed McDermott's finding with better controls for explicit contamination. In Experiment 2, lures showed the same cross-modality patterns as on-list targets: In both cases, priming on the visual test was reduced by auditory study, whereas explicit stem-cued recall was not. In Experiment 3, false memory decreased with multiple (visual) study presentations with explicit, but not implicit, retrieval. Results (1) dissociate implicit and explicit false memory, (2) show that semantic priming in a perceptual task is modality specific, and (3) support Schacter et al.'s (1998: *J. Cog. Neurosc.*) notion that improved veridical memory suppresses false gist-based responses under normal explicit circumstances.

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**Misinformation Interference in Studies of Eyewitness Memory: Memory Impairment in Fully Informed Witnesses.** THOMAS A. SCHREIBER, DEBORAH EAKIN, & SUSAN D. SERGENT, *University of Kansas*—We investigated misinformation effects using special recall tests that eliminate response biases, source confusions, and social demands, but not effects attributable to misinformation interference (e.g., retrieval blocking). In all experiments, subjects were told at test that they had been misled and they even were told what the specific misleading item had been and that it was not the witnessed item. Substantial memory impairment occurred even when subjects received such detailed cautions. Giving subjects similar cautions *immediately* after they encoded the misinformation can reduce interference effects under some circumstances. However, the most important finding was that when the misinformation is highly accessible, substantial memory impairment occurs regardless of whether subjects are warned at test only, at both test and immediately after encoding the misinformation, or whether they receive either a general warning or a specific warning in which the misinformation is identified. We discuss both theoretical and practical implications of these findings.

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**More on Age-Related Working Memory Binding Deficits.** KAREN J. MITCHELL, MARCIA K. JOHNSON, & CAROL L. RAYE, *Princeton University*—Mitchell, Johnson, Raye, Mather, and D'Esposito (1999) demonstrated that, compared with young adults, older adults exhibit a deficit in their ability to memorially bind object and location information in a working memory task. This age-related deficit in memory for item-plus-location combinations existed despite the fact that memory for individual features (i.e., items and locations alone) was quite good in both groups. We argued that this binding deficit signals, in large part, a general age-related deficit in the efficacy of reflective component processes that support long-term memory encoding. The present set of experiments addressed some criticisms of our previous findings, and generalized our findings to a working memory task that required binding object and color information. Results will be dis-

cussed in terms of our hypothesis regarding age-related reflective component process (i.e., encoding) deficits.

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**Interactions Between Implicit and Explicit Memory: fMRI Evidence That Priming Impairs Episodic Encoding.** ANTHONY D. WAGNER, ANAT MARIL, & DANIEL L. SCHACTER, *Harvard University*—Neuroimaging studies have revealed that (1) magnitude of left inferior prefrontal (LIPC) activation during the encoding of words predicts subsequent explicit memory for those words, suggesting that factors that decrease LIPC activation may hinder episodic encoding; and (2) prior processing of a word results in reduced LIPC activation during repeated processing of the word, with this "priming" effect reflecting implicit memory for the initial experience. Here, the relation between priming and episodic encoding was assessed via a fMRI study of the lag effect. Results revealed that, whereas behavioral priming (RT reductions) and neural priming (LIPC activation reductions) were greater following a short versus a long lag between study episodes, subsequent recognition memory was greater in the long lag condition. Thus, measures of implicit memory (priming) and explicit memory (recognition) were negatively associated, suggesting that implicit and explicit memory may interact during episodic learning, with priming impairing new episodic encoding.

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**Does Human Memory Reflect the Environment of Early Hominids?** LAEL J. SCHOOLER, *Pennsylvania State University*, JUAN CARLOS SERIO-SILVA, *Universidad Veracruzana*, & RAMON RHINE, *University of California, Riverside*—The rational analysis of memory proposes that human memory has evolved to cope optimally with the informational demands that the environment places on people. We have shown that human memory performance reflects patterns with which environmental stimuli (e.g., words) occur and recur. However, one may wonder about informational demands that were placed on hominids during critical periods in evolution. Though impossible to study these environments directly, we can study primates whose current ecological niches share something in common with those of early hominids. Studying the ranging behavior of howlers through forests and baboons through savannas tells us something about the informational demands that the environment placed on early hominids. We found that the ranging behavior of howlers and baboons mirror the statistics of modern environments. This suggests common patterns in the informational demands placed on past and present hominids. Implications for models of memory will be discussed.

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**Subthreshold Rehearsal and Memory.** SCOTT A. OTTAWAY, IRA HYMAN, JR., & LESSEL HUTCHINS, *Western Washington University*—To examine whether unconscious rehearsal of previously studied words facilitates recall, two experiments assessed the influence of subthreshold presentation of words on two direct tests. Subjects studied a list of low-frequency words. In the next phase, subjects attempted to read words presented at varying speeds (16 vs. 500 msec). Half of the words presented below and above threshold had been previously studied. Subjects then completed free recall and recognition tests. In contrast to our prediction, subthreshold repetition impaired recall.

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**Measuring Insight: "Aha" Sentences and ERPs.** AMANDA M. WARREN, SAL A. SORACI, RICHARD A. CHECHILE, & PHILLIP J. HOLCOMB, *Tufts University*—Auble, Franks, and Soraci (1979) demonstrated enhanced recall for sentences that were initially incomprehensible (e.g., "The haystack was important because the cloth ripped.") and subsequently comprehended with a solution cue (i.e., "parachute"), as compared with sentences that were understood from the outset. In the present study, we explore the neurophysiological correlates of this "aha" effect using event-related potentials (ERPs). Easy and difficult "aha" sentences were compared with normal-

and anomalous-ending sentences, all of which were followed by cue words. Results replicated previous findings in the literature that have reported the presence of an N400 to anomalous endings. In addition, results indicated that ERPs to cue words for both types of “aha” sentences show a distinct pattern of brain activity, and one unlike the typically reported effects for anomalous sentence endings. The involvement of working memory is discussed as a possible mechanism that accounts for recall advantages for “aha” sentences.

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**SIMPLE: A Local Distinctiveness Model of Memory and Perceptual Identification.** GORDON D. A. BROWN, *University of Warwick*, IAN NEATH, *Purdue University*, & NICK CHATER, *University of Warwick*—Models of memory and perception often assume that psychological processes adaptively reflect the statistical structure of the environment. Many natural systems in the environment are fractal and exhibit scale-invariant temporal and spatial statistical structure, suggesting that psychological mechanisms may possess similar properties. A model of memory and perceptual identification, SIMPLE (scale invariant memory, perception, and learning) is described. The model embodies two main claims. The *scale-independent memory* claim asserts that similar mechanisms govern memory performance over many different time scales, and the *local neighborhoods* claim suggests that performance on many different perceptual identification and memory tasks is determined by interference from local psychological neighbors in similar fashion. The model accounts for several dozen experiments on free recall, serial recall, and perceptual identification with just a few free parameters. We conclude that similar principles may govern memory performance at all time scales.

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**Learning and Conceptual Change in Socio-Moral Argumentation.** RONAN S. BERNAS, *Eastern Illinois University*, & NANCY L. STEIN, *University of Chicago*—Argumentation researchers claim that engaging in argumentative reasoning can facilitate learning and conceptual change. This study identified the different forms of learning and conceptual change in socio-moral argumentation. College students declared their stances on abortion and acted as judges on cases where they had to determine whether a woman could seek an abortion. The cases were designed to challenge their stances. Arguments before and after reading the cases were analyzed. Further entrenchment occurred as students gave more evidence about the benefits of upholding their position, the harms entailed in the opposing side, and the other values that gave further credence to their position. They also generalized their position across a wider range of situations. Revisions occurred when students noted the difficulties entailed in supporting their positions in certain situations, recognized the benefits of adopting the opposing side, and acknowledged the importance of the values that underlie the opposed view.

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**False Memory Rates Increase With Repeated Attempts at Recall.** LINDA A. HENKEL, *University of North Florida*—Two experiments showed that people were more likely to falsely recall seeing items they had imagined when the imagined items were physically or conceptually similar to items they did actually see. In Experiment 1, they judged the source of each remembered item either during the recall attempt or right after. False recall rates did not differ across these two tasks. However, in Experiment 2, they made repeated attempts at recall, and although repeated attempts at recall improved the number of items recalled, such net gains were associated with more source errors. This was particularly marked when the memory task required people to repeatedly recall the items without considering their source. Hence, the increased source confusions between similar imagined and perceived items can accelerate even more when people reflect on their memories without carefully considering their source.

• MENTAL MODELS •

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**Constraints on Reasoning With Spatial Relations.** MERIDETH GATTIS, *University of Sheffield*—Reasoning with spatial representations involves establishing correspondences between abstract concepts and perceptual aspects of a spatial representation. Humans are surprisingly good at reasoning with spatial representations, suggesting that these correspondences, or mappings, may be cognitively constrained. Four constraints are proposed to guide the mapping process: iconicity, associations, polarity, and relational structure. Experiments presented here focus on the third constraint, polarity. Young children were shown graph-like drawings and asked to judge which of two comparatives in a story was represented by a particular line. Children’s judgments established a correspondence between perceptual polarity in the drawing and linguistic polarity in the story. When the comparatives were not linguistically polar, judgments were random. The results indicate that reasoning with spatial representations is constrained by similarities of organizational structure, such as the polar structure of perceptual and linguistic dimensions.

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**Comprehension of Text: Orientational Metaphors Also Help to Build Mental Models.** WILLIAM LANGSTON & NEIL NORMAN, *Middle Tennessee State University*—Glenberg and Langston (1992) showed that diagrams facilitated the comprehension of texts by assisting in the formation of mental models. The question for this experiment was: Could providing readers with orientational metaphors also assist in the formation of mental models? Forty-nine participants read 28 texts describing complex arrangements of items along the more–less dimension. One third read plain texts, one third read the texts with diagrams, and one third read the texts with the suggestion to “think of more as up.” If readers formed a spatial model, we would expect a symbolic distance effect for questions about the arrangements (near comparisons will be more difficult than far comparisons). For participants reading plain texts, there was no symbolic distance effect. Picture and metaphor participants both showed a symbolic distance effect. These findings suggest that orientational metaphors may work akin to a diagram to assist in forming mental models.

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**Temporal Distance and Spatial Distance Affect Focusing During Text Comprehension.** MIKE RINCK, *Technische Universität Dresden*, & GORDON H. BOWER, *Stanford University*—We investigated how distance in discourse time (real time passing “outside” the text), distance in story time (time passing by description “inside” the text), and spatial distance in the situation model of a text affect focusing of attention during reading. Participants memorized the layout of a building, then read narratives describing characters’ activities in that building. After critical motion sentences, passages describing activities of the protagonist were inserted. Each passage consisted of one or six sentences, thereby varying the amount of discourse time elapsed during reading of the inserts. Story time was varied independently by stating that the inserted activities lasted for a few minutes or several hours. Following the inserted passage, the accessibility of discourse entities was tested by test probes of the type “Is object X in room Y?” Accessibility of objects was affected by spatial distance and story time distance, but not by discourse time distance.

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**Expert Golf Putting: Better Prediction and Higher Consistency of Ball Trajectories?** LEONARD A. HILL, K. ANDERS ERICSSON, & JACK C. WATSON II, *Florida State University*—When a golfer strikes a ball with a putter toward the hole, the ball follows a complex, yet predictable, trajectory over the slight hills and ridges in the green and is influenced by variations in the resistance of the grass. To determine the correct direction to strike the ball, the golfers must try to predict the ball’s trajectory. Expert and recreational golfers reported

how they would aim their putts in actual putting situations and about its imaged path toward the “hole.” Their reported ball trajectories were compared with the “correct” actual paths generated by a consistent mechanical device. We also measured the variability of their putts when the golfers were asked to complete the same putt aimed at the same target several times in succession. Finally, the golfers’ performance on the experimental tasks was related to information about the development of their overall golf performance, and their practice and average putting performance.

• REPETITION/PRIMING EFFECTS •

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**Repetition Priming of Faces in Access to Biographical Information.** ROBERT A. JOHNSTON, *University of Birmingham*, & CHRIS BARRY, *University of Cardiff*—Four experiments examined the priming effects from repeating faces in tasks requiring access to biographical information. Participants could make the same decision in priming and test tasks (e.g., “British or not?” followed by “British or not?”) or a different decision in each case (e.g., “Actor or not?” followed by “British or not?”). All combinations of priming and test tasks produced reduction of the time required to respond to the repeated faces in the test task compared with previously unseen faces. The repetition effects occurred irrespective of whether decisions were positive or negative. The largest priming effect was produced when the priming and the test tasks were the same (and, again, this was independent of whether the decisions to particular faces were positive or negative). These findings are used to propose two new models of face recognition based on an architecture first developed by Burton et al. (1990).

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**Using Priming to Resolve Imagery’s Role in False Memory Creation.** JON B. HOLBROOK & CAROLYN BACKER CAVE, *Vanderbilt University*—In the Deese/Roediger and McDermott false memory paradigm, participants are presented with a list of words associatively related to a nonpresented target word. At test, participants tend to false alarm to the nonpresented target. Some have suggested that these false alarms occur because of high levels of semantic overlap among presented items and the nonpresented targets; participants base their recall and recognition decisions on gist information about the items. Others have suggested that participants mentally generate or image the nonpresented targets at study, and memory errors occur when participants cannot distinguish previously presented items from internally generated items. In the current experiments, perceptual repetition priming was used to determine whether participants mentally generated the nonpresented targets due to the presentation of lists of associates. Because perceptual priming occurs only for physically presented or mentally generated items, this procedure should distinguish between gist-based and imagery-based theories of false memory creation.

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**The Role of Syllable Phonology and Aging in Priming Tip-of-the-Tongue Resolution.** KATHERINE K. WHITE & LISE ABRAMS, *University of Florida*—This experiment investigated the role of phonological priming in resolving tip-of-the-tongue (TOT) states in young and elderly adults. Young (18–25 years), older (60–72 years), and oldest (72–90 years) adults were presented with 90 general knowledge questions and responded “know,” “TOT,” or “don’t know” accordingly. Following “TOT” and “don’t know” responses, participants read a list of words that included 3 phonological primes and 7 unrelated words or read a list that included 10 unrelated words. The phonological primes corresponded solely to the first, middle, or last syllable of the target word. Results indicated differential priming effects: Young adults resolved more TOTs after first and middle syllable primes, older adults resolved more TOTs after first syllable primes, and oldest adults showed no increase in TOT resolution following any primes. Theoretical implications of these results are dis-

cussed within node structure theory (MacKay, 1987) and the transmission deficit hypothesis (MacKay & Burke, 1990).

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**The Effect of Manual Responses on Task-Shift Costs.** RONALD HÜBNER, *Universität Konstanz*—When participants have to shift mentally between simple reactive tasks, there are usually shift costs (i.e., performance is reduced on shift trials compared with that on non-shift trials). Since these costs cannot fully be prevented by endogenous control, it has been suggested that the reconfiguration of the mental system can only be completed if a stimulus is processed with respect to the new task. However, also responding with respect to the new task might be important. To test these hypotheses, an experiment was conducted in which a cue task alternated with a main task. Depending on the outcome of the cue task, the participants had either to repeat the cue task or to shift to a different one. In some conditions a response was also required to the cue. The results show that task-repetition effects are larger when the participants have to respond manually also to the cue.

• LETTER/WORD PROCESSING •

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**Response Congruity Effects Evoked by Subliminally Presented Prime Words.** MARKUS F. DAMIAN, *Max Planck Institute for Psycholinguistics, Nijmegen*—In a size judgment task on words denoting concrete objects, subliminally presented stimuli that precede the targets are shown to influence response times, dependent on whether a response to the prime is congruent or incongruent with the response to the target. This congruity effect mirrors recent findings by Dehaene et al. (1998) obtained in a numerical size judgment task, and implies that the primes are unconsciously categorized and processed to the response stage. However, further experiments show that the effect does not generalize to primes that are not in the response set, and that even repeated preexposure to primes not in the response set fails to induce it. But the effect generalizes from lowercase primes to the same set of uppercase targets, indicating an abstract level of operation. These findings suggest that the congruity effect results from automatized stimulus-response mappings, rather than from unconscious prime categorization.

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**Context Dependency of Hemisphere Differences for Processing Nouns and Verbs.** CHRISTINE CHIARELLO, CONNIE SHEARS, STELLA LIU, & NATALIE KACINIK, *University of California, Riverside*—Dissociations in the processing of nouns versus verbs can occur after brain injury, and some studies indicate that, in neurologically intact individuals, there is an rvf/LH advantage for verb, but not for noun, recognition. We report a large-scale study of noun versus verb processing across the visual fields, varying task and list context. The word classes were equated for imageability, frequency, and length. VF × word class interactions were obtained (rvf/LH advantage smaller or absent for nouns, for both RT and  $d'$ ), but only under some very specific processing conditions. We discuss the implications of these data for views that the right hemisphere may play a greater role in noun, than in verb, processing.

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**Morphological Effects in Visual Word Recognition: A Time Course Study.** KATHLEEN RASTLE & MATT DAVIS, *University of Cambridge*, WILLIAM MARSLÉN-WILSON, *Cognition and Brain Sciences Unit, Cambridge*, & LORRAINE K. TYLER, *University of Cambridge*—Some theories of visual word recognition suggest that there is a level of processing or representation at which morphemes are treated differently from whole words. Support for these theories has been derived from priming experiments in which the recognition of a target word is facilitated by the prior presentation of a morphologically related prime (departure–DEPART). Such facilitation could be

due to morphological relatedness, or to some combination of the form- and semantic-relatedness characteristic of derivationally related words. We report a series of priming experiments in which the morphological, semantic, and form relationships between primes and targets are varied, in three SOA conditions (42, 70, and 232 msec). Results show that morphological relatedness plays a significant role in early visual word recognition that is independent of both semantic and form relatedness. Findings are discussed in terms of current approaches to morphological processing.

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**Polysemy Effects in Lexical Decision and Semantic Categorization Tasks.** YASUSHI HINO, *Chukyo University*, STEPHEN J. LUPKER, *University of Western Ontario*, & PENNY M. PEXMAN, *University of Calgary*—Typically, polysemous words (e.g., BANK) are responded to faster than single-meaning words (e.g., FOOD) in both lexical decision and naming tasks. In PDP terms, what polysemous words involve is the mapping of a single orthographic code onto multiple semantic codes. Thus, this polysemy advantage has been considered a challenge for PDP models because an inconsistent, one-to-many mapping is expected to produce a cost. In the present experiments, we examined polysemy effects in lexical decision and semantic categorization tasks using an identical set of items. Whereas a polysemy advantage was observed in lexical decision, a polysemy disadvantage was observed in semantic categorization. These results suggest that (1) a polysemy disadvantage does exist when a task requires meaning determination, and (2) the polysemy advantage in lexical decision is due to semantic feedback to orthographic codes.

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**Effects of Consistency on the Recognition of Consonants and Vowels.** STUART E. BERNSTEIN, *Middle Tennessee State University*, MARCO ZORZI, *Università di Padua*, & MERAL TOPCU, *Wayne State University*—The time course of vowel and consonant activation in reading English was assessed using a masking task (Berent & Perfetti, 1995). Three experiments compared the effects of masking consistent and inconsistent graphemes in pairs of matched CVC words. Target durations were varied from 17 to 51 msec. The first two experiments used typed responses, and consistency had an early effect on both the speed and accuracy of consonant identification and little early impact on vowel identification. The third experiment used a spoken response to determine whether response modality would alter the time course of vowel and consonant consistency effects. Implications for models of word recognition are discussed.

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**Comparing Intralingual Stroop Interference in Chinese and English: A Meta-Analysis.** JENN-YEU CHEN, *National Chung Cheng University*—The question of whether there is a greater intralingual Stroop interference in Chinese than in English was examined in a meta-analysis, which integrated research findings from 13 published and unpublished studies. Stroop interference was expressed both in terms of reaction time (RT difference and RT ratio) and in terms of an effect size index (Hedge's *g*). No difference was observed between Chinese and English, in RT difference, RT ratio, or in Hedge's *g*. This was the case whether the analysis included only monolingual experiments, only bilingual experiments, or both. The results of the meta-analysis contradict the findings of previous studies that intralingual Stroop interference differs between different writing systems. Possible confounds in the previous studies, including the lack of control for visual angles of the stimuli and the bias against using the ratio measure of Stroop interference, are discussed in light of some recent experimental findings.

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**Blocking and Sequence Effects as a Function of the Response–Stimulus Interval: An Evaluation of the Time-Criterion Account.** TAMSEN E. TAYLOR & STEPHEN J. LUPKER, *University of Western Ontario*—When rapidly named (“fast”) stimuli and more

slowly named (“slow”) stimuli are presented in the same “mixed” block, latencies for the fast stimuli are slower and latencies for the slow stimuli are faster than when the two stimulus types are presented separately in “pure” blocks (a “blocking” effect). Further, in mixed blocks, naming latencies are affected by the difficulty of the previous stimulus, with shorter naming latencies for all stimuli after a fast stimulus is named in the preceding trial (a “sequence” effect). These two “context” effects have both been explained in terms of the placement of a time criterion that guides the initiation of pronunciation. In the present experiments, these effects were investigated as a function of the response–stimulus interval (RSI). Predictable RSIs led to changes only in the blocking effects, consistent with the time-criterion account. Unpredictable RSIs led to a more complicated data pattern not fully consistent with the time-criterion account.

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**Automatic Phonological Activation in Chinese Character Recognition: Evidence From the Stroop Effect.** LI HAI TAN, *University of Hong Kong*, & YING LIU & CHARLES A. PERFETTI, *University of Pittsburgh*—A series of experiments with the Stroop paradigm was conducted to examine whether phonological codes influence access to semantics in the visual recognition of Chinese characters. Unlike English, Chinese has many homophones, including homophones for color terms. Subjects named the color of the ink of written characters or color patch. Key items were color name characters and their homophones printed in ink whose color was either congruent or incongruent with the color named by the character. A crucial finding is that Chinese characters homophonic to color characters produced a significant interference effect in incongruent conditions relative to control character conditions. However, this effect was restricted to the homophones of the same tone as the color characters. These findings suggest that phonological information is activated automatically and provides early sources of constraint in access to Chinese characters' meaning.

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**Examining Naming Errors to Test the Assumption of Independent Reading Processes.** WILLIAM J. OWEN & RON BOROWSKY, *University of Saskatchewan*—Recent research on visual word recognition has utilized mathematical equations to measure basic reading processes. For example, Borowsky, McDougall, MacKinnon, and Hymel (1999) applied process dissociation equations to exception word and regular word naming accuracy in order to estimate reliance on sight vocabulary (SV) and phonetic decoding (PD). Coltheart, Duffy, Cestnick, and Bates (1998) applied similar equations to exception word and nonword naming accuracy in order to predict regular word naming accuracy. Both of these applications implicitly assumed that SV and PD are mathematically independent. It follows from this assumption that there should exist a manipulation that selectively affects SV but not PD, and vice versa, as well as a manipulation that should influence both SV and PD. Evidence from the pattern of naming errors that skilled readers produced during four different reading conditions provided an explicit test of this assumption. A bias account of the data is also examined.

• LANGUAGE/DISOURSE PROCESSING •

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**Facilitation and Inhibition in Antecedent Retrieval.** ANNE E. COOK, *University of New Hampshire*, JEROME L. MYERS, *University of Massachusetts*, & EDWARD J. O'BRIEN, *University of New Hampshire*—Two experiments were conducted to examine further the role of inhibition in antecedent retrieval processes. Previous studies have suggested that when there are two or more possible antecedents for a given anaphor, the nonreinstated antecedent is suppressed or inhibited. In the first experiment reported, participants read passages in which two possible antecedents from the same general category were present, but only one was reinstated. Naming times provided evidence for facilitation of the reinstated antecedent, but no inhibition of the

nonreinstated antecedent. In a second experiment, a recognition procedure was substituted for the naming procedure. Recognition times showed evidence for inhibition of the nonreinstated antecedent; however, no facilitation for the reinstated antecedent was observed. The results provide evidence that inhibition may be a post-lexical process, occurring during integration. Results are discussed within the context of the Myers and O'Brien (1998) resonance model.

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**The Influence of Working Memory Span on Predictive Inference Generation.** MARK A. CASTEEL, *Pennsylvania State University*—This study builds on my research presented at last year's Psychonomic Society Meeting and examines one of Rosen and Engle's (1997, 1998) theoretical claims regarding the role of working memory (WM) in discourse processing. Rosen and Engle propose that WM span differences between readers should only be evident on tasks that tap into controlled processes because high-span readers are more able to suppress inappropriate activations. More automatic processes, however, should show little evidence of span differences. Highly constrained predictive inferences (believed to be fairly effortless) should therefore show few differences as a function of WM span. This study addressed this claim. Participants were given a test of WM, and read short stories suggesting a highly likely outcome. An inference, explicit, or neutral word was then presented and recognition latencies collected. Results will be discussed in terms of Rosen and Engle's theoretical perspective, and additional work in progress will be mentioned.

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**Tongue-Twisters Twist More Than the Tongue.** TIMOTHY A. KELLER, PATRICIA A. CARPENTER, MARCEL ADAM JUST, & JENNIFER K. ROTH, *Carnegie Mellon University* (sponsored by Patricia A. Carpenter)—The present study provides evidence for phonological processes playing an interactive or collaborative role in a large-scale language-processing network. The study used fMRI to investigate the distribution of cortical patterns of activation related to the tongue-twister effect in a sentence comprehension task. Right-handed participants silently read sentences equated for syntactic structure and the lexical frequency of the constituent words but differing in the proportion of words that shared similar initial phonemes. This manipulation affected not only the reading times and comprehension performance, confirming previous behavioral work, but also the amount of activation seen in a number of left-hemisphere language-related cortical areas. This effect was not restricted to cortical areas known to be involved in articulatory speech programming or rehearsal processes, but also extended to areas associated with other aspects of language processing.

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**Conceptual and Contrastive Agreements in Reference.** MIJA VAN DER WEGE & HERBERT H. CLARK, *Stanford University*—When making a reference, people invoke many principles in deciding what referring phrase to use. Some deal with the nature of the referent, others with the context, others with the addressee, and still others with the perspective to take on the referent. People use conceptual agreements to coordinate perspectives (Brennan & Clark, 1996). They continue to use these agreements even when doing so violates Grice's maxim of quantity (1975). In these experiments, subjects performed a matching task with everyday objects (Clark & Wilkes-Gibbs, 1986). When shown a picture in a new context, they preferred to use preexisting agreements, as found by Brennan and Clark. When referring to a new picture, they contrasted their new agreements with preexisting ones by using different phrases, even when unnecessary. The experiments help rank order the different principles in making conceptual agreements for reference.

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**Do Men and Women Use Nonliteral Language Differently When They Talk About Emotions?** KRISTEN E. LINK & ROGER J.

KREUZ, *University of Memphis*—Participants watched film clips in which characters experienced positive or negative emotional events. A second group read narratives that were analogous to the clips. Each participant wrote a description of the character's emotion or a description of how they would have felt in the same situation. There was no correlation between the perceived intensity of the emotion and the amount of nonliteral language in the participants' descriptions. This result is inconsistent with Ortony's (1975) vividness hypothesis. Males used more nonliteral language in their descriptions of negative emotions than of positive emotions, whereas the female participants did not show this pattern. Finally, males tended to use more nonliteral language in descriptions of others' emotions. Female participants, however, tended to use more nonliteral language in descriptions of their own emotions. These findings suggest that nonliteral language is used differently by men and women, at least in the context of emotional communication.

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**The Role of Phonology in Error Recovery During Reading Comprehension.** JESSICA A. KEIR & SUSAN A. DUFFY, *University of Massachusetts*—We investigated the role of the reader's short-term memory for a word's phonological code in recovering from errors in meaning selection during sentence comprehension. We induced errors by presenting sentences in which biased ambiguous words were preceded by neutral context and later disambiguated toward their less frequent meaning. Readers' eye movements were monitored as they read. We hypothesize that error recovery processes involve retrieving a short-term memory for the ambiguous word's pronunciation (phonological code) to reaccess the word and select the intended meaning. If this is the case, recovery processes will be more difficult for heterophones (words with multiple meanings and pronunciations) than for homophones (multiple meanings and one pronunciation) because the reader initially selects the wrong pronunciation as well as the wrong meaning for the heterophones. Heterophone targets produced more processing difficulty than did matched homophone targets, supporting the conclusion that phonology is involved in error recovery during sentence comprehension.

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**Pretense and Echoic Accounts of Verbal Irony Comprehension: An Evaluation With Auditory Presentation.** HERBERT L. COLSTON, KAREN E. SUMMERS, & STEFFANY L. STRICKLAND, *University of Wisconsin, Parkside*—Two long-competing accounts of verbal irony comprehension—echoic mention/reminder and pretense—were evaluated with a novel, auditory presentation paradigm. In four experiments on 128 participants, an asymmetry in pretense and echoic mention/reminder accounts was found. Participants made ratings on auditorially presented utterances that referred to negative situations. The utterances factorially manipulated pretense (positive intonation vs. negative intonation) and echo (positive words vs. negative words). Findings revealed that positive words (echo) "alluded to expectations" more than negative words (nonecho), whereas positive intonation (pretense) did not "allude to expectations" more than negative intonation (nonpretense). Conversely, positive words (echo) and positive intonation (pretense) "pretended" more than negative words (nonecho) and negative intonation (nonpretense), respectively. In essence, echo pretends, but pretense does not (necessarily) echo. Pretense and echo were also found to additively combine to enhance sarcasm, and to reduce clarity of meaning. The implications of these results for verbal irony comprehension theories are discussed.

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**Encoding and Recall of Spoken Discourse in Adult Aging.** DEBORAH M. LITTLE & ARTHUR WINGFIELD, *Brandeis University*—Using the auditory moving window technique as an online measure of the encoding of a passage, we examined the extent to which poorer recall by older adults is a consequence of less effective encoding strategies. We present evidence that the demonstration of a

“passage-initial encoding pattern” (as indexed by pause durations that are longer at the beginning of a passage) reflects a more effective encoding strategy and results in higher levels of recall. Additionally, this pattern of encoding of the passage can be manipulated in both young and older adults. For young adults, when passage difficulty was increased or when an additional task requirement was introduced (a secondary task), participants tended to slow across the passage and produced a pattern that mimicked older adult performance. The passage-initial encoding pattern, which is not normally observed in older adults, reappeared when passage difficulty and task demands were reduced.

• MOTOR CONTROL •

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**Are Modality-Specific Central Control Units Responsible for Preciseness in Sensorimotor Synchronization?** KATHARINA MÜLLER, *Max Planck Institute for Psychological Research, Munich*, FRANK SCHMITZ, *University of Düsseldorf*, GISA ASCHERSLEBEN, *Max Planck Institute for Psychological Research, Munich*, ALFONS SCHNITZLER & H.-J. FREUND, *University of Düsseldorf*, & WOLFGANG PRINZ, *Max Planck Institute for Psychological Research, Munich*—Normal subjects synchronize on-the-beat tapping to an isochronous, auditory metronome with an anticipatory error. The “code-generation-hypothesis” suggests that this “negative asynchrony” reflects the difference in conduction times and assumes central coincidence of the sensory pathways involved. To get information on central processing associated with negative asynchrony, neuro-magnetic studies with variation of pacing modality were performed. Subjects had to synchronize taps of the right index finger to (1) isochronous, binaural clicks, (2) isochronous tactile stimuli to the other finger, and (3) the toe. Behavioral data showed negative asynchrony in Condition 1, but no asynchrony in Conditions 2 and 3. Source analysis resulted in two modality-independent sources in MI and SI. A third modality-dependent source was active in posterior parietal cortex (tactile pacing) or inferior postcentral gyrus (auditory pacing). This source may play the crucial role in mediating between an external stimulus (perception) and motor activation (action).

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**Temporal Control of Repetitive Movements in the Tapping Task.** FRANK MIEDREICH & GISA ASCHERSLEBEN, *Max Planck Institute for Psychological Research, Munich*—Wing and Kristofferson (1973) have introduced a model for the analysis of the tapping task in a continuation paradigm. In this paradigm, subjects perform a simple motor task to a regular isochronous beat. The model postulates two independent processes, a central process for the generation of temporal intervals, and a peripheral process of motor control. The validity of the model’s predictions and the classical interpretation of the processes as central and peripheral were investigated. In three experiments, interval length, feedback, and effector were varied. On the basis of the results, the model’s hypothesis of two independent processes can be confirmed, whereas the interpretation of the motor component as a purely peripheral process has to be reevaluated. A modified interpretation of the processes is offered that identifies two central processes, one of timing and the other of motor planning and control.

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**Expert Control of Rapid Finger Movements.** RALF T. KRAMPE, ULRICH MAYR, & ANTJE JANKOVIK, *University of Potsdam* (sponsored by K. Anders Ericsson)—Participants from three skill levels (novices, amateurs, and expert pianists) performed structured series of finger movements at their maximum tempos. Within each trial, two sequences alternated according to a prespecified AABB schema. We manipulated the degree to which alternating sequences differed from each other as well as the positions at which changes occurred. As expected, the three skill groups differed from each other in their overall performance tempos. We found evidence for specific expertise ad-

vantages related to (1) the time necessary to retrieve and activate a certain motor chunk and (2) the size of these motor chunks or the degree of preplanning. In addition, we identified reliable costs of switching between sequences that were similar for different expertise groups. We compare our data with predictions derived from tree-traversal, hierarchical editing, and buffer loading models of motor programming.

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**Calibration Versus Alignment in Prism Adaptation.** GORDON M. REDDING, *Illinois State University*, & BENJAMIN WALLACE, *Cleveland State University*—Exposure adaptation occurred more slowly when the pointing limb was visible only in starting and target positions (movement path occluded), compared with when the limb was visible only after the starting position (movement path and target visible). Total visual and proprioceptive aftereffects were not different. Visual calibration of the limb is not necessary for spatial realignment aftereffects of prism exposure and may interfere with adaptive performance during prism exposure when eyes and limb are misaligned.

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**Effects of an Orientation Illusion on Action: Evidence for Separate Planning and Control Systems.** SCOTT R. GLOVER & PETER DIXON, *University of Alberta*—A small bar was placed in front of subjects on top of a background grating. In perceptual judgment tasks, the orientation of the grating produces an illusory effect on the apparent orientation of the bar. We found that the grating also has an effect on the orientation of the hand during the course of reaching and grasping. A large effect of the illusion was obtained shortly after the onset of reaching, but the effect decreased to near zero by the time the bar was grasped. Removing vision lessened (but did not eliminate) the gradual tuning of the hand orientation to the veridical bar orientation. These results suggest two separate, but interacting, spatial representations in reaching: One representation is used to plan the reach, and is affected by illusions; a second representation is used to monitor and correct the reach, and is not affected by illusions.

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**Evidence for Execution-Based Intrahemispheric Interference in Motor Control.** ROBERT MICHAEL KOHL, *College of William & Mary*, HAIM A. BEN-DAVID, *Wayne State University*, & MARK A. GUADAGNOLI, *University of Nevada, Las Vegas*—Earlier, we demonstrated that (1) maximally alternating ipsilateral hand and foot responses produced slower and more variable responses than contralateral responding, and (2) maximally alternating bilateral hand/foot dual responses produced slower and more variable dual responses than alternating ipsilateral dual responses. In two experiments we used a version of the Wing and Kristofferson (1973) timing model to determine whether the proposed intrahemispheric interference effects were response selection or execution based. As remembered timing intervals approached maximal speed, variable errors (as opposed to drift errors) were more pronounced when the single and dual response conditions were controlled within hemisphere. This pattern indicates that the demonstrated intrahemispheric interference effects were execution based.

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**Constraints on Grip Selection: Test of the End-State Comfort Effect.** MARK G. FISCHMAN & CRAIG A. LANE, *Auburn University*—We investigated the “end-state comfort” effect (Rosenbaum & Jorgensen, 1992) by requiring 47 participants to pick up a lightweight wooden dowel and place one end to 14 targets at variable heights. In two conditions, participants started at the extreme highest and lowest targets and systematically converged toward the middle target, and in two conditions they started at the middle target and systematically diverged toward the extreme highest and lowest target. The main dependent variable was the type of grip selected: overhand or underhand. Two distinct groups emerged: One group tended to change its grip ac-

ording to the height of the target, thus exhibiting a sensitivity to end-state comfort. However, a second group never switched grips in at least three of the four conditions, thus appearing to be insensitive to end-state comfort. Our results suggest that end-state comfort may not be as powerful a constraint on grip selection as previously thought.

• NEUROPSYCHOLOGY •

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**Lateral Biases in Size Estimation in Hemispatial Neglect and Normals.** JOCELYN KEILLOR, *Defence and Civil Institute of Environmental Medicine, Toronto*, SHARON NORTON & GINA M. GRIMSHAW, *California State University, San Marcos*, & KENNETH HEILMAN, *University of Florida and VA Medical Center, Gainesville*—Whereas patients with hemispatial neglect resulting from right-hemisphere lesions bisect lines to the right of the objective midpoint, neurologically intact individuals demonstrate the opposite bias. One possible explanation for this bias is that attention to a region results in a perceptual magnification of the stimulus therein. We tested this hypothesis by having a neglect patient and a group of normals make size judgments on pairs of shapes presented simultaneously to the left and right hemispace. PSEs were calculated over 720 experimental trials. The neglect patient consistently judged objects on the right to be larger than those on the left, a finding that was consistent with his rightward bias in line bisection performance. Normals also demonstrated a perceptual bias that was consistent with bisection performance, in that they overestimated the size of the stimulus in left hemispace. This finding suggests that lateral biases in attention influence the perception of object size.

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**An Input to the Language Module?** V. S. RAMACHANDRAN, E. L. ALTSCHULER, C. FOSTER, & S. WISDOM, *University of California, San Diego*—To test Rizzolatti's "mirror neuron" hypothesis of language origins, we examined Broca's aphasia patients and found that they did not experience the McGirk effect, suggesting a strong visual input to the language areas. Secondly, point light sources (luminous dots) were affixed to a model's lower face (using a technique adapted from G. Johansson, 1973). When the model made vocalization movements, normal subjects instantly recognized the dots as belonging to a human face. We intend to test the ability of Broca's aphasia patients in recognizing human faces solely on the basis of these Johansson-type vocalization movements.

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**Spatial and Temporal Shifts of Attention.** ANNE P. HILLSTROM, *University of Texas, Arlington*, KAREN CLARKE, *University College London*, KIMRON L. SHAPIRO, *University of Wales, Bangor*, & MASUD HUSAIN, *National Hospital for Neurology, London*—Functional imaging and lesion studies have previously implicated human superior parietal lobe in spatial shifts of attention. More recent evidence suggests that this function is carried out by the inferior parietal lobe, damage to which leads to spatial neglect. It has been demonstrated that people with visual neglect are slow in switching attention between sequential targets presented at fixation (i.e., nonspatial shifts of attention). Is this due to damage to the same mechanism that underlies spatial shifts of attention? Here, we investigated *nonspatial* shifts of attention in patients without neglect who have lesions of the superior or inferior parietal lobe. We also examined *spatial* and *nonspatial* shifts of attention in patients with neglect.

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**Dissociating Production and Temporal Order of Actions After Brain Damage.** RAFFAELLA IDA RUMIATI & SERGIO ZANINI, *Scuola Internazionale Superiore di Studi Avanzati*, & TIM SHALLICE, *University College London and Scuola Internazionale Superiore di Studi Avanzati*—Two patients with limb apraxia, D.R. and R.D., were compared with a control patient (W.H.2) with an executive function

disorder but without limb apraxia. D.R. and R.D. were impaired in performing everyday activities with objects that they could recognize from sight, while they were able to sequence photos depicting those same activities. W.H.2's performance doubly dissociated from that of the apraxic patients: She showed spared action production but faulty sequencing of photos. She succeeded both in sequencing stimuli other than actions (e.g., shapes and numbers) and in recognizing actions from the photos. These results show that the kind of apraxia observed in D.R. and R.D. is not produced by a degraded action sequence representation (Poeck & Lehmkuhl, 1981). We interpret our results within a contention scheduling modeling (Cooper & Shallice, in press; Norman & Shallice, 1986).

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**Patterns of Impaired Verbal, Object, and Spatial Working Memory After Thalamic Lesions.** ALCIA K. KUBAT, DALE DAGENBACH, & JOHN R. ABSHER, *Wake Forest University*—Neuroimaging studies have found sporadic evidence for thalamic activation in working memory tasks, and we previously have reported impaired verbal working memory spans in individuals with thalamic lesions. The present study further assesses the possible contributions of the thalamus to human verbal, object, and spatial working memory in a population of patients with discrete thalamic lesions using the n-back task. Impairments are found in all three tasks, with some variation between individuals. The functional nature of the impairment is evaluated, with a special focus on errors due to incorrect sequencing information and failures of inhibition.

• LATERALITY •

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**Mechanisms of Hemispheric Specialization in Linguistic and Prosodic Processing.** GINA M. GRIMSHAW & KRISTIN M. PEZDEK, *California State University, San Marcos*—Perceptual asymmetries can result from two mechanisms. In direct access, the nonspecialized hemisphere processes incoming stimuli, but is less efficient than the specialized hemisphere. In callosal relay, the nonspecialized hemisphere must relay information to the specialized hemisphere for processing, resulting in delay. The present study examined whether asymmetries for linguistic and prosodic processing on a dichotic listening task arise through direct access or callosal relay. Stimuli were words spoken in different emotional tones of voice. Subjects listened for a target word on two blocks of 144 trials, and a target emotion on another two blocks. For each target, they responded to one block with each hand. Overall, there was an REA on the linguistic task, and an LEA on the prosodic task. Results indicate direct access for linguistic processing and callosal relay for prosodic processing. These results are discussed in terms of a dynamic model of hemispheric specialization.

(498)

**Hemispheric Differences in Lexical Processing Between Depressed and Nondepressed Individuals.** AUBREY HANKS, RUTH ANN ATCHLEY, & STEVE ILARDI, *University of Kansas*—Clinically depressed, previously depressed, and never-depressed control individuals participated in a divided visual field priming study designed to look at the lexical connections between person-descriptive adjectives in the two cerebral hemispheres. Participants were undergraduate students who were classified using a structured clinical diagnostic interview. Results suggest that the greatest differences in lexical organization between these three participant groups exist in the lexical priming scores shown for targets presented to the right hemisphere. Depressed participants exhibited significant right hemisphere priming between negative person-descriptive adjectives (STUPID–SELFISH). Participants who had previously experienced clinical depression show a pattern of priming that is very similar to the participants who are presently experiencing a depressive episode. In contrast, normal controls demonstrated priming between positive adjectives (CHEERFUL–BRAVE).

(499)

**Interhemispheric Lexicality Priming.** ERAN ZAIDEL, *UCLA*—Consider a lexical decision task with peripherally cued lateralized targets and with distractors in the opposite visual hemifield using unimanual two-choice responses. Targets and distractors are words varying in length, frequency, or neighborhood size (N-size) and pronounceable nonwords. This task shows a right visual field advantage (RVFA) signaling left hemisphere (LH) specialization, but also a target wordness  $\times$  VF interaction signaling independent strategies and processing in each hemisphere (“direct access”). Further, when the lexical status of the target and distractor is congruent (word-word or nonword-nonword), responses are better than when they are incongruent (word-nonword or nonword-word). This “lexicality priming” effect is stronger in the LVF than in the RVF and stronger for words than for nonwords. The effect does not occur when target and distractor are in the same VF. It is sensitive to lexical variables (length, N-size), and it shows individual differences.

(500)

**Global and Local Lateralization in Audition.** LLOYD ANDREW DAWE, *Cameron University*—Ivry and Robertson (1998) have recently presented a theory that the global features of a stimulus presentation are processed in the right hemisphere while the local features are processed in the left hemisphere. Although there is an abundance of data to support the theory with respect to visual processing, much less research exists in audition on the lateralization of global versus local processing. Three experiments were conducted using ambiguous chromatic sequences of Shepard-like tones. When the local partials of the tones ascended in pitch, the overall global envelope descended, and vice versa. Participants had to quickly identify the sequences that were presented to either the right or the left ear as ascending or descending. Using response time measures and the number of global- versus local-based responses under the various conditions, data were collected that supported Ivry and Robertson’s theory.

• NEUROBIOLOGY OF LEARNING/MEMORY •

(501)

**Different Neural Correlates on Category Learning and Dot Pattern Recognition.** KEN A. PALLER, BRIAN GONSALVES & PAUL J. REBER, *Northwestern University*, & LARRY R. SQUIRE, *VA Medical Center, San Diego*—Neuropsychological and neuroimaging evidence suggests that different sorts of memory storage are responsible for category learning and recognition of dot patterns. We directly compared neural correlates of these two types of memory using scalp EEG recordings. During categorization, the amplitude of a posterior brain potential at a latency of about 100 msec differed between patterns from the target category and those from a nontarget category. This amplitude modulation was not present during recognition. Instead, a later and broadly distributed positivity was elicited by recognized target patterns compared with foil patterns. Differences between the way categorical and noncategorical patterns were processed were thus not the same as differences between the way recognized target and foil patterns were processed. These findings support the notion that different sorts of neural processing are responsible for performance during categorization and recognition tests, and they highlight an additional way to study these distinct memory functions.

• ANIMAL LEARNING/BEHAVIOR •

(502)

**Configural Rather Than Hierarchical Switching Rule Learning in Pigeons’ Conditional Discrimination.** SADAHIKO NAKAJIMA, *Kwansei Gakuin University*—Pigeons were trained with a hierarchical conditional discrimination task. Pecking a left (R1) or right (R2) key was rewarded according to colors (C1 and C2) of a center sample key, presence (B1) or absence (B2) of flashing of the three keys with another color prior to the sample presentation, and general illumina-

tion conditions (A1 and A2) of the chamber. Eight types of rewarded trials were prepared: (1) A1-B1-C1-R1, (2) A1-B1-C2-R2, (3) A1-B2-C1-R2, (4) A1-B2-C2-R1, (5) A2-B1-C1-R2, (6) A2-B1-C2-R1, (7) A2-B2-C1-R1, and (8) A2-B2-C2-R2. Seven out of these eight types were used for training of a given bird, and then the remaining trial type was presented as testing. The test performance suggested that the strategy employed by the birds to solve the task was configural rather than hierarchical switching rule learning.

(503)

**Interval Timing in Pigeons: Interrupting the Clock.** J. J. HIGA, *Texas Christian University*, & M. GONZALEZ & J. E. R. STADDON, *Duke University*—We present the results from timing experiments with pigeons, in which turning off the signaling-stimulus interrupts the to-be-timed interval. In these “interruption” studies, the location and duration of the interruption varied either across or within a session. During baseline, pigeons responded on a fixed interval (FI) 60-sec reinforcement schedule. In interruption conditions, the key light turned off for either a fixed (or variable) amount of time at different points within the interval, for example, at either 10, 30, or 50 sec since the start of an interval. The total time before and after an interruption remained equal to the programmed baseline interval duration. The results are discussed in terms of pacemaker and memory mechanisms for timing.

(504)

**Activity Anorexia in High-Saccharin and Low-Saccharin Rats.** NANCY K. DESS, *Occidental College*—In the clinical syndrome of anorexia nervosa, excessive, ritualistic exercise often accompanies severely restricted food intake. The exercise is sometimes presumed to be part of a conscious weight-loss strategy. However, restricting rats’ access to food increases running which, in turn, further reduces food intake. Thus, rats show the same vicious cycle of excessive activity and “self-starvation” as do people with anorexia. This finding compels attention to basic behavioral analyses of the phenomenon. In the present study, individual differences in activity anorexia were assessed in rats selectively bred for differential saccharin intake. Relative to high-saccharin-consuming rats (HiS), LoS rats appear to be more anxious and arousable. Because human eating disorders are associated with personal and family histories of emotional distress, we predicted that LoS rats would be more vulnerable to activity anorexia. Results of three experiments confirm this prediction.

(505)

**Conditioning a Postfood Focal Search Mode.** FRANCISCO J. SILVA, *University of Redlands*, & WILLIAM TIMBERLAKE, *Indiana University*—This poster describes a study that tested a behavior systems view of backward excitatory conditioning. In the first phase, two groups of rats were exposed to an 8-sec light CS that either followed (Group Backward) or preceded (Group Forward) the delivery of food. In the second phase, a novel lever was compounded with the last half of the 8-sec CS, and the offset of this compound stimulus was followed by food. A third group of rats (Group Control) was exposed to the compound conditioning phase without prior training. Lever contact was highest when the lever was compounded with the previously backward CS. Groups Forward and Control did not differ significantly in lever contact. The results supported the hypothesis that backward CSs acquire control of a postfood focal search mode.

• INGESTIVE BEHAVIOR •

(506)

**The Sweet Taste of Success: Glucose Effects on Attention.** CAROLINE R. BUSCH, HOLLY A. TAYLOR, ROBIN R. KANAREK, & PHILLIP J. HOLCOMB, *Tufts University*—Does eating candy make you smarter? The relationship between ingested glucose and cognitive function, after a period of fasting, was examined using a variety of cognitive tasks, in a sample of 20 fourth- and fifth-grade boys. The boys showed improved vigilance attention after consuming the

glucose snack. Participants had significantly higher hit rates and significantly lower miss rates after the glucose snack, as compared with a placebo snack. In addition, miss rates and false alarm rates either decreased or remained constant as a function of time after the glucose snack, but when the children had the placebo snack, the miss and false

alarm rates increased over time. Thus, the glucose snack enhanced ability to stay on task for an extended period of time, enabling the children to more accurately identify target information, as well as correctly reject nontarget information. No significant differences were found on other cognitive measures.

**ATTENTIONAL BLINK AND INHIBITION OF RETURN**  
**Pacific Palisades, Saturday Afternoon, 1:30–3:20**

*Chaired by Roger W. Remington, NASA Ames Research Center*

**1:30–1:45 (507)**

**Object- and Location-Based Inhibition of Return in Static and Dynamic Scenes.** RICHARD A. ABRAMS & SHAWN E. CHRIST, *Washington University*, & CHRISTINA SMITH, *South Texas Veterans Health Care System*—Inhibition of return (IOR) refers to a cost in returning attention to a recently attended object or location. IOR is believed to access both object- and location-based frames of reference: If a cued object moves to a new location, some IOR remains with the object, while some IOR also affects reorienting to the originally cued location. These separate object-based and location-based components are generally assumed to both operate in a static situation in which a cued object remains in its original location throughout a trial. We present results from several experiments that challenge this assumption. In particular, we show that the IOR is dramatically reduced when the cued object moves away from, but then returns to, its initial location. The results suggest that IOR for static stimuli may be fundamentally different from IOR that operates with dynamic stimuli.

**1:50–2:10 (508)**

**Inhibition of Return in a Spatial Illusion.** LISA L. BARNES, *Veterans Administration and University of California, Davis*, & ALEXANDRA L. BEUCHE & LYNN C. ROBERTSON, *Veterans Administration and University of California, Berkeley* (read by Lynn C. Robertson)—Using a Posner precuing method and a spatial illusion that altered the perceived distance between locations within a line, Robertson and Kim (1999) reported greater validity effects (valid minus invalid target response times) for perceived long than perceived short lines. Although the two lines were the same length on the computer screen, the perceived length accounted for performance. The present study examines whether inhibition of return (IOR) may also be guided by perceived length. Using the same illusion as Robertson and Kim, we find that the magnitude of IOR does not appear to be affected by the perceived length of the lines. Implications for theories of IOR and attentional facilitation are considered.

**2:15–2:30 (509)**

**Visual Marking Is Distinct From Inhibition of Return.** C. N. L. OLIVERS & GLYN W. HUMPHREYS, *University of Birmingham* (sponsored by Glyn W. Humphreys)—Visual marking (VM) refers to our attentional blindness to old items when new stimuli are presented in our visual field. We examined whether VM was due to inhibition of return (IOR), applied following the serial search of the old items, by comparing two main conditions. In the IOR condition, subjects searched a first set of items for a target and then a second, new set while the old items remained in the field. In the VM condition, subjects expected the target only to be in the second (new) set. Selection of new items in the IOR condition was relatively poor, and always worse than expected if subjects only searched the new stimuli. In contrast, selection of the new items in the VM condition was good, and equal to that expected if there was exclusive search of the new stimuli. We conclude that the mechanism of VM is distinct from IOR.

**2:35–2:50 (510)**

**Targets in a Common-Object File Reduce the Attentional Blink.** FRANCES KELLIE & KIMRON L. SHAPIRO, *University of Wales, Bangor*, & ANNE P. HILLSTROM, *University of Texas, Arlington* (read by Kimron L. Shapiro)—The attentional blink (AB) is a deficit in accurately reporting a second target occurring within 100–500 msec of the first. Using RSVP streams in apparent motion, Raymond and Sorenson (1994) found no AB when the first target and the preceding distractors adopted a common object file (because they were the same object). Rather than using apparent motion, we used morphing technology to create a stream percept of one object smoothly changing

into another. Targets were either textured frames within a sequentially presented morph movie or the same frames embedded within a stream of random object pictures. A reduced AB was observed in the morph condition despite comparable masking in each condition. These results are discussed in terms of object file theory and are consistent with Duncan (1984), who found no dual-task deficits in a spatial task, when the tasks involved a single object.

**2:55–3:15 (511)**

**Constraints on the Locus/Loci of the Attentional Blink Phenomenon.** JACQUELYN M. CREBOLDER, *DCIEM*, & PIERRE JOLICOEUR, *University of Waterloo* (read by Pierre Jolicoeur)—We manipulated the probability of the first target (T1) in an attentional blink (AB) paradigm, or of the second stimulus (S2) in a psychological refractory period (PRP) paradigm, and found that this variable modulated the size of the AB effect, and produced additive effects with SOA in the PRP experiment. Thus, the locus of stimulus probability is at, or before, the AB bottleneck and at, or after, the PRP bottleneck. If stimulus probability affected the same stage in both paradigms, a locus of interference in the AB paradigm must be at, or beyond, the locus of the PRP interference. Since AB interference is unlikely to take place after the locus of PRP interference, the results suggest that some portion of the interference in the AB paradigm occurs at the same stage as the PRP bottleneck.

**COGNITIVE DEVELOPMENT**  
**Plaza, Saturday Afternoon, 1:30–3:00**

*Chaired by John Whalen, University of Delaware*

**1:30–1:50 (512)**

**The Impact of Object–Kind Novelty and Word–Sound Similarity on Preschoolers’ Mapping of Novel Names.** LORNA HERNANDEZ JARVIS, *Hope College*, & WILLIAM E. MERRIMAN, *Kent State University* (read by William F. Merriman)—Four- and five-year-olds’ judgment that a novel noun (e.g., *glower*) is more likely to refer to a novel kind of object than to a familiar object that has a similar-sounding name (e.g., *flower*) was investigated. In Experiment 1, the novel objects were strongly favored on initial test trials, but after encountering a trial that presented a choice between two familiar objects, the bias to select novel objects became significantly weaker. This carry-over effect was obtained in three other experiments, and was shown to depend on sensitivity to word–sound similarity. Two experiments also included test trials in which the novel names did not sound like the names of the familiar choice objects. An encounter with a familiar–familiar choice trial had no impact on the bias to map these names onto novel objects.

**1:55–2:10 (513)**

**Operation Span and Language Processing in Young and Elderly Subjects.** GLORIA S. WATERS, *Boston University*, DAVID CAPLAN, *Massachusetts General Hospital*, GAYLE DEDE, *Boston University*, & KAREN A. KEMTES, *Brandeis University*—One hundred and thirty-nine individuals ranging in age from 18 to 86 were tested on seven operation span tasks (alphabet span, backward digit, missing digit, subtract 2, running item, and sentence span for simple and complex sentences), an on-line measure of sentence processing efficiency (the auditory moving windows paradigm with syntactically simple and complex sentences), and the reading comprehension subtest of the Nelson Denny Reading Test. There were significant effects of age on five of the seven operation span measures and both language processing measures. There were low to moderate correlations between the operation span measures. An exploratory factor analysis showed that the operation span measures (other than missing digit) loaded on one factor. Operation span scores were not related to measures of on-line processing efficiency but were related to performance on the Nelson Denny Reading Comprehension Test.

**2:15–2:30 (514)**

**Development of the Numeral-Size Stroop Effect.** ROCHEL GELMAN, *UCLA*, JOHN WHALEN, *University of Delaware*, JIM STIGLER, *UCLA*, & SUK-FONG TANG, *University of Chicago*—Children in Grades K/1, 3, 5, and 7 as well as adults participated in a numeral-size Stroop task. Digits were either congruent (3, 7) or incongruent (3, 7); responses were either taller or more. Numeral and size incongruity slowed RTs in the three oldest groups. Only number RTs were slowed by size incongruity in the younger groups. The developmental function on numerical incongruity fits Gallistel and Gelman's (1992) view that symbols have to be mapped to nonverbal quantities.

**2:35–2:55 (515)**

**Advancing Downward to the Basic Level.** JEAN M. MANDLER, *University of California, San Diego*, & LARAINE McDONOUGH, *Brooklyn College, CUNY*—Infants as young as 9 months treat little replicas of objects representationally. Using replicas we can assess infant concepts about the world by the way they imitate. We model events such as giving a dog a drink and then give infants a choice of objects to use for their imitations. By varying the available choices we can determine how infants construed the modeled events and how far they are willing to generalize their properties. At first, infants understand many objects mainly at an abstract, global level. Their understanding only becomes concrete and detailed with development. The present experiments show that the broad concepts of 14 month olds narrow down and become more adult-like by 19 months in the realm of artifacts, but not until older for natural kinds. The way in which infants' associations and generalizations are controlled by the meaning of objects, rather than by their physical features, is discussed.

**RECOLLECTION AND RECOGNITION**

Santa Monica, Saturday Afternoon, 1:30–4:10

Chaired by John F. Kihlstrom, *University of California, Berkeley*

**1:30–1:50 (516)**

**Dual Processes in Recognition: Does a Focus on Measurement Operations Provide a Sufficient Foundation?** MICHAEL S. HUMPHREYS, SIMON DENNIS, KERRY A. CHALMERS, & SIMON FINNIGAN, *University of Queensland*—Current theoretical thinking about dual processes in recognition relies heavily on the measurement operations embodied within the process dissociation and the remember-know procedures. We critically evaluate the ability of these procedures to support this theoretical enterprise. We show that there are alternative explanations for the findings with the process dissociation procedure. We also show that the remember-know procedure does not make unambiguous predictions about the pattern of results to be expected and, thus, it is impossible to say whether results obtained with this procedure do or do not support current ideas about dual processes in recognition. Our conclusion is that more specific theories incorporating ideas about representation and process are required.

**1:55–2:10 (517)**

**Consciousness, Control, and Confidence in Recognition Memory.** ANDREW P. YONELINAS, *University of California, Davis*—The contributions of recollection and familiarity to recognition memory performance were examined using the process dissociation, remember-know, and receiver operating characteristic (ROC) procedures. The three measurement procedures led to process estimates that were almost identical, and to similar conclusions regarding the effects of different encoding manipulations. Dividing attention led to a large decrease in recollection and a smaller (sometimes nonsignificant) decrease in familiarity. Semantic, compared with perceptual, processing led to a large increase in recollection and a moderate increase in familiarity. Moreover, the results showed that familiarity was well described by

classical signal-detection theory, but that recollection reflected a threshold process. The convergence observed across the three measurement procedures shows that the procedures tap similar underlying processes, and that recollection and familiarity differ in terms of conscious awareness, intentional control, and response confidence.

**2:15–2:35 (518)**

**The Complexities of Associative Recognition.** ROBERT KELLEY & JOHN WIXTED, *University of California, San Diego* (read by John Wixted)—What factors influence a subject's decision about whether a pair of items is intact (i.e., both items were studied together on a list) or rearranged (i.e., both items were studied but as members of different pairs)? Item familiarity, associative familiarity, and retrieval have all been posited to play an important role. We investigated the interplay of these three factors by attempting to selectively influence each of them and by examining their effects on hit and false alarm rates and on the shape of the confidence-based ROC. The results bear not only on theories of associative recognition but also on the phenomenon of "registration without learning."

**2:40–2:55 (519)**

**Recall-to-Reject in Recognition: Evidence From ROC Curves.** CAREN M. ROTELLO, *University of Massachusetts, Amherst*, NEIL A. MACMILLAN, *Brooklyn College, CUNY*, & GORDON VAN TASSEL, *University of Massachusetts, Amherst*—Dual-process models of recognition assume that recognition judgments are based on a fast-acting familiarity-based process and a slower, more accurate, recall-based process. Often, the recall process is assumed to operate as a *recall-to-reject* mechanism in which mismatching information that is retrieved from memory is used to reject test foils that are similar to studied items. We used receiver operating characteristic (ROC) curves to evaluate the evidence for a recall-to-reject process in recognition task, but robust evidence for recall-to-reject processing appeared in an associative recognition task. Importantly, however, evidence for recall-to-reject emerged only when sufficient time was allowed for a recall process to contribute to the recognition judgments (i.e., decisions made after 2,000 msec rather than after 450 msec).

**3:00–3:20 (520)**

**Recognition Memory as a Multidimensional Decision Process.** WILLIAM P. BANKS, *Pomona College*, & MATTHEW W. PRULL, *Whitman College*—Recognition memory, source memory, and, more recently, exclusion performance and "false fame" effects are important domains of study in memory, but ones that use different paradigms, methods of analysis, and theoretical interpretations. We propose here that results from these domains can be treated with a single analytic model. We show how to generate a multidimensional memory representation based on signal-detection theory (a version of general recognition theory) and make predictions for each of these paradigms. The detection model is simpler than comparable multinomial models, it is more easily generalizable, and it does not make threshold assumptions. Results show clearly and intuitively the relationship between exclusion and source discrimination and how decision processes in the multidimensional space can result in effects like false fame. We also show how to use the technique to separate item memory from schema-based reconstruction in memory for narratives.

**3:25–3:45 (521)**

**The Role of Perceptual Similarity in Explicit Recognition: Evidence Against Multiple Systems.** LYNNE M. REDER, DIMITRIOS K. DONAVOS, & MICHAEL A. ERICKSON, *Carnegie Mellon University*—Subjects studied words in different unique fonts and were later asked whether the word had been studied earlier. Words could be re-presented in the original font, a font studied with another word, or a font not seen earlier. In two additional experiments, we varied the numbers of words studied in the same unusual font (1 vs. 12 words per font). Recognition memory for the words was better if the

test and study fonts matched, and this effect was larger for fonts not shared with other words (low fan font). Moreover, old judgments were more likely to be classified as *remember* responses when words were re-presented in the same low fan font. Although we found significant levels of processing effects, these did not interact with matching font. These results are consistent with the predictions of the SAC model of memory, but challenge the independent memory systems and independent processing systems perspectives.

### 3:50–4:05 (522)

**Recognition: A Context Noise Process.** SIMON DENNIS & MICHAEL S. HUMPHREYS, *University of Queensland*—Performance in recognition memory paradigms has been thought to be dominated by noise originating with the other items that appear within the same study list. This approach is supported by two main pieces of evidence—the list length effect and high false alarm rates to distractors that are similar to list items. First, we demonstrate that when delay, attention, and contextual reinstatement are controlled, there is no list length or list strength effect in recognition memory under conditions where substantial word frequency effects are found. Second, we review data suggesting that false alarms to similar distractors are sensitive to test trial manipulations, implying that it is not the inherent overlap of item representations that drives these effects. We conclude that recognition memory is dominated by noise originating with the other contexts in which items have previously appeared.

## PSYCHOLINGUISTICS I

Beverly Hills, Saturday Afternoon, 1:30–3:30

Chaired by Julie Boland, Rutgers University

### 1:30–1:40 (523)

**Interviews Under Duress: An Extreme Instance of Orality.** CYNTHIA M. UPCHURCH & DANIEL C. O'CONNELL, *Loyola University, Chicago* (read by Daniel C. O'Connell)—Ten excerpts of both President Clinton's Grand Jury Testimony of August 17, 1998, and of each of two interviews with Hillary Rodham Clinton ("Today Show," January 27, 1998; "Good Morning America," January 28, 1998) were analyzed as examples of interviews under duress and instances of extreme orality. In all of them, the topic under discussion was the President's insistence on his innocence in the Lewinsky case. Comparisons between the President and First Lady revealed long and short within-speaker pauses, respectively. His replies to questions averaged more than twice the length of hers. Comparisons were also made with other speech genres of both speakers. President Clinton's statement of his innocence at his press conference on January 26, 1998, and his prepared statement at the beginning of his Grand Jury Testimony were found to vary notably from other genres.

### 1:45–2:05 (524)

**Latent Semantic Analysis Can Reliably Evaluate Student Contributions in AutoTutor.** ARTHUR C. GRAESSER, KATJA WIEMER-HASTINGS, PETER WIEMER-HASTINGS, DEREK HARTER, NATALIE PERSON, & ROGER J. KREUZ, *University of Memphis*—AutoTutor is a fully automated computer tutor that assists students in learning about introductory computer literacy. AutoTutor presents questions and problems from a curriculum script, attempts to comprehend learner contributions that are entered by keyboard, formulates dialogue moves that are sensitive to the learner's contributions (such as prompts, elaborations, corrections, and hints), and delivers the dialogue moves with a talking head. Latent semantic analysis (LSA) is a major component of the mechanism that evaluates the quality of student contributions in the tutorial dialogue. LSA is equivalent to the evaluations provided by intermediate experts of computer literacy, but not quite as high as more accomplished experts in computer science. The LSA component can accurately discriminate good verbose students, good succinct students, vague students, erroneous stu-

dents, and mute students. LSA is capable of discriminating these different classes of student ability and tracking the quality of student contributions in tutorial dialogue.

### 2:10–2:20 (525)

**Criterion to Articulate in the Naming Task.** SACHIKO KINOSHITA & ANNA WOOLLAMS, *Macquarie University*—Lupker, Brown, and Colombo (1997, *JEP:LMC*) showed that in a naming task, the decision to initiate articulation is largely modulated by the composition of the items presented in a block. The present study further examined the factors that affect the criterion to initiate articulation. The results suggest that the time criterion is measured from when the signal is given to articulate, not from the presentation of the word target. Further, the modulation of criterion depends on the actual articulation, rather than the computation of phonology. The results have implications for using the naming task to model the process of visual word recognition.

### 2:25–2:45 (526)

**Default Nominal Inflection in Hebrew: Evidence for Mental Variables.** IRIS BERENT, *Florida Atlantic University*, STEVEN PINKER, *MIT*, & JOSEPH SHIMRON, *University of Haifa*—According to the "word-rule" account, regular inflection is computed by a default, symbolic process; irregular inflection is achieved by associative memory. Conversely, pattern-associator accounts attribute both regular and irregular inflection to an associative process. The default is ascribed to the asymmetry in the distribution of regular and irregular tokens in phonological space. Hebrew challenges the distributional asymmetry hypothesis. Hebrew speakers use regular masculine inflection as a default despite the overlap in the distribution of regular and irregular masculine nouns. We demonstrate that default regular inflection is unaffected by the similarity to stored regular nouns, applying even for phonologically idiosyncratic nonwords. The default is triggered by the failure to activate a canonical irregular root. Consequently, names and borrowings take default inflection despite their identity to existing irregular nouns. Our findings are incompatible with either the distributional asymmetry or type frequency hypotheses. Instead, they support the symbolic view of default inflection.

### 2:50–3:05 (527)

**Reading Spelling: Can People Improve Spellings After Reading Them?** V. M. HOLMES & M. BABAUTA, *University of Melbourne*—Does reading a spelling allow more precise orthographic information to be brought to bear on the spelling production process? Students typed spellings of difficult-to-spell words, and were permitted to see only the last one to four letters. After each spelling, they were allowed to read what they had typed, and asked if they wanted to make any corrections. Students almost never changed correct spellings, but they did change about one in four misspellings. However, they were no more likely to improve a misspelling than they were to change it to something equally incorrect or worse. The number of letters visible at the time of initial spelling had no impact on initial spelling accuracy or on ability to improve misspellings. The results suggest that the orthographic representation people consult for spelling is the same as the one they access to identify words during reading.

### 3:10–3:25 (528)

**Is Less Really More? Learning a Miniature Artificial Language in Adulthood.** ALAN W. KERSTEN & JULIE L. EARLES, *Florida Atlantic University*—Three experiments provide support for a key prediction of Newport's (1990) "Less is More" hypothesis. Adults were found to learn a miniature artificial language better when they were initially presented with only small segments of language than when they were presented immediately with the full complexity of the language. Adults who were presented initially with individual words and only later with complex "sentences" composed of several such words learned the meanings and morphology of those words better than did adults who were presented with entire sentences throughout

learning. The externally imposed constraint of processing only small segments of language in this experiment may have had effects similar to those of the internal processing constraints of children. Implications for a critical period in language acquisition and for the learning of a second language in adulthood will be discussed.

**CHOICE, COMMITMENT, AND GOALS**  
Westside, Saturday Afternoon, 1:30–3:25

*Chaired by David V. Budescu, University of Illinois*

**1:30–1:50 (529)**

**Violations of Stochastic Dominance and Coalescing by Financially Motivated People.** MICHAEL H. BIRNBAUM & TERESA MARTIN, *California State University, Fullerton*—Students made choices between pairs of gambles, knowing that some people would play one of their chosen gambles for real monetary payoffs. Violations of stochastic dominance were observed in three studies, replicating previous studies without payoffs and with other procedures for displaying the choices. Significantly more than half of participants in two studies chose a dominated gamble over the dominant gamble. Systematic event-splitting effects were also observed, as significantly more than half of the participants reversed preferences when choosing between the split versions of the same choices. The third experiment found that the incidence of violations depends on the probability distribution. Results are not consistent with rank-and-sign-dependent utility theories, including cumulative prospect theory, which imply stochastic dominance and coalescing.

**1:55–2:15 (530)**

**The Impact of Time and Time Framing on Gains and Losses.** MARY KAY STEVENSON & KATHLEEN LAGRAVE, *California State University, Hayward*—The effect of temporal discounting on the evaluation of outcomes has been shown to be influenced by the magnitude of the outcome, the sign of the outcome (gain or loss), and the frame or temporal reference point. The current study was designed to estimate discount rates within a neutral frame, expedited frame, and delayed frame for both gains and losses. Unlike previous studies, the focus was on individual differences and the format of the framing manipulation. The results indicated that individuals differ in the way that they deal with gains and losses that are evaluated in expedited and delayed frames. Furthermore, the response scale also influenced the results. Participants who were asked to express their evaluations in dollar amounts had different relative discount rates than participants who were asked to express their evaluations in new temporal deadlines. These results were summarized in a general theory of temporal discounting.

**2:20–2:35 (531)**

**Emerging Coherence Drives Decision Making.** DAN SIMON, *University of Southern California*, & LIEU B. PHAM, QUANG A. LE, & KEITH J. HOLYOAK, *UCLA* (read by Keith J. Holyoak)—Previous research indicates decision making is accompanied by an increase in the coherence of assessments of individual arguments related to the decision alternatives. We investigated whether this coherence shift is obtained before a decision is made (or even before people know they will have to reach a decision). College students were presented with a complex legal case involving multiple conflicting arguments. Participants rated agreement with the individual arguments in isolation before seeing the case, after processing it under various initial sets, and again after reaching a verdict. The results demonstrate that a coherence shift can be triggered before making a decision one expects to make later, by a set to memorize the case, and by sets to receive additional information or to communicate information about the case to someone else. Emerging coherence appears to drive decisions, rather than merely rationalizing decisions that have already been made.

**2:40–2:55 (532)**

**The Roles of Choice and Feedback in Escalation of Commitment Research.** HAL R. ARKES, *Ohio University*—Most escalation of commitment experiments use the same design: Experimental group participants select the option in which to invest, experience failure, and then choose how many resources to invest in the floundering original choice versus an alternative. Control group participants are given the second investment opportunity but neither the original choice among options nor any outcome feedback. Although escalation of commitment has generally been attributed to the negative outcome feedback, the results of this experiment instead implicate being given the original choice of options. When control group participants were allowed to choose one of the stocks to be included in the Trial 2 choice, just as experimental group participants were allowed to do, the remaining factor that differentiated the two groups—the receipt versus nonreceipt of outcome feedback—did not result in significantly different escalation. Also, positive Trial 1 investment outcome led to more escalation than did negative.

**3:00–3:20 (533)**

**Too Many Goals, Too Little (or Too Much) Time.** SANDRA L. SCHNEIDER & FORREST A. W. SAMNIK, *University of South Florida*—The goals to which people aspire influence the decisions they make both in the short and the long run. We collected descriptive data to explore the types and frequency of commonly sought-after goals. We examined three different time horizons: goals for the next week, the next 3 to 5 years, and an entire lifetime. The sample of 260 females and 170 males was divided into four age groups: 18–29, 30–44, 45–59, and 60–95. Although there was substantial agreement about many aspects of the reported goals in all conditions, there were also large differences as a function of time horizon, gender, and age group. The data highlight the need to understand decision making within the larger context of the goals that the decisions are intended to support. Issues include how people prioritize their goals, to what extent they consider goals before acting, and how well they integrate short-term and long-term goals.

**INVITED SYMPOSIUM: FUNCTIONAL BRAIN IMAGING  
AND HIGHER LEVEL COGNITION**  
Century, Saturday Afternoon, 1:30–3:35

*Chaired by Marcel Adam Just, Carnegie Mellon University*

As functional neuroimaging is making the transition from an esoteric technology to a mainstream tool of experimental psychology, researchers are asking, “What is fMRI or PET doing for cognitive psychology? What kinds of new questions can it answer?” The talks in this symposium attempt to elucidate new properties of the cognitive system, such as its composition and component interaction, emphasizing the new perspectives or insights that functional neuroimaging is providing concerning higher level cognition.

**1:30–1:50 (534)**

**fMRI and the Neuro-Architecture of Cognition.** MARCEL ADAM JUST & PATRICIA A. CARPENTER, *Carnegie Mellon University*—New findings in functional neuroimaging suggest a fundamental reconception of how the cognitive architecture is organized and neurally implemented, including (1) the decomposition and characterization of the cognitive system in terms of the underlying cortical components and their communication and (2) the dynamic changes in the neural underpinnings of cognition during the course of processing, learning, and stroke recovery. For example, the cortical systems supporting language comprehension dynamically configure themselves depending on qualitative and quantitative properties of the task, such as the syntactic structure and lexical content of a sentence, its visuospatial reference, or possible ambiguities, as well as the attributes of the comprehender, such as his/her learning state, strategy, or possible brain

damage. The dynamics of the neural recruitment and the interactivity among the cortical components question the old assumption that brain function consists of a static set of decomposable systems, particularly with respect to high-level cognition.

1:55–2:15 (535)

**Can Functional Neuroimaging Help Decipher the Function of the Human Prefrontal Cortex or Is It a Case of the Lion and the Statue?**

JORDAN GRAFMAN, *National Institute of Neurological Disorders and Stroke*—The human prefrontal cortex occupies approximately one third of the total cortical space in the brain. Yet assignment of specific cognitive operations or representations to that area of cortex has lagged behind our investigation and understanding of the functions of posterior brain areas. Functional neuroimaging can be used as a tool to test the hypothesis that aspects of planning, sequencing, thematic knowledge, social understanding, and reasoning are stored as memories/representational knowledge in prefrontal cortex. Taken together with evidence from lesion studies, our functional neuroimaging studies suggest that different features of structured event complexes are processed by topographically restricted brain sectors in the prefrontal cortex with different sectors concerned with sequencing events, processing certain kinds of semantic information across and within events, and representing emotional and nonemotional categories of knowledge. In our hands, functional neuroimaging supplements, but cannot replace, lesion studies as the gold standard for brain mapping.

2:20–2:40 (536)

**Neuroimaging of Priming: What Have We Learned?** DANIEL L. SCHACTER, *Harvard University*—Priming refers to changes in identifying or producing an item that result from a specific prior encounter with an item. Neuropsychological studies of brain-injured patients and cognitive studies of healthy individuals demonstrate clearly that priming can be dissociated from explicit memory. During the past several years, a growing number of functional neuroimaging studies have examined the neural correlates of priming. This paper will assess how imaging research has informed cognitive and neuropsychological analyses of priming, focusing on PET and fMRI studies that have examined such issues as within- versus cross-modality priming and the perceptual specificity of priming. It will be suggested that imaging studies can help to advance cognitive theorizing by providing converging evidence concerning theoretical constructs proposed on the basis of behavioral data, and by suggesting new hypotheses that can help to resolve apparent inconsistencies among behavioral studies of priming.

2:45–3:05 (537)

**The Education of the Brain: Evidence From Functional Magnetic Resonance Imaging.** JOHN GABRIELI, *Stanford University*—The brain records, retains, and retrieves memories, so that experiences from the past can guide behavior in the present. The nature of this constant education of the brain varies considerably. Some kinds of memory may involve experience-dependent tuning of a specialized processing system. Other kinds of memory may involve switching the architecture of the neural network that mediates performance, a transformation that may convert unskilled naive performance into skilled expert performance. Behavioral studies cannot distinguish between such fundamentally different ways of educating the brain. Functional neuroimaging studies, however, can reveal diverse forms of plasticity that characterize different ways in which the brain capitalizes on current experience in order to progress toward a wiser and more efficient future.

3:10–3:30 (538)

**Cognitive Neuroimaging and Cognitive Psychology: General Issues.** EDWARD E. SMITH, *University of Michigan*—Neuroimaging studies of cognition involve analyzing phenomena at both the neurological and cognitive (functional) levels. Clearly, cognitive principles can direct our search at the neurological level, but how does what we

discover at the neurological level affect our understanding of the cognitive level? We consider three different ways in which neuroimaging studies can affect our understanding of cognition. Neuroimaging analyses can (1) provide converging evidence for various cognitive hypotheses, in a manner quite distinct from behavioral data; (2) offer a functional decomposition of various cognitive tasks; and (3) offer novel insights about cognitive concepts and principles. Examples of these three types will be considered. We will also note some limitations of neuroimaging analyses compared with standard cognitive methods.

**SKILLED PERFORMANCE**

**Pacific Palisades, Saturday Afternoon, 3:30–5:25**

*Chaired by Ulrich Mayr, University of Potsdam*

3:30–3:50 (539)

**Evidence Monitoring Theory: Foundation and Experimental Application.** JAMES T. TOWNSEND, *Indiana University*, & MICHAEL J. WENGER, *University of Notre Dame*—The tools of linear dynamic systems are used to propose a meta-analytic framework for relating response probabilities and response latencies across a range of expected response accuracies. It is shown (by way of numeric simulations) that the approach is consistent with approaches that deal with probabilities and latencies separately. Theoretical results pertinent to an initial experimental task, along with data from an initial empirical investigation, will be reported.

3:55–4:10 (540)

**Microstrategies and Macroskill: Investigating Processing Strategies for Concurrent-Task Performance.** ANDREW C. PECK & RICHARD A. CARLSON, *Pennsylvania State University* (read by Richard A. Carlson)—We found evidence of two distinct types of response strategies underlying concurrent-task performance in a sequence-learning paradigm. Response scheduling strategies involved responding serially, which produced slower performance, but allowed effective transfer to conditions with novel response combinations. Response synchronizing strategies involved responding concurrently, which resulted in faster performance but limited effective transfer to conditions requiring identical response combinations. Although the mechanisms underlying scheduling strategies have received considerable attention (e.g., research on task switching and the PRP), research has just begun to address the psychological existence of synchronous strategies and their implications for learning and transfer. We will discuss several follow-up experiments designed to investigate underlying mechanisms in single-step concurrent tasks. These experiments examined the effects of instruction, the consistency with which particular responses were required together, and the effects of manipulating temporal aspects of the presentation of information.

4:15–4:30 (541)

**More on Intertrial Effects on Simon Interference.** J. TOBY MORDKOFF, *Pennsylvania State University*—Last year I reported some results that suggested that the magnitude of Simon interference depends on the type of previous trial (i.e., compatible vs. neutral vs. incompatible). This was taken as evidence of reactive gating, which involves variable gating of irrelevant information. It was also claimed that the evidence in favor of reactive gating could not be explained in terms of simple repetition effects or negative priming. Well, that was wrong. As will be shown, it is more likely that reactive gating is a new form of negative priming.

4:35–4:55 (542)

**Does Learning of a Complex Task Have to Be Complex?** FRANK J. LEE & JOHN R. ANDERSON, *Carnegie Mellon University* (read by John R. Anderson)—Many theories of skill make the implicit assumption that complex tasks consists of many smaller parts that are

being learned according to basic learning principles. However, there has been rather sparse empirical testing of this crucial assumption. In this paper, we examine this assumption directly by decomposing learning in Kanfer–Ackerman–Air Traffic Controller (KA–ATC) task from learning at the global task level to all the way down to learning at the keystroke level. First, we reanalyze data from Ackerman (1988) and show that learning in this complex task does indeed reflect learning of smaller parts. We show that the various components are all speeding up according to a common power function. Second, in a follow up eyetracking experiment, we show that a large portion of learning at the keystroke level in this task reflects even lower level, attentional learning of where not to look.

5:00–5:20 (543)

**Interpreting the Effects of Aging on Reaction Time Using a Diffusion Model.** ROGER RATCLIFF, *Northwestern University*, ANJALI THAPAR, *Bryn Mawr College*, & GAIL MCKOON, *Northwestern University*—Ratcliff's diffusion model for two-choice decisions is used to examine processing differences between undergraduates and 60- to 75-year-olds. In two signal-detection experiments and a masked-letter identification experiment, accuracy was manipulated to span the range from chance to ceiling, and speed–accuracy instructions were manipulated. With only drift rate varying, the model accurately fits all the data (with only boundary separation varying across speed–accuracy levels), including error rates, response times for both correct and error responses, and the shapes of response time distributions. For both the signal-detection tasks and letter identification task, the older subjects differ from the young only in having a longer nondetection component of response time and in setting more conservative response criteria (fewer errors). Only in the letter identification task does the decision process for older subjects depend on information of lower quality (lower drift rate in the model) than that of the younger subjects.

ATTENTIONAL CAPTURE  
Plaza, Saturday Afternoon, 3:40–5:15

Chaired by Kimron L. Shapiro, *University of Wales, Bangor*

3:40–3:55 (544)

**Competition for Visual Attention as a Function of SOA.** MARY C. POTTER & ADRIAN STAUB, *MIT*—Two brief masked words were presented, one above the other, at stimulus onset asynchronies (SOAs) ranging from 0 to 213 msec. Overall, about 1.2 words were reported per trial. However, the relative performance on the first and second words changed markedly over SOA: The second word was increasingly advantaged as SOA increased to 40 msec, but by 213 msec (in the attentional blink range) this advantage reversed significantly. At an intermediate SOA of 107 msec, the first and second words were nearly equal. Controls ruled out abrupt onset and metacontrast masking (as usually defined) as major factors in this shift in attention with SOA. We hypothesize that if the first word has not been identified by the onset of the second word, processing the latter takes precedence; if the first word has been identified, its consolidation takes precedence over consolidation of the second word (see Chun & Potter, 1995).

4:00–4:10 (545)

**Distractor Effects Depend on Attentional Focus Requirements of Target Processing.** MARYLOU CHEAL, *Arizona State University*, & GARVIN CHASTAIN, *Boise State University*—Folk and Remington (1998) found a dissociation between two forms of attentional control based on a red (green) distractor that captured attention when a red (green) target was used, but not when a green (red) target was used. Furthermore, if there was no distractor, reaction times (RTs) were faster than with either type of distractor. The interpretation was that two forms of attentional control were involved. However, Lavie and

Cox (1997) suggested that stimuli outside the focus of attention can have more distracting effects when the task is simple than when it is difficult. Therefore, we tested whether a more difficult target identification would eliminate the dissociation. Although there was capture by a same-colored distractor, the different-colored distractor resulted in RTs approximately the same as the no-distractor condition. Our interpretation is that the dissociation found by Folk and Remington represents two forms of the same attentional process.

4:15–4:30 (546)

**Evidence for a Distinction Between Attention and Selection.** ROGER W. REMINGTON, *NASA Ames Research Center*, & CHARLES L. FOLK, *Villanova University*—Task processing consists of preattentive and attentive stages exhibiting distinct processing characteristics. For example, preattentive processing can be restricted to individual features consistent with current goals (e.g., Folk, Remington, & Johnston, 1992). Attempts to so restrict attentive processing often fail, leading to interference from irrelevant dimensions. Focusing attention has been taken to be synonymous with selection, and the point at which the nature of processing changes. The spatial cuing study reported here challenges this view. Subjects judged either the identity or the orientation of a red character among white distractors. A red precue drew attention to one of four locations. The task-irrelevant dimension of the target produced interference when incompatible with the target response. However, only the task-relevant dimension of the cued item affected performance, evidence that under focused attention processing was restricted to the relevant dimension. Selection, though closely linked to attention, appears to constitute a separate action.

4:35–4:50 (547)

**A Closer Look at Contingent Capture.** BRADLEY S. GIBSON, *University of Notre Dame*—Folk, Remington, and Johnston (1992) have recently argued that stimulus-driven attentional capture is contingent on the attentional set of the observer. This conclusion was supported by findings which showed that uninformative cues captured attention when they were congruent with the defining features of the target, but not when they were incongruent with such features. The present research shows that the standard interpretation of these attentional cuing effects is misleading and that response times typically reflect two opposing orienting effects—one that is associated with the cue and the other that is associated with the target. More important, the present research also shows that incongruent onset cues do capture attention when the opposing effects of the target are neutralized. These findings are discussed within a broader theory of attentional control settings that has the virtue of integrating other recent findings (e.g., Gibson & Kelsey, 1998).

4:55–5:10 (548)

**Oculomotor Capture and Aging.** ARTHUR F. KRAMER, *University of Illinois*, SOWON HAHN, *University of California, Riverside*, & DAVID E. IRWIN, *University of Illinois*—A dominant view in the field of cognition and aging is that aging is associated with a general decline in inhibitory function. Indeed, this view is supported by a variety of studies that have employed paradigms such as negative priming, Stroop color-word processing, and stopping. In the present study, we examine age-related differences in oculomotor control in a task that required subjects to make a rapid saccade to a uniquely colored object in a display with several other distractor objects. On half of the trials, a new but task-irrelevant object was presented along with the color change in the display that defined the color singleton target. Contrary to the general inhibitory failure view of aging, old and young adults mistakenly made a saccade to the task-irrelevant onset (new object) on the same proportion of trials (~ 25% of the total number of trials). Additional studies examined this surprising finding. We found that older and younger adults were equally efficient in inhibiting incorrect reflexive saccades as long as they were unaware of the occurrence of the sudden onset stimulus that elicited the reflexive saccade.

However, when aware of the occurrence of the onset stimulus, younger adults were quite successful in inhibiting saccades to this event. On the other hand, older adults had great difficulty inhibiting saccades to the task-irrelevant sudden onset. These results have implications for our understanding of age-related differences in the ability to inhibit stimulus-driven oculomotor behavior.

#### COGNITIVE AGING

Santa Monica, Saturday Afternoon, 4:20–5:45

Chaired by Gloria S. Waters, Boston University

##### 4:20–4:35 (549)

**Age-Related Changes in Monitoring and Control of Cued Recall.** COLLEEN M. KELLEY & LILI SAHAKYAN, *Florida State University*—We compared the processes of metamemorial monitoring and control during cued recall for older versus younger adults using the methods of Koriat and Goldsmith (1996). Younger and older participants were first forced to respond to a retrieval cue, then rate their confidence in the generated response, then allowed to exercise control during the final free report. Incentives were manipulated between conditions to study control processes in free report. Control items and deceptive items were unassociated word pairs, but deceptive items had a semantically related word that could also fit the retrieval cue (e.g., study NURSE-dollar, cue NURSE-do\_\_\_r). These deceptive items produce high levels of false recall of the semantic associates, particularly in older adults. Older adults showed less effective memory monitoring in measures of calibration and resolution, particularly on deceptive items. Free report was tightly linked to confidence for both age groups.

##### 4:40–4:55 (550)

**Effects of Age and of Item Frequency on the Memory and Computational Components of Instance Learning.** JOHN CERELLA, DAYNA R. GREEN, & WILLIAM J. HOYER, *Syracuse University* (read by William J. Hoyer)—In their simplest form, Logan's instance theory and Rickard's CMPL theory assume that item learning is driven by repetitions. Thus learning should be equal for frequently and infrequently presented items when plotted by repetitions. Using memory probes interspersed among standard item-learning trials, and three levels of item frequency, we found that more frequent items were learned faster. This suggests that the lag between successive repetitions modulates learning. Surprisingly, item learning of an older subject group exceeded that of a younger group at all frequency levels, perhaps because the computational alternative was relatively more burdensome for older adults than for younger adults. Sensorimotor probes, computational probes, and memory probes were interspersed among the standard trials. These data permitted an exhaustive evaluation of the CMPL depiction of standard trial performance as reflecting a mixture of memory-based and computation-based item evaluations.

##### 5:00–5:15 (551)

**A Whirlwind of Memories: Mother–Child Conversations About a Devastating Tornado.** DANA L. DUNISCH, *University of Minnesota*, JENNIFER K. ACKIL, *Gustavus Adolphus College*, & PATRICIA JEAN BAUER, *University of Minnesota* (read by Patricia Jean Bauer)—Examination of mother–child conversations has shed considerable light on the content of children's autobiographical memory for emotionally positive experiences. In contrast, research examining children's memory for negative, traumatic experiences has typically involved structured interviews. Thus, it is not clear what mothers and children might recall together about traumatic events. The present research examined differences in length and content of mother–child conversations about traumatic and nontraumatic events as a function of age (range, 4–11 years). The traumatic event discussed by all participants was the touchdown of a devastating tornado in their home

town, St. Peter, Minnesota. Event conversations were coded for number of instances of each of several coding categories. Preliminary analyses indicate that tornado conversations were longer than non-tornado conversations and included a greater variety of coding categories. Specifically, recollections of negative emotion, sensory details, context, and conversation content were more likely to be present in the tornado conversations.

##### 5:20–5:40 (552)

**What Is the Role of Strategies in Cognitive Aging? A Case Study of Arithmetic.** PATRICK LEMAIRE, SANDRINE DU VERNE, MIREILLE LECACHEUR, & FERNAND FARIOLI, *CNRS & Université de Provence*—The goal of the present work was to assess strategic aspects of cognitive aging. We used the theoretical framework originally proposed by Lemaire and Siegler (1995) to analyze several aspects of strategy use—namely (1) which strategies people use, (2) when each strategy is used, (3) how each strategy is executed, and (4) how strategies are chosen among. The present empirical work was pursued in the context of computational estimation. Younger and older adults had to estimate as quickly as possible (and in less than 5 sec) the result of problems like 367+789. The data illuminate which aspects of strategy use change with age and which aspects remain constant. These data have implications for understanding the role of strategies in cognitive aging in general and in computational estimation in particular.

#### PSYCHOLINGUISTICS II

Beverly Hills, Saturday Afternoon, 3:40–5:45

Chaired by Daniel C. O'Connell, Loyola University, Chicago

##### 3:40–4:00 (553)

**Constraints on Plurals in Compounds: Some Implications of Compounds Research.** MARK S. SEIDENBERG, TODD HASKELL, & MARYELLEN C. MACDONALD, *University of Southern California*—In English morphology there is a constraint on the occurrence of rule-governed plurals as modifiers in compounds. Thus, an eater of rats is a rat-eater, not a \*rats-eater. In contrast, irregular plurals are acceptable as modifiers (e.g., mice-eater). These facts have been taken as evidence that rule-governed and irregular plurals are generated by separate morphological subsystems governed by different principles (Pinker, 1994). Moreover, children are sensitive to this constraint at a young age (Gordon, 1986), even though they are not explicitly taught the rule or provided with negative evidence (examples of what not to say), suggesting that the constraint is unlearned—that is, innate. New behavioral data, corpus analyses, and simulation modeling results present a different picture: the constraint is a probabilistic one that arises from distributional, semantic, and pragmatic factors. This account also explains how the constraint could be learned without either innate grammatical knowledge or negative evidence.

##### 4:05–4:25 (554)

**“Yesterday I Spoke at Psychonomics”: Errors on Irregular Past-Tense Verbs in Association With Semantic Deficits.** K. E. PATTERSON, *MRC Cognition and Brain Sciences Unit*, J. L. McCLELLAND, *CNBC*, & M. A. LAMBON RALPH & J. R. HODGES, *MRC Cognition and Brain Sciences Unit*—Two distinct mechanisms are often considered necessary to account for generation of English past-tense verb forms (lexical look-up for irregular forms like speak → spoke; rule-governed addition of -ed for regular and novel forms like talk → talked and wug → wugged), but recent connectionist models employ one complex procedure to process all three past-tense types. Neuropsychological dissociations are explained, in this framework, by reduced input from word meaning that plays a greater role in successful generation of lower frequency irregular forms, and by general phonological deficits that disproportionately affect regular and novel

forms. Nine patients with semantic dementia (a selective disruption to semantic knowledge resulting in loss of differentiation of word meanings) were tested on both generation and forced-choice recognition of the past-tense in sentence contexts. Results revealed a significant and frequency-modulated impairment on irregular forms, with error types that further support the connectionist account.

4:30–4:50 (555)

**The Relationship Between Anomia and Comprehension: Neuropsychological Evidence and a Computational Model.** M. A. LAMBON-RALPH, *MRC Cognition and Brain Sciences Unit*, J. L. McCLELLAND, *CNBC*, & K. E. PATTERSON & J. R. HODGES, *MRC Cognition and Brain Sciences Unit* (sponsored by W. D. Marslen-Wilson)—A deficit in object naming always accompanies acquired semantic impairment. The degree of anomia is sometimes disproportionately greater than the comprehension impairment, suggesting to some an additional deficit in activating phonological representations from semantics. Fourteen cases of semantic dementia (a progressive, selective disruption to semantic memory arising from temporal-lobe atrophy) reveal two different patterns: Anomia in patients with more right than left atrophy is closely coupled to level of comprehension impairment, whereas patients with more extensive left than right atrophy reveal extra-severe anomia relative to comprehension. We describe a connectionist model that accounts for these two patterns by assuming that damage affects only semantic representations in both cases. Representation of conceptual knowledge is bilateral, but left-sided units are more strongly connected to unilateral left phonological representations for speech output. Predominantly left damage leaves considerable residual semantics while drastically impairing verbal output.

4:55–5:15 (556)

**The Autonomy of Lexical Orthography: Evidence From Cortical Stimulation.** BRENDA C. RAPP, *Johns Hopkins University*, & DANA BOATMAN & BARRY GORDON, *Johns Hopkins Medical School*—In written language production, do we need to access the spoken form of a word to retrieve its spelling: *meaning* → *lexical phonology* → *lexical orthography* (obligatory phonological mediation)? Or, instead, is it possible to retrieve spelling directly from word meaning: *meaning* → *lexical orthography* (orthographic autonomy)? Orthographic autonomy is favored if, through cortical electrical stimulation, we can interfere with the retrieval of phonological forms without interfering with the retrieval of orthographic forms (and vice versa). We examined the spoken and written naming performance of individuals with chronic epilepsy who had subdural electrode arrays temporarily implanted for clinical purposes prior to the surgical removal of seizure foci. The results reveal that electrical stimulation of the cortex can disrupt spoken processing, whereas written naming remains intact and, furthermore, that the spoken naming deficits cannot be attributed to interruption of spoken production at a peripheral level. The results clearly support the hypothesis of orthographic autonomy in spelling.

5:20–5:40 (557)

**H.M.'s Reading Deficits: Relations Between Language, Memory, Aging, and Hippocampal Binding.** DONALD G. MACKEY & LORI E. JAMES, *UCLA*—Five studies examined H.M.'s ability to read high- and low-frequency words, pseudowords, and sentences containing high-frequency words. For isolated high-frequency words, reading performance was equivalent for H.M. and controls of similar age, background, intelligence, and education, but H.M. more often misread the remaining stimuli, usually without correction and in anomalous ways involving major changes in meaning, syntax, morphology, or phonology. Even when he read these stimuli correctly, H.M. introduced unusual pauses before and during production. These results were not due to misperception, speed-accuracy tradeoff, practice effects, or attentional deficits, and contradicted stages of processing theories that link H.M.'s deficits to a storage stage that is in-

dependent of “content processes” underlying perception, comprehension, retrieval, and production of verbal materials. Instead, present results supported distributed-memory theories with integrated storage/content processes, and one distributed-memory theory in particular that predicted interactions between aging and hippocampal damage.

**JUDGMENT/DECISION MAKING:  
EXPERTISE AND CONFIDENCE  
Westside, Saturday Afternoon, 3:35–5:40**

*Chaired by Joseph V. Baranski, Defence and Civil Institute of Environmental Medicine*

3:35–3:45 (558)

**Analysis of Judgment Confidence Using Item-Response Theory.** LAURA T. FLANNELLY, *University of Hawaii*, & KEVIN J. FLANNELLY, *Center for Psychosocial Research* (read by Kevin J. Flannelly)—Two studies were conducted to examine subjects' calibration of judgment in terms of their actual performance and their expected performance on test questions. Expected performance was estimated for each item using subjects' ability level and item difficulty, according to item-response theory. The one-parameter Rasch model was used. Both methods of scoring judgment bias (or calibration) yielded the commonly reported hard-easy effect, with subjects being overconfident that they correctly answered hard test questions and underconfident that they correctly answered easy questions. A closer examination of this effect in Study 1 revealed that subjects were overconfident on the questions they answered wrong and underconfident on the ones they answered right. Study 2 confirmed that overconfidence was highest on questions that were answered incorrectly, and also showed that subjects who performed poorly were more overconfident of their answers than were subjects who performed well.

3:50–4:10 (559)

**Comparing Cross-Cultural Confidence: Contingent Conclusions.** HONGBIN GU & THOMAS S. WALLSTEN, *University of North Carolina, Chapel Hill* (read by Thomas S. Wallsten)—Yates, Lee, Shinotsuka, Patalano, and Sieck (1998) found Chinese respondents to be more overconfident, less discriminating, and more variable than Japanese or American respondents in a hypothetical medical diagnosis task involving asymmetric prior probabilities and six binary symptoms. We reanalyzed their data to (1) separate group effects on choice from those on confidence estimates and (2) determine the consequences of analyzing the data conditioned on responses versus conditioned on objective probabilities (Erev, Wallsten, & Budescu, 1994). Group differences appeared in response distributions (Chinese having the most extreme estimates), percent correct choices (Chinese having most errors), and within- and between-subjects variability (Chinese being the most variable). Japanese were least sensitive to base rates and Chinese least responsive to symptom patterns. Whether the Chinese were the most over- or underconfident depended on the method of analysis.

4:15–4:25 (560)

**Judging Confidence Influences Decision Processing in Sensory Detection.** WILLIAM M. PETRUSIC, *Carleton University*, & JOSEPH V. BARANSKI, *DCIEM*—To examine the effects of confidence on the properties of the decision process, we used a visual detection task with four levels of signal strength. All observers worked for three blocks without rendering confidence judgments. For the subsequent three blocks, a control group continued to not provide confidence judgments and three experimental groups provided confidence judgments with two (“certain” or “not certain”), four (“guess,” “low,” “moderate,” “certain”), or six (“50,” “60,” “70,” “80,” “90,” “100”) confidence categories. Rendering confidence increased decisional

RTs on noise and all signal trials, with the increase varying with the number of confidence categories. The two-category—“certain” or “not certain” condition—altered the speed–accuracy tradeoff, with decreases in detective sensitivity occurring along with a speeding of responses over blocks. Thus, the effects of confidence judgment on the primary decision depended on both the number of confidence categories and the content of the categories.

**4:30–4:50 (561)**

**Psychological Science and Managed Care: Origins of Practice Variation in Medicine.** VALERIE F. REYNA, FARRELL J. LLOYD, & RONALD WOODARD, *University of Arizona*—The aims of this research were to determine whether medical judgments for patients with chest pain deviate from recommendations in a national guideline and to test predictions about the psychological sources of such deviations and their implications for clinical training and managed care. Physicians in cardiology, internal medicine, family practice, and emergency medicine were presented nine patient scenarios (three each at three levels of risk) and asked to make probability judgments and admission decisions. Decisions deviated significantly from those recommended in the guideline and from an expert-defined standard, and were associated with level of cardiovascular training. Physicians with less training processed more information, consistent with fuzzy-trace theory. Contrary to assumptions of managed care, primary care physicians had lower decision thresholds and were more likely to admit patients, compared with specialists. Results also confirmed that physicians’ disjunctive probability judgments—required by the guideline—were subject to biases predicted by fuzzy-trace theory.

**4:55–5:10 (562)**

**Mental Representations and the Design of Future Naval Decision Support Systems.** MICHAEL L. MATTHEWS & ROBERT D. G. WEBB, *Humansystems Incorporated*, CAROL MCCANN, *Defence & Civil Institute of Environmental Medicine*, & DAVID J. BRYANT, *Humansystems Incorporated* (read by David J. Bryant)—This talk highlights some implications of a cognitive task analysis (CTA) of a naval frigate operations room officer (ORO) position. Four pairs of experienced OROs talked through an operational scenario and described their cognitive activities based on their operational experience. Results suggest that OROs employ both analytic and intuitive (or naturalistic) decision-making approaches, based on the time available. The analysis points to the generation, maintenance, and use of a variety of forms of more-or-less abstract mental representations (pictures, models, or schemata) to acquire and maintain situation awareness and make decisions. Experienced OROs appear to rely heavily on such mental representations (generated during training and refined with experience and during mission planning) to rapidly categorize situations and make decisions. Current work further explores the role of mission planning in generating and using mental representations.

**5:15–5:35 (563)**

**Decision Making by Experts: Effects of Task Characteristics on Expertise.** JAMES SHANTEAU, *Kansas State University*—The purpose of this research is to propose and test a new model of how task characteristics influence performance of experts. Previous efforts to characterize the behavior of domain experts from a judgment/decision making perspective are reviewed. Several unexplained anomalies are considered (e.g., the nearly perfect calibration of weather forecasters in some tasks and the poor calibration in others). To account for both traditional results and anomalies, a four-category (left to right) taxonomy of tasks is proposed: aided tasks (such as forecasting weather), competent tasks (such as judging livestock), restricted tasks (such as clinical psychology), and quasi-random tasks (such as stockbrokers). Data from previous studies of experts were reanalyzed according to this taxonomy. The results are consistent: The more structured (further to the left) the stimulus environment, the better the performance measures. The implications of these results for selection, training, and evaluation of experts are considered.

**REPETITION/PRIMING EFFECTS  
Century, Saturday Afternoon, 3:45–5:35**

*Chaired by David S. Gorfein, University of Texas, Arlington*

**3:45–4:05 (564)**

**Short-Term Priming: Data and a Model for Bias and Interference.** DAVID HUBER, KEITH LYLE, & RICHARD SHIFFRIN, *Indiana University* (read by Richard Shiffrin)—Primes precede a briefly flashed and postmasked word, followed by two choices. Neither, one, or both choices are related to the primes (both related = unbiased). The relation is associative, identity, or orthographic. Unbiased orthographic and identity priming produce a large performance decrease. Passive processing of primes produces a large bias to choose the (only) related choice, but active processing eliminates or even reverses the bias. Our model assumes that perceived features arise from the flash, noise, and the primes, the source being unidentifiable. A Bayesian decision model uses estimates of the source probabilities to determine the evidence favoring either choice. The model accounts for the interference effects, the presence or absence of bias, and the interactions of these with similarity of alternatives and primes. We discuss the relation to previous short-term priming results and to attentional blink, repetition blindness, and negative priming.

**4:10–4:20 (565)**

**Rapid Semantic Activation of the Mental Lexicon: The Limits of the Lexical Decision Task.** STEVE BUENO & CHERYL FRENCK-MESTRE, *CNRS and CREPCO–Université de Provence* (read by Cheryl Frenck-Mestre)—Herein we will present the results from several reaction time studies aimed at determining the onset of semantic facilitation between word pairs. Prime words were presented for 29, 43, and 70 msec, followed by a backward mask. Priming facilitation was found as early as 29 msec, but this effect depended on both the type of prime–target relationship and the task. At 29 and 43 msec of prime exposure, facilitation was found only for pairs sharing semantic features and only in a semantic categorization task. The lexical decision task did not reveal priming for these pairs until 70 msec of prime exposure.

**4:25–4:40 (566)**

**Creating Repetition Priming Bias Effects Without Repetition.** MICHAEL E. J. MASSON & GLEN E. BODNER, *University of Victoria*—Repetition priming of word identification in a two-alternative forced-choice task has been characterized as a bias effect in which a studied alternative either attracts more evidence counts (counter model) or better matches the target’s contextual information (REM model). In these models, the alternatives presented in a forced-choice task serve only to specify which word counters or lexical images to consider. In contrast, we propose that making a forced choice between orthographically similar alternatives is affected by the differential fluency with which a studied and a nonstudied alternative are encoded. In support of this proposal, we show that by inducing differential processing fluency between alternatives without using prior study, bias effects like those caused by prior study can be replicated: Bias occurred with orthographically similar but not dissimilar alternatives. This pattern was also obtained with nonwords, which have no counters or lexical images.

**4:45–5:05 (567)**

**Dumb or Smart? Unconscious Cognition of Valence Uses Small Pieces of Words.** ANTHONY G. GREENWALD & RICHARD L. ABRAMS, *University of Washington*—Previously we reported that, after categorizing words as pleasant or unpleasant, masked multiletter parts of these words were more effective in priming further valence judgments than were previously uncategorized whole words. The present findings extend this result to single letters: Unpronounceable consonant strings (e.g., “DKMC”) primed with the valence of previously categorized words in which they appeared. This method can be used to identify units on which unconscious cognitive analysis operates.

**5:10–5:30 (568)****Beyond Lexical Decision: Lexical Access in Categorization Tasks.**

KENNETH I. FORSTER, *University of Arizona*—Valuable information about lexical access can be gained by comparing performance across different tasks. Comparison of several phenomena across syntactic (e.g., is it a noun?) and semantic categorization tasks (e.g., is it

an animal?) reveals a curious dissociation. Frequency effects are observed in a semantic categorization task but not in a syntactic task. However, semantic ambiguity effects are observed in a syntactic task but not in a semantic task. Similar anomalies apply in the case of masked priming. Interpretations of these phenomena in an activation model and a search model are contrasted.

## POSTER SESSION IV

California Showroom, Saturday Evening, 6:15–7:45

## • PERCEPTION •

(569)

**Parsing the Behavior Stream: The Detection of Intention-Based Units.** JODIE A. BAIRD, DARE A. BALDWIN, & BERTRAM F. MALLE, *University of Oregon*—Two studies investigated the hypothesis that people parse continuous human behavior into units defined by boundaries between intentions. Study 1 compared adults' memory for tones located at the completion points of intentional action (endpoints) with that for tones located in the midst of ongoing action—immediately preceding the completion of intentions (midpoints). Adults' placement of endpoint tones was remarkably accurate, suggesting they had no trouble remembering the completion points of intentions. In contrast, their placement of midpoint tones was inaccurate and consistently delayed toward the endpoint locations. When human action sequences were replaced with sequences of colored images (Study 2), this response pattern disappeared, suggesting that meaningful differences in the placement of endpoints and midpoints within the action sequence—as opposed to the mere timing of the tones—generated the Study 1 findings. Together, these results suggest that completion points of intentions define units in adults' parsing of behavior.

(570)

**Combining Illusory Effects of Horizontal-Vertical and Müller-Lyer Illusions.** FLORENTINO BLANCO, DAVID TRAVIESO, MARTA CASLA, & JUAN BOTELLA, *Universidad Autónoma de Madrid* (sponsored by Juan Botella)—The illusory effects of two new combinations of the horizontal-vertical (HV) and Müller-Lyer (ML) illusions are measured and compared. Three figures are considered: (1) an inverted T-shaped figure, (2) combination A—the illusory effects are added by including the outgoing angles of ML illusion in the vertical segment of the HV and the ingoing angles in the horizontal segment, and (3) combination B—the effects are subtracted by placing the arrows opposite to combination A. The figures were presented in two formats: (1) a static format in which the subjects were asked to decide whether the vertical segment was longer, shorter, or the same as the horizontal segment, and (2) a dynamic format in which the subjects were asked to match the size of both segments by enlarging or diminishing the vertical segment (presented in two different lengths). Results show significant interactions between both classical illusions in the expected direction.

(571)

**Relative Mislocalization of Briefly Presented Stimuli.** JOCHEN MÜSSELER, *Max Planck Institute for Psychological Research, Munich*, & A. H. C. VAN DER HEIJDEN, *University of Leiden*—The ability to localize flashed stimuli is studied with a relative judgment task. When observers are asked to localize the peripheral position of a target with respect to the midposition of a spatially extended comparison stimulus, they tend to judge the target as being more outer than the midposition of the comparison stimulus. Experiments revealed that this mislocalization emerges with both a bilateral and a unilateral presentation mode—with the latter mode, however, only if probe and comparison stimulus are presented in succession. Among other dependencies, the size of the mislocalization is influenced by the eccentricity of presentation and by figural features of the stimuli. The results are related to comparable tendencies observed in eye-movement behavior, and it is concluded that the system in charge of guiding saccadic eye movements is also the system that provides the metric in perceived visual space.

(572)

**Stimulus-Task Mapping in Interrupted Time Production.** CLAUDETTE FORTIN & JULIE CHAMPAGNE, *Université Laval*—We showed previously that breaks in time estimation, dur-

ing a time interval production, result in duration of produced intervals positively related to prebreak duration. This effect of break location was observed when interruptions in time estimation were marked by an interruption of a tone stimulus. In Experiment 1, the break location effect is shown not to be dependent on a compatible stimulus-task mapping, since it is obtained when interruptions in time estimation are marked by a tone presentation. In Experiment 2, compatible and incompatible stimulus-task mappings in interrupted time production are compared in a within-subjects design, with break periods marked either by an interruption or a presentation of a tone. In addition to the break location effect, which is observed in both conditions, produced intervals are consistently longer when a tone is presented during the break than when it is interrupted.

(573)

**Action-Related Determinants of Spatial Coding in Perception and Memory.** LOTHAR KNUF, JÖRG GEHRKE, & BERNHARD HOMMEL, *Max Planck Institute for Psychological Research, Munich*—Our investigations explored the organization of spatial information in perception and memory. Participants first performed simple or complex actions toward configurations of objects (houses on a map) and then estimated the Euclidean distance between, and judged the relative position of, seen or memorized object pairs. Judgments were faster between objects associated with the same than with different actions, independent of their spatial relationship, whereas estimations were unaffected. The findings suggest a hierarchical, action-related organization of spatial information in perception and memory.

(574)

**Understanding Bias in Proportion Production.** TAKESHI TANAKA, JUSTIN G. HOLLANDS, & BRIAN P. DYRE, *University of Idaho*—Magnitude estimation and production are well-accepted methods for estimating Stevens's exponents to quantify human perceptual biases. However, estimated exponents from magnitude production often differ from those obtained through magnitude estimation. The family of power models (Hollands & Dyre, in press; Spence, 1990) can be used to estimate Stevens's exponents from proportion judgments, and the estimates should be less subject to the measurement bias seen in magnitude judgments. In this study, the power models were extended to proportion production and the stability of estimated exponents for this task was examined. Sixteen participants performed magnitude estimation, magnitude production, proportion estimation, and proportion production on stimulus dimensions of volume and color saturation. The results showed greater consistency for proportion judgments over magnitude judgments for volume (Stevens exponent less than unity). However, estimated exponents for color saturation judgments (exponent greater than unity) were inconsistent for both magnitude and proportion judgments.

(575)

**Psychological Research on the Web: Promise and Problems.** BEM P. ALLEN, *Western Illinois University*—Running psychology experiments on the Web is relatively new (e.g., the American Psychological Society's Psychological Research on the Net page has been available for only a few years). Three experiments are described with regard to attractiveness to Web participants, validity of results (do Web results replicate laboratory results?; are Web results consistent with theory?), and special problems (e.g., how do we know that participants have followed instructions?; how representative of people are "Web cruisers"?). One experiment is about "false memory" and the other two are about visual perception. Two of the experiments met the three criteria well, but a third never got off the ground, because few participated. The latter suggests that some kinds of research will not work well on the Web. It is concluded that, although some problems may be difficult to solve, Web research has a bright future.

## • SPEECH PERCEPTION •

(576)

**The Role of Dimorphism in Hearing Talker Sex From Brief Vowel Segments.** JO-ANNE BACHOROWSKI, *Vanderbilt University*, & MICHAEL J. OWREN, *Cornell University*—Even brief sounds can be richly informative about talker characteristics. Earlier acoustic analysis confirmed predictions that the best statistical classification of vowels by talker sex occurred using acoustic correlates of dimorphism in vocal-fold and vocal-tract lengths. In follow-up perceptual testing, 24 participants in Experiment 1 classified talker sex from 180 /e/ sounds that balanced fundamental frequency (*F*<sub>0</sub>) and estimated vocal tract length (VTL) cues. Responses were both accurate (98% correct) and fast (478 msec), but latencies were longer for high-*F*<sub>0</sub>/short-VTL male talkers and low-*F*<sub>0</sub>/long-VTL female talkers. In Experiment 2, 24 participants heard stimuli composed of small numbers of waveform cycles. Classification “threshold” was 1.8 cycles, with male talkers more accurately classified than females. Results show that indexical cuing is an inherent component of even the shortest possible vowel segments, and that biologically related acoustic cuing involved in talker-sex perception is fundamentally related to features also known to influence speech processing.

(577)

**Phonological Variation: Mapping From the Speech Signal to Lexical Representations.** PAUL LOCASTO & CYNTHIA M. CONNINE, *SUNY, Binghamton*—Processing of place assimilation variants and their baseword counterparts were investigated in a cross-modal repetition priming paradigm. Potential assimilation candidates (e.g., SHIN → SHIM) as well as pseudo-assimilated variants (e.g., ARM → ARN) were presented in isolation. Priming was observed for the baseword stimuli (repetition priming) but not for the assimilated or pseudo-assimilated counterparts. In a second experiment, we tested whether articulations of assimilated or pseudo-assimilated stimuli embedded in sentences differed in perceptibility of the final critical consonant as a function of their context of origin. Participants heard sentence fragments where the final syllable was an assimilation variant originally produced with a following context that did or did not license the assimilation. Identification and acceptability ratings of the final consonant will be presented.

(578)

**Residual Lexical Activity at Word Offset: Evidence From Pause and Click Detection.** SVEN MATTYS & JAMIE HERSLOW, *Johns Hopkins University*—This study explores the effect of lexical activity on two nonlinguistic tasks: pause and click detection. Short pauses [p] inserted in five-syllable-long spoken sequences were found to be detected more slowly after words (e.g., camper[p]ton•dee•lo) than after spliced nonwords (e.g., goomper[p]ton•dee•lo), whereas clicks were detected faster after words than nonwords. Moreover, the size of the inhibitory lexical effect on pause detection decreased as a function of both word length and lexical uniqueness, whereas the facilitatory lexical effect on click detection was not sensitive to either variable. The results provide on-line evidence for the sequential nature of speech processing. In addition, they suggest that lexical representations are activated automatically upon speech reception, even when no lexical processing is required. The contrastive patterns with pauses and clicks are interpreted in terms of the different impact that these two events have on word-offset residual lexical activity.

(579)

**Integration of Emotional Tone of Voice and Semantic Content in Spoken Word Recognition.** JENINIFER S. QUEEN & LYNNE C. NYGAARD, *Emory University*—Previous research has demonstrated that emotional tone of voice mediates lexical access early during spoken word recognition. The present study was designed to determine whether the influence of emotional tone of voice is similar to that of sentential context. A cross-modal priming task was used with auditory

single word primes and visual lexical decision targets. Primes included homophones with one affective meaning and one neutral meaning (e.g. *bridal/bridle, die/dye*) said in different emotional tones of voice (happy, sad). Each of the emotional homophones was paired with target words that were related to the emotional meaning, related to the neutral meaning, or unrelated to the stimulus word. The priming benefit for related targets depended not only on affective meaning, but also on tone of voice. This suggests that emotional tone of voice is integrated with semantic meaning early in the recognition of spoken words.

(580)

**Uniqueness Points in Prefixed English Words.** LEE H. WURM, *Wayne State University*—Wurm (1997) introduced a construct called the conditional root uniqueness point (CRUP), defined as the uniqueness point of the free root of a prefixed word, given the prefix in question. Prefixed words with free roots can be divided into two mutually exclusive categories: those with CRUPs equal to the full-form uniqueness point, and those with CRUPs that precede the full-form uniqueness point. The current study compares recognition performance for these two groups of prefixed words. Results indicate a substantial processing advantage for words with early CRUPs. Additional analyses will examine the effects of full-form and morpheme frequencies, prefix likelihood, and semantic transparency.

## • ATTENTION •

(581)

**Conjunction Only Benefits Found When Features Contribute Independently to a Decision: Implications for Object-Based Models.** LISA R. FOURNIER, RHONDA J. HERBERT, & CARRIE FARRIS, *Washington State University*—In contrast to earlier research, we showed that discriminating the *presence* of feature conjunctions is faster than discriminating the presence of the less discriminable feature alone (conjunction benefits, CBs). An asynchronous priming model can account for CBs and assumes the following: Each task-relevant dimension *independently* primes its task-relevant response, easily discriminated features prime responses *earlier* than less discriminable features, and priming by different features is *combined* to meet a decision criterion. Thus, CBs result from early priming by the more discriminable features that is combined with priming by the less discriminable features. The model predicts that CBs occur *only* if each task-relevant dimension *independently* contributes to the decision. CBs should not occur if priming by a *single* feature is contingent on the presence of another. We show that the lack of CBs found in earlier research is due to this feature contingency. Relevance of these findings for object-based attention models is discussed.

(582)

**Attention Shifting and Attentional Dwelling in the Attentional Blink.** ADDIE EHRENSTEIN, *Utrecht University*—Breitmeyer, Ehrenstein, Pritchard, Hiscock, and Crisan (in press) found that detection of a second target (T2) in a rapid serial visual presentation paradigm with multiple targets was better when T2 occurred in the same position as the first target (T1) than when it did not. The present work systematically explored the effect of target and distractor position on performance. The basic message is clear: Identification of T2 is enhanced when T2 occurs in the same position as T1, and is hurt when the distractors are in the same position as T1. The absence of any interactions between T2 position and distractor positions suggests that the enhancement of performance due to shared target position is independent of the performance costs due to distractors appearing in the T1 position. An account is offered in terms of separate effects of attention shifting (an active process) and attentional dwelling (a passive process).

(583)

**Trainability of Task-Switching Skill.** PRITI SHAH & HOLLY YETMAN, *University of Memphis*, & AKIRA MIYAKE, *University*

*of Colorado*—The ability to rapidly switch back and forth between different tasks is an important part of an executive control system. This research addresses whether this ability can be improved through brief, focused training of task-switching skills. A training group performed tasks that required rapidly switching between two speeded component tasks (e.g., judging whether a number is >50 or <50 or whether it is odd or even). A control group performed a variety of speeded perceptual judgment tasks. The training group showed improved task-switching skill compared with the control group on transfer tasks that required switching between novel subcomponent tasks. In a second study, we are examining whether improvement transfers to complex cognitive tasks that presumably involve task-switching skill such as the Wisconsin Card Sorting Task. These studies demonstrate that executive skills can be improved through training and may lead to effective interventions for those with executive control impairments.

(584)

**Determinants of the Color–Word Similarity Effect in Stroop Interference.** DALE S. KLOPFER, *Bowling Green State University*—Previous work has shown that there is more Stroop interference when the word and its color are similar (e.g., YELLOW in orange) than when they are not (e.g., YELLOW in blue). Using (1) manual instead of oral responses, (2) colors that are color mixtures (brown, purple, orange, turquoise) rather than primary colors, and (3) words that did not overlap with names of the colors (RED, GREEN, YELLOW, BLUE), the relationship between color–word similarity and amount of interference vanished. The overall level of interference was markedly reduced despite using a high proportion of neutral control words (CAT, HORSE, DONKEY, WOLF), contrary to what Tzelgov, Henik, and Berger (1992) found. Results of other studies using variations on the above conditions are presented, and implications for the color–word similarity effect are discussed.

(585)

**Level of Cross-Modal Interactions: Evidence With 3-D Paradigms and Similarity-Judgment Tasks.** ELISHEVA BEN-ARTZI, *Bar-Ilan University*—A series of experiments examined the level of cross-modal interactions among perceptual dimensions by means of 3-D speeded-classification tasks, magnitude estimation, and similarity judgments. In speeded classification, participants classified 3-D stimuli according to their values on one dimension (e.g., size of a rectangle), while either one irrelevant dimension (e.g., brightness and pitch) was held constant and the other varied orthogonally, both irrelevant dimensions were held constant, or both irrelevant dimensions varied orthogonally. In general, Garner interference and congruence effects were greater between the visual dimensions than between either visual dimension and the auditory one. In addition, when the two irrelevant dimensions were of different modalities (i.e., pitch-size; pitch-brightness), an additive multidimensional model accounted well for the pattern of both Garner interference and congruence effects, suggesting an elaborated processing of irrelevant information. The second series of experiments presented multivalued cross-modal dimensions for which participants made magnitude estimation and similarity judgments.

(586)

**Inhibition of Return for Target-Directed Responses Versus Abstract Target–Response Mappings.** KEVIN A. BRIAND & SHAMINA KHATOON, *Rutgers University*, & ANNE B. SERENO, *University of Texas, Houston*—We previously reported that saccadic responses to visual targets developed IOR at shorter SOAs than did manual responses. This finding is revisited here in tasks requiring subjects to either respond directly (e.g., prosaccade or reaching) or indirectly to targets (e.g., keypress). Responses directed toward stimuli developed IOR sooner than responses that only abstractly mapped onto target position. This suggests an alternative to our explanation for our previous finding, and further constrains models of spatial attention.

(587)

**Is There More to Negative Priming Than Meets the Eye? Explorations in Audition.** MARK SCHMUCKLER, STEVE JOORDENS, & YOLANDA YUEN, *University of Toronto*—Many studies have demonstrated negative priming using visual stimuli, but very few have reported similar effects in audition. Across a number of experiments, we examine auditory negative priming and compare it with its visual analogue. Our results show that although auditory negative-priming effects are relatively weak when tradition procedures are used, they become very strong—even stronger than visual effects—when participants are forced to make relative judgments (e.g., MacDonald, Joordens, & Seergobin, 1999). The implications of these results for theories of negative priming are discussed, as are issues related to potential differences with respect to memory and attention across the visual and auditory modalities.

(588)

**Spatial Modulation of Repetition Blindness and Repetition Deafness.** SALVADOR SOTO I FARACO, *Barcelona University*, & CHARLES JASON SPENCE, *Oxford University*—Previous studies suggest that spatial displacement has no effect on repetition blindness (RB). However, experiments involving dichotic presentation of repeated syllables (Soto-Faraco, in press) indicate that repetition deafness (RD) is significantly greater in across-ear as compared with within-ear presentations. We hypothesized that besides the change of modality, two critical factors underlie this discrepancy: The predictability of C2 location in previous studies (Hochhaus & Mahron, 1991; Kanwisher & Potter, 1989) and the lack of comparison between same- versus different-position repetitions (Luo & Caramazza, 1995). We presented pairs of numbers auditorily (Experiment 1), or pairs of letters visually from various spatial displacements (Experiments 2 and 3). Larger RD and RB effects were reported when the stimuli were presented from different positions, rather than from the same position, although this effect was not modulated by distance (consistent with Luo & Caramazza, 1995). Therefore, both RB and RD are modulated by spatial displacement.

(589)

**Attenuation of the Attentional Blink With Motivationally Salient Stimuli.** PAUL HAERICH, AMY D. CLEGG, & STEPHEN R. NITCH, *Loma Linda University*—Previously we reported data which indicated that the attentional blink could be attenuated by a motivationally salient stimulus. Now we report data from two additional experiments that support our previous conclusions and address some questions raised in the earlier study. Subjects were presented with a stream of nonword letter-string stimuli in rapid serial visual presentation format in which two target stimuli were included. The first target was always a high-frequency affectively neutral word. The second target was either a word, varying in affective valence from trial to trial, or a nonword. After identifying the first target, subjects either identified the second target (always a word in one experiment) or made a non-speeded lexical decision (in the other experiment). In both experiments, the performance decrement on the second target following a correct first target identification was lessened when the second target was a motivationally salient, in comparison with a high-frequency neutral, word.

(590)

**A Global–Local Stroop Task.** CHRISTOPHER J. KOCH, JUSTIN MANGLES DORE, & TRISTAN NICHOLAS, *George Fox University*—Colors and words are combined in the Stroop task to make color congruent and incongruent stimuli. RTs for color naming are faster for congruent stimuli than for incongruent stimuli. Similarly, in a hierarchical recognition task, global letters are composed of smaller letters (e.g., an I composed of Hs) with faster RTs for congruent stimuli. The present study combines these tasks to examine Stroop processing. In Experiment 1, typical color-word stimuli were presented. Stroop interference was found. In Experiment 2, the color-word stimuli were

made of letters composed of blocks. Subjects were cued before each trial to name either the global (i.e., word) or local (i.e., color blocks) stimulus. Stroop interference was found. In addition, local stimuli were processed faster than global stimuli. The results suggest that Stroop interference may occur at the response phase, but that color information may be available faster in the process than has previously been assumed.

(591)

**Automatic Allocation of Attention to Negative Emotion Stimuli.** CLARK G. OHNESORGE, *Gustavus Adolphus College*—The emotional valence evoked by stimuli (usually visually presented) has been shown to influence performance across a wide range of cognitive and perceptual tasks. Generally the concept of attention is invoked in developing theoretical explanations for this phenomenon, with a conclusion that negative stimuli attract or receive more attention than do positive or neutral stimuli. Three studies are presented that trace the dynamic unfolding of an attentional channel following the presentation of emotionally valenced lexical stimuli. The data from our low-level visual task reveal that in this context the attentional enhancement effect occurs within a relatively tightly focused region of space formerly occupied by the emotion-eliciting stimulus. Consistent with previous results we find evidence for increased allocation of attention to negative, but not to neutral or positive, stimuli.

(592)

**Familiarity and Eye Movements in Visual Search.** HAROLD H. GREENE, *University of Detroit Mercy*, & KEITH RAYNER, *University of Massachusetts, Amherst*—Studies have shown with manual reaction times (MRTs) that distractor familiarity (not target familiarity) facilitates visual search. We evaluated MRTs and eye movements in visual search as a function of distractor/target familiarity. In an unfamiliar distractor (UD) condition, a target letter Y appeared among a uniform set of nonsense elements. In a familiar distractor (FD) condition, the nonsense element appeared among distractor Ys. As expected, MRTs were faster for the FD condition. Facilitation, as indicated by eye movements, occurred in the form of fewer fixations during the FD condition. Fixation duration was not systematically different in the search conditions. Thus, for visual search, a yes/no decision (“is this the target?”) may suffice to initiate an eye movement, and fixation (i.e., attention) is drawn to unfamiliar elements among familiar uniform clutter.

• JUDGMENT/DECISION MAKING •

(593)

**Judgment Certainty Using Forced-Choice and Subjective Probability Scales.** LAURA T. FLANNELLY, *University of Hawaii*, & KEVIN J. FLANNELLY & MALCOLM S. McLEOD, *Center for Psychosocial Research* (sponsored by Kevin J. Flannelly)—Random samples of registered voters were asked two questions during telephone surveys conducted 1, 2, or 4 weeks before an election: (1) For which candidate would you vote if the election was held today? (2) How likely are you to vote for each candidate on election day? People’s certainty that they would vote for the same candidate on election day that they would vote for “today” increased linearly as the time between the survey and the election decreased. People’s subjective probabilities of voting for each candidate on election day (using a 0%–100% scale) were complementary in two-candidate elections, but exceeded 100% in elections with three or four candidates. The results demonstrate a source of error in election polls using forced-choice questions about candidate choice that is unrelated to sampling error. The ability of people to use subjective probability scales to express their certainty of future, real-world decisions is discussed.

(594)

**The Role of Categorization in Determining Context Effects in Judgment.** JONATHAN C. PETTIBONE & DOUGLAS H. WEDELL,

*University of South Carolina* (sponsored by Douglas H. Wedell)—Participants learned to associate names with computer-generated schematic faces drawn from one of two overlapping groups. The leprechaun group consisted mostly of faces with narrow features, and the gnome group consisted mostly of faces with wide features. After the learning phase, participants judged the width of features and the pleasantness of faces on the basis of either direct reexposure to the face or retrieval from memory using name cues. For both descriptive and preference judgments, effects of the category contexts were smaller when faces were presented visually for judgment than when faces were retrieved from memory. Descriptive ratings of width showed contrast effects relative to the two category contexts when made prior to pleasantness ratings, but they showed assimilation effects when made after pleasantness ratings. Results were discussed in terms of the roles of affect and ideal point processing in the use of categorical contexts.

(595)

**Memory Representation in Multiattribute Choice.** STUART M. SENTER & DOUGLAS H. WEDELL, *University of South Carolina*—Senter and Wedell (1999) reported evidence that there was an accuracy advantage in choice of dimensionwise access over alternative-wise access over and above that due to strategy differences. The current experiments explore whether this advantage might be due to differences in memory representation. Participants were required to view sets of four apartments described on four dimensions in one of two sequences, alternatively or dimensionwise. They subsequently recalled a subset of the apartment information, either the four dimensions for a single alternative (alternatively probe) or the values of a single dimension for the four alternatives (dimensionwise probe). Consistent with the encoding specificity principle, dimensionwise participants better recalled dimensionwise probes and alternatively participants better recalled alternatively probes. Overall, there was a weak memory accuracy advantage for dimensionwise participants. These results from memory were used to interpret choice differences across presentation sequences.

(596)

**A Hyperbola-Like Model of Temporal Discounting Describes Choice Between Rewards Available at Different Delays.** LEONARD GREEN & JOEL MYERSON, *Washington University*—Twenty-four undergraduates made choices between two delayed rewards, one available sooner and the other available later. The amount of the reward available after the briefer delay was adjusted until it was judged equal in value to the larger, more delayed reward. A hyperbola-like model,  $\text{value} = 1/(1+k*\text{delay})^s$ , accurately described the decrease in the value of the more delayed reward as the delay until its receipt was increased. The discounting rate parameter,  $k$ , decreased systematically as the delay to the sooner reward increased. These results are contrary to the hypothesis that subjects simply respond to the difference between the delays to the sooner and later rewards. However, an interpretation of the hyperbola-like model that views subjects as choosing between two rates of reward does predict this decrease in discounting rate.

(597)

**Correlates of Effective Real-Life Decision Making.** KATHLEEN M. GALOTTI, *Carleton College*—Undergraduate students were asked to describe the most important decision they had made within the last year, the resources they had consulted to make that decision, the factors/criteria they had used, and the importance they had given to each of those factors/criteria, and the number of alternatives they had considered. Participants also rated their decision making on a number of descriptive and affective rating scales, and filled out a planning inventory and an inventory of thinking styles. Results showed that students who report themselves to be good planners were significantly more certain they had made the right decision, more comfortable with the process, more satisfied with the information they had gathered,

and more likely to make their decision on the basis of their overall values or principles.

(598)

**Relational Complexity in the Judgment of Events.** ALAN SANFEY & REID HASTIE, *University of Colorado, Boulder*—A fundamental question regarding judgments of the probabilities of experienced events is whether absolute or relative frequencies are used when judging the likelihood of a particular occurrence. The goal of this research is to explicate the conditions under which people rely on remembered-event raw frequencies versus inferred-event relative frequencies (proportions) when making predictions of outcomes. Most theorists have proposed either/or hypotheses; that people either exclusively rely on absolute frequencies or exclusively rely on relative frequencies. But, we believe that adults are flexible in this regard. Our experiments demonstrate that as the “relational complexity” of the relevant stimuli increases, the tendency to rely on absolute as opposed to relative frequency also increases.

(599)

**Faster Learning of Casual Interactions When Causes Are Presented Serially.** MICHAEL E. YOUNG, EDWARD A. WASSERMAN, & KARA L. DIERKING, *University of Iowa*—The temporal relations among candidate causes were manipulated in a causal learning task using an ambiguous occasion setting design. One of the causal events, the positive conditional cause, was immediately followed by the effect only on trials in which another causal event, the occasion setter, was also present. Another of the causal events, the negative conditional cause, was immediately followed by the effect only on trials in which the occasion setter was absent. When the events were presented serially (the occasion setter preceding the conditional causes), participants learned the efficacy of the occasion setting compounds at least as quickly as the efficacy of the conditional causes. When the events were presented simultaneously (the occasion setter and the conditional causes were contemporaneous), participants learned the efficacy of the compounds more slowly than the efficacy of the conditional causes.

(600)

**Use of Base Rate Information and Perceived Similarity in Surrogate Medical Decision Making.** ANGELA FAGERLIN & JOSEPH H. DANKS, *Kent State University*, RENATE M. HOUTS, *University of North Carolina*, PETER H. DITTO, *University of California, Irvine*, & WILLIAM D. SMUCKER, *Summa Health System*—When surrogates make medical decisions on behalf of incompetent patients, they often base decisions on their own treatment preferences. One possible reason for surrogates’ projection is that they believe their own preferences reflect the preferences of the majority (i.e., the base rate) and, hence, will reflect the patients’ preferences. Our results indicate, however, that surrogates’ perception of the similarity of their preferences to the base rate was not related to their use of projection during decision making. Another possible reason is that surrogates may believe their preferences to be similar to the patients’ and thus are a useful guide to predicting the patients’ preferences. In fact, surrogates’ perception of the similarity of their preferences to the patients’ predicted surrogate projection. If the surrogates’ preferences are similar to either the base rate or the patients’ preferences, the use of projection may be a rational decision-making strategy. However, this perception did not improve the accuracy of their decisions.

(601)

**Reaction Times and Hypothetical Life and Death Dilemmas.** PATRICIA E. O’NEILL, JAMIE NEAL, & BRAD STROWD, *University of Mississippi*—We have identified dimensions that are important in the resolution of hypothetical life and death moral dilemmas. We have also argued that these dimensions reflect an evolved human nature. A series of hypothetical life and death dilemmas was presented in either a standard survey format, or in a reaction time task.

The reaction time task varies from the standard survey format in that it is a speeded task and participants are forced to choose between two individuals or two sets of individuals. In the survey, participants rated agreement/disagreement with each outcome. For the reaction time task, individuals were instructed to press a button indicating which individual presented on the screen they would save. Mean reaction times for the dimensions of interest were negatively correlated with mean approval rating, while choice frequency was positively correlated with mean approval rating. These results provide further support for the universality of these dimensions.

(602)

**Predictive and Diagnostic Learning: Is One More Fundamental Than the Other?** MARC J. BUEHNER, *University of Sheffield*, & JOSEF KREMS, *University of Technology, Chemnitz*—People often fail to distinguish diagnostic from predictive conditional probabilities (Tversky & Kahnemann, 1980). We investigated how predictive and diagnostic reasoning is influenced by context and learning direction. Participants studied two alternative causes ( $c_1$  and  $c_2$ ) and one effect ( $e$ ) in a sequential learning paradigm. The task was structured such that  $c_1$  always produced  $e$ ,  $c_2$  produced  $e$  50% of the time, and  $P(e|c_1) > P(e|c_2)$  but  $P(c_1|e) < P(c_2|e)$ . Cover stories provided predictive, diagnostic, or neutral contexts. We also manipulated learning direction (cause to effect vs. effect to cause) and task demands (passive attending vs. trial-by-trial predictions). Context did not influence either judgment. Predictive judgments were biased when learning was diagnostic, especially in the high task demand condition. Diagnostic judgments were largely unaffected by all three factors. We speculate that biases in conditional reasoning are determined by attentional focus on predictive or diagnostic aspects of the causal structure during learning.

• COMPREHENSION/REASONING •

(603)

**The Measurement of Knowledge Integration by Item Response Theory.** SALVADOR ALGARABEL, EVA ROSA, & MANUEL PEREA, *Universidad de Valencia*—We present an experiment in which three groups of university students are exposed differently to knowledge of experimental design. Previously, all students had attended a theory course of statistical concepts related to the analysis of experiments. Afterward, the first group completed applied exercises of design on real published papers. A second group carried out the same type of exercises but at a theoretical level, and the third group engaged in the same types of exercises but formulated in a numerical manner. We presented a set of concepts and asked the students to rate the degree of relationship among them. We used a generalized partial credit model to estimate the ability of subjects. An analysis of a posteriori distributions showed the superiority of the first group, but only when they had to assess concepts coming from actual published studies.

(604)

**The Cortical Bases of Strategy and Skill in Sentence–Picture Verification.** ERIK D. REICHLE, MARCEL ADAM JUST, & PATRICIA A. CARPENTER, *Carnegie Mellon University*—Functional magnetic resonance imaging (fMRI) was used to examine the relation between individual differences in cognitive skill and the amount of cortical activation engendered by two strategies (linguistic vs. visual–spatial) in a sentence–picture verification task. The verbal strategy produced more activation in language-related cortical regions (e.g., Broca’s area), whereas the visual–spatial strategy produced more activation in regions that have been implicated in visual–spatial reasoning (e.g., parietal cortex). These relationships were also modulated by psychometrically assessed cognitive skill: Individuals with better verbal skill showed less activation in Broca’s area when they used the verbal strategy, whereas individuals with better visual–spatial skill showed less activation in the left parietal cortex when they used the visual–spatial strategy. These results indicate that language and visual–

spatial processing are supported by partially separable networks of cortical regions, and suggests that strategies may be used to minimize the cognitive workload imposed by task demands.

(605)

**The Effect of Causal Directionality and Question Type on Cue Association.** FERNE J. FRIEDMAN-BERG & ARNOLD D. WELL, *University of Massachusetts, Amherst*—We investigated differences between “diagnostic” learning tasks in which cues were interpretable as effects (E) and outcomes as their causes (C), and tasks in which the cues were interpretable as causes and outcomes as their effects. Cover stories were created such that with very similar wordings, the same features could take on the roles of either causes or effects. In each block of trials, participants first completed learning trials in which they categorized patterns of cues, then estimated the conditional probabilities  $p(\text{outcome}|\text{cue})$ ,  $p(\text{cue}|\text{outcome})$ , or answered causal questions. Finally, they were given test trials in which novel patterns of cues were presented without feedback. Results indicated strong systematic differences depending on both the type of question and the direction of causality in learning. Also, base rate information was used appropriately in both kinds of tasks.

• HUMAN LEARNING/MEMORY •

(606)

**Effective Real-World Learning Techniques for Acquiring Semantic Knowledge.** L. MARK CARRIER & LASHAUNE THOMAS, *California State University, Dominguez Hills*—How do people learn health-related information? People’s semantic knowledge about HIV/AIDS and source memories for that information were examined using a true/false knowledge test and a cued-recall source memory test. The cues were possible sources of health-related information (brochures/pamphlets, health class, HIV/AIDS class, television, friends) about which participants recalled dates, times, and locations. Television and health class were most frequently recalled. However, participants remembered few details of learning via television, suggesting they inferred television as a source. Participants remembered more details about learning via health class. A HIV/AIDS class was the most effective learning technique when taking into account semantic memory.

(607)

**False Memories and the Semantic Differential Dimensions of Evaluation and Activity.** JAMES P. JAMES, *Western Illinois University*—Many of the previous studies of false memories have presented very specific lists of highly associated words, such as sleep- or needle-related words. False recall or false recognition is then defined as intrusions of the nonpresented critical associates (i.e., “sleep” or “needle”) of these presented list items. In the present research, word lists were constructed according to more general dimensions of meaning: semantic differential ratings of pleasantness–unpleasantness and activity–passivity (Heise, 1965). Participants saw lists of words high in pleasantness and activity and then were given recognition tests of nonpresented words varying along the pleasantness–unpleasantness and activity–passivity dimensions. The highest frequencies of false memories were found with nonpresented words that were most similar in pleasantness and activity to the presented list words. The results are discussed in terms of Underwood’s implicit response hypothesis, the “gist” notion, and other theories.

(608)

**Improved Recall Following Unfilled Waiting Period in Reading Span Test.** MATTHEW A. RASHOTTE & GARY L. ALLEN, *University of South Carolina*—A series of experiments showed that inserting an unfilled delay of 30 sec between the final mandatory processing portion in each trial of the reading span test (reading the last sentence in a set) and the cue to recall improved recall scores in comparison with a condition in which no delay was required. Participants

reported that, during the unfilled delay period, they were frequently rehearsing the to-be-remembered words. Improvement was related to fewer within-list errors of commission at recall, suggesting that at least part of the reason for improved recall in the delay condition was an enhanced ability to distinguish the information to be remembered in the current trial from the information to be remembered in previous trials.

(609)

**What Happens to Environment Knowledge Over Time?** M. JEANNE SHOLL, *Boston College*—The present study explores the retention and retrieval of environment knowledge over time. Environment knowledge is defined as survey knowledge of a physical environment large enough in scale so that it cannot be seen in its entirety from a single location, but small enough in scale so that it can be navigated by foot. In this study, the test environment was a satellite campus of Boston College, the Newton Campus, which contains freshman residence halls and the law school. One group of current residents and two groups of former residents—for one group, there was a 1-year interval between residency and test and, for the other group, there was a 2- to 3-year interval—were tested in a point-to-unseen-targets task. The findings are discussed in terms of the frames of reference used at retrieval and the accuracy with which interlandmark relations are retained over time.

(610)

**Distribution of Working Memory Resources and Strategy Instruction.** KANDI JO TURLEY-AMES & MICHELLE M. WHITFIELD, *Idaho State University*—The use of rehearsal, imagery, and semantic strategies on a working memory (WM) operation span test was assessed under conditions in which time spent on the processing and storage components of the task was controlled. Participants completed two operation span tests in a pre/posttest fashion. To control distribution of WM resources, participants were given an equivalent amount of time to engage in the processing and storage component of the span test. Prior to the second operation span test, participants received either one of three strategy instructions or no strategy instruction. Performance on the operation span test differed as a function of WM capacity and strategy instruction. Correlations between measures of WM span and reading comprehension based on type of strategy instruction are reported.

(611)

**Gaze Aversion: Benefits Extend to Encoding and Older Adults.** GILLES O. EINSTEIN & HEATHER M. COLLINS, *Furman University*, & JULIE L. EARLES, *Florida Atlantic University*—Recent research has shown that people tend to look away from distraction or close their eyes during retrieval and that there are retrieval benefits from averting one’s gaze. We examined whether the benefits of gaze aversion extend to encoding and the extent to which there are age-related differences in the benefits of gaze aversion. Relative to looking at complex stimuli, closing the eyes and looking at simple stimuli produced small but reliable improvements in memory for younger and older adults at both encoding and retrieval. Contrary to what might be expected from current theorizing, the benefits of gaze aversion were similar at encoding and retrieval and for younger and older adults.

(612)

**Misattributing Thoughts to Perception: The Role of Source Errors in Creating False Memories.** ELIZABETH J. MARSH & GORDON H. BOWER, *Stanford University*—The Deese/Roediger-McDermott (DRM) paradigm creates false memories of a critical word by first having participants study a list of related words (e.g., “table, sitting, bench ...”); participants are later very likely to report having studied the centrally related nonpresented lure (e.g., “chair”). One explanation is that participants covertly call to mind the critical nonpresented lure during the study phase, and later misattribute memory of this in-

ternally generated event to its external presentation. To investigate this, we modified the DRM paradigm and collected on-line thoughts during the study phase. Probability of false recognition increased with the number of times a lure was generated during study. Moreover, the high false alarm rates caused by several manipulations (e.g., list length, group differences) were partly explained by how often the critical lure was generated during the study phase.

(613)

**Similarity Does Not Increase Proactive Interference.** DANIEL J. BURNS, SARI LEIVENT, & AMY GERSTEN, *Union College*—A commonly accepted view among memory researchers is that proactive interference (PI) is affected by the similarity between the prior and target material. A review of the literature, however, revealed little evidence either for or against this view when memory was tested with a free-recall test. The experiments reported here show that neither categorical similarity or processing similarity increased PI in free recall. In fact, in one experiment categorically similar lists produced less interference than dissimilar lists. These surprising results suggest that most previous explanations of PI are inadequate.

(614)

**Encoding Specificity Affects Monitoring and Report Bias, but Not Retrieval.** PHIL A. HIGHAM, *University of Northern British Columbia*—Performance on tests where there is control over reporting (e.g., cued recall with the option to withhold responses) can be characterized by three underlying components (Koriat & Goldsmith, 1996): retrieval (proportion of potential responses that would be correct if reported), monitoring (discrimination between correct and incorrect potential responses), and report bias (willingness to report responses). Typically, researchers do not examine all these components in cued test performance. At best, bias effects and monitoring are eliminated by forcing responding to every trial, allowing for a pure measure of retrieval. At worst, blanks are counted the same as errors, meaning that cued test performance is a mixture of bias, monitoring, and retrieval. In this research, a two-stage testing procedure is described that allows measures of retrieval, monitoring, and bias to be derived from the original encoding specificity experiments (Thomson & Tulving, 1970). The results show that encoding specificity affects monitoring and bias, but not retrieval.

(615)

**The Functional Role of Inhibitory Processes in Retrieval: Evidence From a Parametric Study of Retrieval-Induced Forgetting.** G. SHIVDE, MICHAEL C. ANDERSON, & D. L. HINTZMAN, *University of Oregon*—Two experiments examined whether the inhibitory process underlying retrieval-induced forgetting (1) is specific to recall, and (2) functions to resolve interference. Subjects encoded homographs with words related to their dominant (*Arm-Shoulder*) and subordinate meanings (*Arm-Missile*). The subordinate associate was then given retrieval practice (*Arm M\_\_\_?*) or extra exposures 0, 1, 5, or 20 times, to examine whether the later recall of the dominant associate would be impaired. Retrieval practice impaired the final recall of this associate, with additional practices increasing impairment. This pattern occurred regardless of whether the dominant meaning was tested with the homograph (*Arm S\_\_\_*) or an independent cue (*Bag S\_\_\_*). Importantly, no inhibition was found when subjects merely got repeated exposures of the subordinate associate. Experiment 2 showed that practicing the dominant meaning does not inhibit the less interfering subordinate meaning. Together, these findings argue for the existence of a recall-specific interference-dependent inhibitory process subserving retrieval.

(616)

**Measuring Memory Control.** MICHAEL J. WATKINS & LANCE C. BLOOM, *Rice University*—A selectivity index is described for assessing the sensitivity of memory to worth. For the partial memory of a set of items of variable worth, the index will tend to 0.0 when worth

is disregarded and will be 1.0 when each remembered item is worth as much or more than each forgotten item. Use of the index is illustrated in a series of free-recall experiments in which words are arbitrarily assigned point values, the subjects' task being to maximize the value of their recall. For the most part, selectivity proved to be in the moderated range (e.g., Experiment 1). As expected, selectivity increased with value variability (Experiment 2) and was greater when the items were shown simultaneously instead of sequentially (Experiment 3). Surprisingly, selectivity did not increase with study time (Experiments 4–6). Although in evidence at all positions, selectivity often waned at the end of the list.

(617)

**Practice Effects on Two Memory Retrievals From a Single Cue.** RANDALL S. NINO & TIMOTHY C. RICKARD, *University of California, San Diego*—Two experiments investigated the effects of practice on the memory retrieval bottleneck. In Experiment 1, subjects were given practice retrieving a vocal response and a keypress response for each of 10 visually presented words. In a subsequent test phase, blocks of these two tasks were interleaved with dual task blocks in which both the vocal and digit responses were made on each trial. The dual task results indicate that a retrieval bottleneck is present even after individual tasks are highly overlearned. In Experiment 2, subjects practiced both the individual and dual tasks extensively. The dual task data again support a persistent retrieval bottleneck, but they also suggest that practice on the dual task may allow some subjects to chunk the two responses into a single retrieval event. This chunking only appears to occur, however, for subjects who adopt a strategy of synchronizing their response output.

(618)

**Efficiency in Learning a Foreign Language.** CHIZUKO IZAWA, SALLY MAXWELL, & ROBERT G. HAYDEN, *Tulane University*—Izawa's study-test-rest (S-T-r) presentation program hypothesis (1993a, 1993b, 1999, in press) posits that learning and retention are a function of (1) programming study (S), test (T), and rest (r) events, (2) repetition method used, and (3) learning difficulty. The said hypothesis was examined via learning German under those four conditions, while holding total time constant. Conditions 1 and 2 utilized the list-repetition program, Conditions 3 and 4 employed item-repetition and S/T alternation programs, respectively. The presentation rates for Conditions 1 and 2–4 were 1 and 3 sec, respectively. Forty non-German-speaking undergraduates participated, 10 per condition, who learned a list of 10 German-English paired associates. Current natural language learning data supported the S-T-r hypothesis in a manner comparable to Izawa's (in press) data from nonsense syllable experiments. Large differences among conditions were found in both short-term acquisition and long-term retention data. S and T alternation conditions were the best overall.

(619)

**Suppression Mechanisms in Visuospatial Working Memory.** CESARE CORNOLDI, ROSSANA DE BENI, PAOLA PALLADINO, FRANCESCA PAZZAGLIA, & TOMASO VECCHI, *University of Padua*—Cornoldi and Vecchi recently (in press) argued that active verbal and visuospatial working memory processes are functionally independent but share common rules. It has been shown (De Beni et al., 1998) that the success in working memory tasks using verbal material is related to the ability of avoiding intrusion errors. The present research shows that similar, but not identical, failures in avoiding intrusion errors are related to the success in visuospatial working memory tasks. Different groups of subjects with low visuospatial working memory ability were submitted to tests requiring them to process series of visual elements and to remember only some of them. It was found that a lower performance to the test was associated to a higher number of intrusions due to the recall of processed, but not target, elements.

(620)

**Sequence Learning and Response Selection Processes: Effects of S–R Compatibility.** IRING KOCH, *Max Planck Institute for Psychological Research, Munich*—The aim of the present study was to investigate the effect of S–R compatibility on sequence learning. In Experiment 1, the type of stimuli (spatial vs. symbolic) as well as their mapping to the response keys was varied in a serial reaction task. RT data and explicit memory measures indicate more sequence learning with less compatible tasks. In Experiment 2, the response–stimulus interval was drastically shortened, but the effect of compatibility on learning persisted. This suggests that the effect is not based on time-consuming response preparation processes. Experiment 3 shows that the influence of irrelevant spatial information (Simon effect) is independent of sequence learning. Taken together, the data suggest that low S–R compatibility pronounces response selection processes. These processes entail frequent retrieval of S–R mappings, which presumably enhances the activation level of the to-be-associated sequence elements, thereby facilitating learning. This effect on the hypothesized learning mechanism seems insensitive to explicit knowledge.

(621)

**Can a Cue to Forget Influence False Memory?** DANIEL R. KIMBALL, ROBERT A. BJORK & TIMOTHY O'BRIEN, *UCLA*, AARON S. BENJAMIN, *University of Toronto*, & THOMAS MURRAY, *UCLA*—This study examines the effects of a cue to forget on recall of previously and subsequently studied information and especially on false recall of information associatively related to the studied information. Three groups of participants studied word lists consisting of the 15 strongest associates of a nonpresented target word (see Roediger & McDermott, 1995). The two experimental groups studied two lists and were cued between lists either to continue to remember or to forget List 1. A control group studied only List 2. Participants in all three groups recalled List 2 immediately after studying that list; participants in the experimental groups then recalled List 1. Results showed evidence of certain dissociations between recall of presented items and false recall of the nonpresented targets, further illuminating the conditions favoring, and processes underlying, false memory.

(622)

**Training With a Partner: Should Practice Schedules Match or Mismatch?** DOMINIC A. SIMON, *McMaster University*, & ROBERT A. BJORK, *UCLA*—Earlier work by Simon and Bjork (1998) showed that presenting a computerized model of a simple skill prior to each practice trial enhanced performance but hindered learning, as measured by performance 24 h later—a mismatching model had the opposite effects. In this experiment, the ability of a partner's practice to act like a model and cause similar benefits and costs to performance and learning, respectively, was assessed. Pairs of participants learned the same several response sequences on a number keypad. Partners alternated trials and either both practiced the same pattern in a given trial block, or each practiced different patterns. In acquisition, the *same* condition was more accurate, but an interaction between the *same* and *different* conditions across acquisition and retention suggested that the *different* condition benefited more from practice. Some measures of incidental memory for the tasks also favored greater learning for the *different* condition.

• RECOGNITION MEMORY •

(623)

**A Similarity Account of Featural Versus Binding Information Differences in Memory Tasks.** RAMESH S. BHATT, TAMEIKA TURNER, & EVELIN BERTIN, *University of Kentucky*—It is widely assumed that both features and binding relations among features form part of memory representations. However, features are thought to be remembered better than binding information. This is

based on the finding that performance is less accurate on recombination stimuli (that are miscombinations of features associated with different study items) than on new feature stimuli (that contain novel features) in memory tasks. However, recombination stimuli are more similar to the study stimuli than are new feature stimuli, and this could account for the difference. To examine this issue, we tested participants on new feature and recombination stimuli that were either equally or not equally similar to the study stimuli. Performance was poorer on recombination stimuli than on new feature stimuli only when there were similarity differences. These results support the similarity model and contradict the proposition that there are differences in memory between features and binding information.

(624)

**Mere Exposure to Facial Expressions Affects Emotional State and Memory.** EIKO SHIMOJO, *Bunkyo Women's University*, & BEENA KHURANA & SHINSUKE SHIMOJO, *California Institute of Technology*—Emotional state can be manipulated by role playing or mimicking facial expressions. Can mere exposure to happy versus sad faces modulate emotional state? Are happy versus sad faces remembered equally well under conditions of mere exposure? To judge the famousness of each face, participants were shown either one of two series of famous faces: Happy series—80% happy, 20% sad faces; Sad series—80% sad, 20% happy faces. Postexposure emotional state was measured using an adaptation of the Multiple Affect Adjective Checklist (MAAC). Participants who experienced the sad series registered greater sadness ( $p < .01$ ). No statistically significant difference was found for registered happiness. However, the happy faces were recognized more accurately than the sad faces, regardless of whether they were a majority or minority ( $p < .01$ ). Mere exposure to facial expression makes a larger difference in negative versus positive feelings, whereas recognition memory is better for happy faces.

(625)

**The Misinformation “Sleeper” Effect in Eyewitness Memory.** ROBERT KACHELSKI, KEVIN STEPHANS, SHAD MILLER, & LAURIE BENNETT, *Williams College*—The effect of blatant misinformation on participants' memory accuracy was investigated to determine whether an effect analogous to the “sleeper” effect in persuasion research also occurs in eyewitness memory. Participants viewed a slide sequence while simultaneously listening to an audiotaped narrative describing the sequence. The narrative was either one that contained obvious errors (suggestions) or a control narrative that contained no such suggestions. When tested immediately, participants who had received suggestions were as accurate at rejecting the suggested items as those who had not received suggestions. When these same groups of participants were tested three weeks later, they were much more likely to say that they saw the suggested items in the slides, but there was no difference between those who had actually received suggestions and those who had not. Apparently, on the second memory test, it was not the original misinformation that caused participants to believe that they had seen the items in the slides, but rather a sense of familiarity with the items obtained by virtue of their inclusion on the first memory test. There was little evidence of a “sleeper” effect in eyewitness memory.

(626)

**Conjunction Errors in Recognition Memory: Issues of Control.** TODD C. JONES, *Victoria University, Wellington*, & PAUL ATCHLEY, *University of Kansas*—In three experiments, participants were given a continuous recognition test for compound words (e.g., *checklist*, *blackmail*, *jailbird*). Some words were repeated (old), while others were recombined to form tricky lures (e.g., *blackbird*; conjunction lures). For all three experiments the lag between first and second presentations (old or conjunction words) was manipulated. Participants were expected to use a consciously controlled process (recollection)

to avoid conjunction errors at shorter better than longer lags. In Experiments 1 and 2, participants committed more conjunction errors at short than long lags. In Experiment 3, participants produced fewer conjunction errors for a zero- than a one-item lag, though errors for the zero-item lag were still substantial. Thus, at very short lags, recollection can be used to overcome the influence of familiarity underlying conjunction errors. The high error rate for the zero-lag condition may represent a form of change blindness.

(627)

**Recognizing Odors and Faces: The Effect of Typicality, Familiarity, Memorability, and Likableness.** DOMINIQUE VALENTIN, *Université de Bourgogne*, & CYNTHIA ARSENAULT, *University of Guelph*—This study investigates the effect of stimuli characteristics on people's episodic memory for odors and images. The stimuli were 26 artificial strawberry aromas and 40 images of American female faces. Twenty-three subjects were tested for recognition memory of 13 odors and 20 faces using standard yes/no recognition tasks. The following week they rated the typicality, memorability, familiarity, and likableness of all the odors and faces. The odor and face data were analyzed using multiple factor analysis (MFA). Results show that (1) memory performance for odors is lower than memory performance for faces, and (2) despite some differences in the patterns of relationships between stimuli characteristics and measures of recognition, both types of memory seem to be affected by the same factors. This qualitative similarity between olfactory and visual memory is at odds with the proposition that olfactory memory should be considered to be different from other types of memory systems.

(628)

**The Influence of Schematic Knowledge on the Subjective Experience of Recognition.** JASON L. HICKS & ROBERT J. NEMETH, *Louisiana State University*—The subjective experience accompanying recognition of common scripted activities (e.g., Bower, Black, & Turner, 1979) was investigated using the remember-know procedure developed by Tulving (1985). A narrative consisting of actions from eight unique scripts was presented to participants for a later recognition memory test. Consistent with prior research, studied items atypical of a script were discriminated very well from atypical lures, whereas studied items typical of a script were poorly discriminated from typical lures. The present results also demonstrate that the subjective experience of recollection as indexed by the remember-know procedure declined as the typicality of scripted actions increased. In contrast, the experience of knowing (recognition in the absence of recollection) increased with greater levels of typicality. These results begin to shed light on the contribution of schematic knowledge in episodic retrieval.

(629)

**Effects of Repetition on False Recognition: Dissociative Consequences of Aging and Time Pressure.** AARON S. BENJAMIN & FERGUS I. M. CRAIK, *University of Toronto*—Two experiments revealed dissociative effects of repetition on false recognition. Subjects studied word lists, in each of which all items were related to a single, unstudied associate (the *critical* item). Half of the lists were shown once and half three times. Under normal testing circumstances, young subjects falsely endorse *fewer* critical items associated with lists that had been presented multiple times than lists presented only once. However, young subjects tested under speeded conditions and elderly subjects endorsed a *greater* number of critical items associated with lists presented three times than from lists presented once. The results suggest dual bases for the recognition decision, one of which is based on the rapid spread of activation within domains of semantic similarity, and the other of which functions to attribute that activation to likely sources and set appropriate decision criteria. The latter capacity is compromised under conditions of time pressure and in the elderly.

## • PICTURE MEMORY/PROCESSING •

(630)

**Ventral and Dorsal Cortical Systems Collaborate During Visual Object Recognition.** VAIBHAV A. DIWADKAR, PATRICIA A. CARPENTER, & MARCEL ADAM JUST, *Carnegie Mellon University*—We demonstrate that shape-based visual object recognition emerges from collaboration between the ventral and dorsal cortical systems. Using 3.0T fMRI, we monitored the amount and time course of cortical activation as participants identified line drawings of common objects. Drawings differed in the amount of deleted contour. The condition in which more contour was deleted was expected to impose more visual demand and, hence, result in more fMRI-measured activation in task-relevant areas. Activation in both cortical systems increased above a resting baseline with increases in the level of deleted contour. Furthermore, the time series of voxels in the two cortical systems were highly correlated and the degree of correlation increased with the amount of imposed visual demand. The responses of both cortical systems and the degree of their collaboration provide a contrast to the hypothesis that associates visual recognition exclusively with the ventral cortical system.

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**The Coding of Categorical Relations in Scene Perception: Evidence From the Flicker Paradigm.** LUKE J. ROSIELLE, BRIAN T. CRABB, & ERIC E. COOPER, *Iowa State University*—If the positions of objects in a scene are coded categorically in memory (e.g., as “above,” “below,” or at the “side of” another object), it should be relatively easy to detect changes in scenes that disrupt these relations. In a flicker paradigm, participants viewed scenes in which an object appeared or disappeared, an object moved so that it changed its categorical relations to other objects in the scene (e.g., went from “above” another object to the “side of” another object), or an object moved yet retained the same categorical relations to other objects in the scene. The results indicated that it was more difficult to detect changes in scenes when the change did not disrupt the categorical relations of the objects within the scene.

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**The Cortical Focus of Explicit Visual Object Recognition.** MOSHE BAR, *Harvard University and MGH-NMR Center*, ROGER B. H. TOOTELL, *MGH-NMR Center*, DANIEL L. SCHACTER, *Harvard University*, & DOUG N. GREVE, JANINE D. MENDOLA, & ANDERS M. DALE, *MGH-NMR Center*—Imaging studies have already revealed several cortical regions related to object recognition, ranging from those involved in the analysis of basic visual information (e.g., contrast and orientation) to semantic areas. However, it is still unclear where conscious object recognition takes place. Subjects attempted to recognize pictures of objects that were presented very briefly, between two masks. Each picture appeared five times under these conditions (randomly intermixed with other objects), and one more time without the mask and for a longer duration. An event-related fMRI design allowed a post hoc comparison of cortical activity based on recognition performance. A ventrotemporal visual region was identified that is modulated by explicit object recognition. For the same visual input, this region was activated differently as a function of subjects' ability to identify the pictures. Possible generalization of these results, as well as insights regarding the flow of information in the visual cortex, will be discussed.

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**A Comparison of Conscious and Automatic Memory for Pictures and Words.** DAWN M. MCBRIDE, *Illinois State University*, & BARBARA ANNE DOSHER, *University of California, Irvine*—Three experiments were conducted to test the transfer-appropriate processing explanation of picture superiority using Jacoby's (1991) process dissociation procedure for stem completion, picture fragment completion, and category production tasks. Data were fit with multi-

nomial processing tree models to obtain estimates of conscious and automatic memory processes for the different tasks. Conscious estimates have been shown to indicate the influence of conceptual processing, while automatic estimates indicate the influence of perceptual processing. Given this, transfer-appropriate processing theory predicts that conscious estimates should be higher for pictures than words for all tasks, and that automatic estimates should depend on the type of perceptual processing required for the task. Results from model fits indicated that pictures had a conceptual processing advantage over words for all tasks. In addition, predicted patterns for perceptual processing were found based on task type. Results show support for a transfer-appropriate processing explanation of the picture superiority effect.

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**Empirical Evidence for Independent Shape and View Dimensions in 3-D Shape Perception.** BRIAN J. STANKIEWICZ, *University of Minnesota*—An important question in object recognition is: “What is the form of the memory representation that serves object recognition?” The current line of research asks whether the human visual system represents object shape using independent shape dimensions (i.e., a structured representation) or not. Using a noise-masking paradigm I investigated whether the human visual system processes different 3-D shape dimensions such as “aspect ratio” and “primary-axis” curvature independently of one another. The results strongly suggest that these shape dimensions are processed independently. Linear discriminant analysis on the pixel data suggests that these dimensions are not independent in pixel/image space. Results from a second experiment suggests that humans have a limited reservoir of shape dimensions available for recognition. Results from a third experiment suggest that the visual system encodes viewpoint information, but viewpoint information is coded independently of shape. These results strongly support the use of a structured representation of object shape serving 3-D object recognition.

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**An Eye-Movements Analysis of the Dynamic Processes in Constructing 3-D Mental Models.** GARY C.-W. SHYI, H.-H. CHUANG, & S.-T. TINA HUANG, *National Chung-Cheng University*—Participants were presented with 2-D orthographic projections of a 3-D object and were asked to imagine what the corresponding object would look while their eye movements were tracked and recorded. Results from three experiments provided support to a proposal in which the process of constructing a 3-D mental model entails (1) locating and identifying the corresponding parts in the presented orthographic projections, (2) assigning both the relative depth between adjacent areas and the absolute depth of a particular area in the projected view, and (3) updating and integrating the solutions pertaining to each area in the 2-D display. Temporal dynamics among the three proposed components as revealed by the eye movements data were also discussed.

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**Color Typicality as a Tool for Understanding Object Representations at Multiple Levels.** GALIT NAOR & MICHAEL J. TARR, *Brown University*, & DANIEL KERSTEN, *University of Minnesota*—A variant of the Stroop paradigm was used to investigate the association between color and shape in object representations. Colors were presented on shapes (or words denoting shapes) for which the colors were typical or atypical. Naming colors was faster for *typical* color–shape pairs (e.g., *yellow banana*) as compared with *atypical* color–shape pairs (e.g., *purple banana*). In contrast, when subjects judged whether the color of each pair matched a color patch, color matching was faster for *atypical* color–shape pairs as compared with *typical* color–shape pairs. Likewise, when object shape was denoted by colored words rather than pictures, subjects were faster to name colors for *atypical* color–shape pairs. This pattern suggests that multiple color–shape associations can become active during object perception.

More speculatively, certain types of statistical learning may produce perceptual and lexical associations that lead to inhibition, while other types of learning may produce conceptual associations that lead to facilitation.

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**The Influence of Color on the Recognition of Novel Objects.** PEPPER WILLIAMS, *University of Massachusetts, Boston*, & JAMES TANAKA, *Oberlin College*—While information about an object’s shape is crucial for recognition, color information might also play an important role in recognition processes if the object’s color provides a diagnostic cue to its identity. In the present experiments, participants learned to name novel objects with easily discriminable shapes. If an object was always trained in the same color, participants later named the object faster when shown in the consistent, diagnostic color than when shown in an inconsistent color or as a line drawing. Objects trained in multiple colors (resulting in low color diagnosticity) were recognized slower than high-diagnosticity objects that were consistently colored but faster than high-diagnosticity objects that were inconsistently colored. The magnitude of the color diagnosticity effect was largest when objects were rotated in depth relative to trained views. Collectively, these results suggest that diagnostic colors serve as prominent cues for object recognition processes.

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**Conceptual Processing and Intentional Retrieval in the Picture Superiority Effect.** YUH-SHIOW LEE, *National Chung-Cheng University* (sponsored by In-Mao Liu)—This study investigated the role of conceptual and perceptual processing in the picture superiority effect. Both explicit and implicit conceptual memory tests were used also to examine the role of intentional retrieval. The picture superiority effect was found in the cued-recall test and the recognition test, but not in the category-production test and the category-judgment test. Asking participants to indicate the color of objects corresponding to the presented words and make sentences based on these words produced the same effect as pictures did. The manipulation of visual distinctiveness did not have an effect on the picture superiority effect. These results suggest that intentional retrieval and conceptual, instead of perceptual processing, play important roles in producing the picture superiority effect.

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**Boundary Extension for Abstract Scenes.** CARMELA V. GOTTESMAN, *University of Oklahoma*—Boundary extension is a robust tendency to remember having seen a larger expanse of a scene than was actually perceived. Intraub (1992) proposed that this distortion is caused by the activation of a perceptual schema of scene layout, including expectations about the layout beyond the picture’s boundaries. These abstract expectations are related to the layout of the scene but not to its meaning (i.e., the identity of the objects and background). To examine if memory for expanse is influenced by the scene’s meaning, memory for photographs of meaningful objects on naturalistic backgrounds (e.g., a cooler on grass) was compared with memory for drawings of geometric forms on abstract texture gradients. The general layout of the scenes was the same in both conditions. Boundary extension was found for both naturalistic scenes and abstract scenes. Apparently, the meaning of the scenes does not influence the processes that cause this distortion.

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**Visual Search For Parts and Objects.** WILLIAM G. HAYWARD, *Chinese University of Hong Kong*, & DARREN BURKE, *University of Wollongong*—A visual search task was conducted, using computer-rendered versions of novel objects, with three conditions: (1) one part as target with another part as distractor; (2) one object as target with another object as distractor, when the only differentiating information between the objects was a single part; and (3) one part as target with two types of distractors; the other part, and the redundant object in-

formation from (2). Thus, the discrimination required was essentially the same in all conditions, and the redundant information in Conditions 2 and 3 was identical. Search slopes (the function fitting set size to RT) were much higher in Condition 2 than the other two, which were generally similar. Thus, visual search was more difficult when target parts were embedded within objects than when part and object information were presented separately in the scene. Implications for current models of object recognition and visual search are considered.

• PSYCHOLINGUISTICS •

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**ERP Indices of Individual Differences in the Metaphor Interference Effect.** DAWN G. BLASKO, VICTORIA A. KAZMERSKI, SHANNON N. LENZE, BANCHIAMLA G. DESSALEGN, & ATHENA FARANTZOS, *Pennsylvania State University, Erie*—The metaphor interference effect (Glucksburg, Gildea, & Bookin, 1982) results from participants' difficulty in suppressing the metaphorical meaning of a sentence when asked to judge its literal truth. In this study, ERPs were recorded as 23 college students read literal sentences, metaphors, or scrambled metaphors. Behaviorally, the metaphor interference effect was not obtained across all participants. Results showed a greater N400 to the metaphor and scrambled sentences in comparison with the literals. Analysis on difference waveforms showed that the literal-metaphor and literal-scrambled ERPs diverged in the late part of the recording epoch (1,100–1,650 msec). IQ scores (K-Bit) correlated with the difference measure for the metaphors, but not the scrambled sentences, primarily in the right hemisphere. This suggests that higher IQ participants may be using different brain processes than are lower IQ participants in suppressing metaphorical meaning.

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**Compound Presentations of Same and Different Transitivity Information.** BEVERLY COLWELL ADAMS & RACHEL MATTHEWSON, *Randolph-Macon Woman's College*—College students read syntactically ambiguous sentences, containing compound verbs in the preposed clause. The compound verbs varied by transitivity information (i.e., optionally transitive verbs and intransitive verbs). (*After the dog scratched [struggled] and struggled [scratched] the vet took off the muzzle.*) Gardenpathing was produced when optionally transitive verbs were repeated, but it was eliminated for the compound intransitive verb structure. Consideration of when, how, and why the presentation order of transitivity information can influence processing will be discussed.

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**Multiple Determinants of Individual Differences in Language Learning.** VERA KEMPE, *SUNY, Oswego*, PATRICIA J. BROOKS, *College of Staten Island, CUNY*, & ANATOLIY KHARKHURIN, *University of Nijmegen*—The study explores predictors for individual differences in adult L2 learning by examining the effects of working memory (WM) capacity, phonological store (PS) capacity, handedness strength, and previous language learning experience on learning Russian gender. Learners were taught to name colored line drawings, a task requiring gender agreement between color adjectives and nouns. Previous experience with another L2 was found to affect learning strategies: Gender-transparent previously learned L2s (e.g., Spanish) increased the likelihood that learners extracted regularities, and generalized to novel items. Generalization ability was positively correlated with WM, but was unrelated to PS capacity. If the previously learned L2 had a nontransparent gender system (e.g., French) or none, learners tended to rote memorize agreement patterns. Memorization accuracy was uncorrelated with WM or PS capacity. In addition, successful generalization was correlated with weak handedness, while successful memorization was correlated with strong handedness, an intriguing finding pointing toward right-hemispheric involvement in extracting linguistic regularities.

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**The Distractor Frequency Effect in the Picture–Word Interference Paradigm: A Paradoxical Result?** MICHELLE MIOZZO, *Columbia University*, & ALFONSO CARAMAZZA, *Harvard University* (sponsored by William Milberg)—Pictures were shown with superimposed word distractors of high and low frequency. Longer picture naming latencies were consistently observed with low- than with high-frequency distractors. Manipulations that facilitate or hinder distractor recognition (e.g., repeated lexical decision, letter degradation, case alternation) did not change the effect of distractor frequency. However, interference declined for distractors that were read aloud several times prior to being shown in the picture-naming task. The results of our experiments suggest that the effect of distractor frequency arises at some stage of lexical access for production and not at the stage of word recognition. The effect of distractor frequency is problematic for models of lexical access that explain the phenomenon of picture–word interference in terms of relative activation of the target and the distractor lexical nodes. Different explanations of this seemingly paradoxical effect of frequency will be discussed.

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**Reading Proverbs in Context: Moment-by-Moment Comprehension.** ALBERT N. KATZ, TODD FERRETTI, & TAMSEN E. TAYLOR, *University of Western Ontario*—A self-paced moving window procedure was employed to examine moment-by-moment processing of familiar and unfamiliar proverbs placed in contexts constructed to invite either a literal or the proverbial sense of the item. To our knowledge, this is the first research to examine the processing of the proverb on a word-by-word basis. Results indicate that the first few words of a familiar proverb were read more rapidly when it was in a context that biased toward its figurative sense, in comparison with a context biased toward the literal sense. For unfamiliar proverbs, reading times across the proverb did not differ for the two contexts. However, a large integration effect was noted for the first few words that followed the proverb: reading times for unfamiliar proverbs used figuratively were much longer than the same item used literally. Theoretical implications will be discussed.

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**Using Common Ground to Resolve Referential Ambiguity.** JENNIFER E. ARNOLD, JOHN C. TRUESWELL, & SARAH M. LAWENTMANN, *University of Pennsylvania*—Researchers have debated whether common ground information influences referential processing immediately (Hanna et al., 1998) or at a second stage (Keysar et al., 1998). Listeners' eye movements were recorded as they participated in a referential communication task, hearing instructions like "Pick up the cat," in three conditions: (1) there was only one cat, visible to both speaker and listener; (2) there was also another cat, visible only to the listener; and (3) there were two cats visible to both listener and speaker. Preliminary analysis of initial fixations shows that listeners fixated the target equally in Conditions 1 and 2, but less often in Condition 3, revealing an even stronger effect of common ground than found by Hanna et al. However, error results suggest that common ground was not used automatically by all listeners. Results are discussed in terms of the relationship between common ground and the interpretation of speaker's goals.

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**Ambiguity in the Brain: How Syntactically Ambiguous Sentences Are Processed.** ROBERT A. MASON, MARCEL ADAM JUST, TIMOTHY A. KELLER, & PATRICIA A. CARPENTER, *Carnegie Mellon University* (sponsored by Marcel Adam Just)—fMRI was used to investigate the time course and amplitude of brain activity in language-related areas (e.g., left inferior frontal and left temporal) during the processing of syntactically ambiguous sentences. Using an event-related fMRI paradigm, brain activity was measured every 1,500 msec during the processing of individual sentences. Beginning with the image acquired 4,500 msec after sentence onset, higher lev-

els of activation occurred during the reading of “unpreferred” (i.e., “garden-path”) sentences, compared with their preferred versions as well as in more complex ambiguities (reduced relative clause vs. prepositional attachment). Furthermore, brain activity increased for ambiguous sentences as compared with unambiguous sentences matched in syntactic complexity. Even when the ambiguities were resolved in favor of the preferred syntactic construction, a higher cost to processing ambiguous sentences was found. The findings indicate that event-related functional imaging can be used to measure cognitive workload associated with syntactic processing in general and ambiguity resolution in particular.

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**Character-Based Inferences in Situation Models.** DAVID N. RAPP & RICHARD J. GERRIG, *SUNY, Stony Brook*—While reading, people develop mental representations for the situations encoded in texts. Theories of situation models, such as the event-indexing model, suggest that readers encode several types of information, including protagonist-based information. Our experiments examined readers’ propensity to represent and apply such protagonist-based information. Early in each of our experimental stories, situations were described that allowed readers to draw trait inferences (e.g., Albert’s shoes were “buried under old candy wrappers, crumpled magazines, and some dirty laundry.”). Control stories omitted trait-relevant information. Each story presented a second episode to which readers could apply their protagonist models (e.g., Would Albert leave a newspaper behind on a bus?). Our results suggest that readers quite readily use protagonist models to constrain their predictions about story outcomes. These results have implications for both theories of situation models and readers’ causal analyses of texts.

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**The Role of Exception Words in Acquiring Linguistic Subcategories.** JANET L. McDONALD, *Louisiana State University*—Linguistic subcategories like grammatical gender are not arbitrary. Rather, at least some members of a subcategory share common (often phonological and/or semantic) features. These common features may be necessary for the acquisition and generalization of linguistic subcategories to both marked and unmarked members (Brooks et al. 1993; Frigo & McDonald, 1998). However, natural languages also often contain exception words—for example, while words ending in -e are usually feminine in German, there are words like *der Junge* “the boy” (masculine) and *das Ende* “the end” (neuter) that are clear exceptions. Using an artificial language paradigm, the effect of exception words on the acquisition and generalization of linguistic subcategories is explored.

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**Meaning, Sound, and Syntax in Lexical Retrieval From Semantic and Episodic Memory.** GABRIELLA VIGLIOCCO, *University of Wisconsin, Madison*, MARCO ZORZI & FRANCESCA CAIELLI, *University of Padova*, & MERRILL F. GARRETT, *University of Arizona*—Previous studies (Badecker, Miozzo, & Zanuttini, 1995; Vigliocco, Vinson, Martin, & Garrett, 1999) have established that anomic speakers when experiencing semantic memory lexical retrieval problems can report syntactic and phonological information about the words they cannot produce. In the present study, we assessed whether the type of partial lexical information that can be retrieved is *task dependent*. Two anomic Italian patients (and matched controls) participated in the study. In one experiment, we assessed the partial information (syntactic and phonological) available in a *semantic memory* task (picture naming and naming on definition); in a second experiment, we assessed the partial information available in an *episodic memory* task (word pair learning). A striking dissociation emerged: During the semantic task, both patients and controls reported information about syntax and phonology above chance. During the episodic memory task, however, although participants reported phonological information, syntax was reported at chance level (as was meaning information).

• LANGUAGE/DISOURSE PROCESSING •

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**The Role of Syntactic Boundaries in Maintaining Global Coherence of Narratives.** ALEXANDRIA E. GUZMÁN & CELIA M. KLIN, *SUNY, Binghamton*—According to a memory-based text processing framework, concepts in the current sentence automatically make contact with related information processed earlier. Recent studies have suggested that readers may reactivate backgrounded information when the story is locally coherent. Two experiments examined the effect of syntactic boundaries, such as periods, on the time course for reinstating backgrounded information in locally coherent passages. In Experiment 1, using a line-by-line reading paradigm, readers were delayed in noticing a contradiction on a target line when the sentence continued onto a posttarget line. Using the same paradigm, Experiment 2 indicated that sentence boundaries facilitate the integration of related background information, but are not necessary; additional time served the same purpose. The results are consistent with the memory-based text processing framework, in which the reactivation of related information is initiated automatically, but an integration stage is influenced by factors such as syntactic boundaries.

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**Updating a Situation Model: The Influence of Working Memory Capacity.** JOHN D. MURRAY, *Georgia Southern University*, & RANDALL W. ENGLE, *Georgia Institute of Technology*—The present project investigated the influence of working memory capacity (i.e., controlled attention) on situation model updating when reading a narrative text. Using the methodology and materials of O’Brien, Rizella, Albrecht, and Halleran (1998, Experiment 1), individuals with low or high working memory span read texts that contained a sentence describing a protagonist engaging in a behavior that was (1) consistent or (2) inconsistent with information stated earlier about the protagonist, or (3) consistent with a qualification under which a previously stated characteristic of the protagonist was relevant. The results from two experiments indicated that both low- and high-span individuals detected violations of global coherence in the inconsistent condition. However, reading time data from the qualification condition indicated that, whereas low-span individuals appeared to retrieve relevant backgrounded text information via a passive, resonance mechanism, high-span individuals may retrieve relevant prior text via a more direct mechanism.

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**I Mean, Understanding You Know and I Mean, You Know?** JEAN E. FOX TREE & JOSEF C. SCHROCK, *University of California, Santa Cruz*—We investigated what happens to listener comprehension after hearing *you know* or *I mean* in spontaneous speech. These discourse markers have been argued to be communicative at several levels, including the utterance level (the organization and repair of ideas), the turn-taking level, and the interpersonal level (speaker’s mental state, formality, politeness). Using a semantic verification task, we found evidence that *I mean* is used by listeners at the utterance level, but found no similar effects for *you know*. We discuss these results in light of the functions proposed for these words. This is the first experimental test of the use of these markers in on-line spontaneous speech comprehension.

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**Pronoun Referencing by Younger and Older Adults.** RUTH E. HERMAN & SUSAN KEMPER, *University of Kansas*—Pronoun interpretation usually requires accessing a previously mentioned antecedent from the discourse. This pronoun–antecedent match may be influenced by both the sentence and the discourse context. Past research has found age-related differences in pronoun interpretation when the pronoun and antecedent are separated by unrelated information. The present study utilized a speeded antecedent verification task to examine the availability of possible antecedents after a pro-

noun is encountered in different discourse settings. Differences in naming latencies to possible antecedents are assumed to reflect differences in the availability of the antecedents in working memory. In one condition, the information between the antecedent and pronoun was related to the discourse topic; in the other, information unrelated to the discourse topic intervened. The interval between the pronoun and the antecedent probe varied across trials. An age-related interaction was found at longer presentation intervals. Results are discussed within an interactive activation model framework.

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**The Role of Reading Span and Critical Task in Thematic Processing of Expository Text.** DESIREE BUDD, *Morehead State University*, & EMILY RICHTER, *Washington State University*—The present study examined whether quantitative differences in working memory capacity affect text level comprehension processes. Participants read brief expository text organized in a simple two-level hierarchical fashion and were oriented to learn either thematic information or detail information. Following their reading of the passages, participants' memory representations of the passages were examined using a speeded priming verification task. Accuracy with which participants identified a target statement in the topic, local, and distant prime conditions was used to reflect the relations that they constructed during reading. The data indicated that reading strategies did not differ by working memory span. Instead, both high- and low-span readers used a variety of different strategies to accomplish their goals. Additionally, the data suggest that researchers need to be cautious when making inferences concerning the relationship between reading and types of processing, especially when they are looking for differences between groups of readers.

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**The On-Line Status of Thematic Inferences During Narrative Text Comprehension.** HAO ZHANG & RUMJAHN HOOSAIN, *University of Hong Kong*—The on-line status of thematic inferences was investigated. We used a rapid serial visual presentation (RSVP) procedure and a lexical decision task in two experiments. The results of the present study showed that when the texts were presented with the RSVP rate of 400 msec and an SOA interval of 600 msec, the readers generated on-line thematic inferences. These findings are consistent with the global coherence assumption of the constructionist theory in which the theme is constructed during narrative text comprehension.

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**Text Comprehension as a Dynamic Neural Network.** MINA C. JOHNSON-GLENBERG, *University of Wisconsin, Madison* (sponsored by Arthur M. Glenberg)—DYNAMITIS is the dynamic interaction between text, individual, and strategies. The model is a recurrent neural network that simulates and predicts individual reading comprehension. Three middle school students with three different reading profiles—(1) poor decoder/poor comprehender, (2) good decoder/poor comprehender, and (3) average overall—were trained for three months in two reading comprehension strategies. The network contains 12 inputs that map to the three levels of text (e.g., syntactic complexity and number of unknown words), individual reader (e.g., motivation and decoding skills), and strategy use (e.g., students' ongoing, microgenetic proficiency with the strategies). Weight change matrices within and between subjects on 14 short science texts are compared. Results suggest how strategy training affects reading comprehension on a highly individualized basis.

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**Monitoring Topics While Reading.** ROBERT F. LORCH, JR., *University of Kentucky*, JUKKA HYONA, *University of Turku*, CLARESE LEMBERGER, KRISTEN RITCHEY, & SCOTT JOHNSTON, *University of Kentucky*, & JOHANNA KAAKINEN, *University of Turku*—Do readers actively anticipate changes of topics while reading expository texts? Processing of topic sentences was ex-

amined as a function of the types of transition sentences that preceded them. Transition sentences used (1) either a main clause ("marked") or subordinate clause ("unmarked") to introduce a new concept that (2) correctly or incorrectly predicted the new topic established in the subsequent topic sentence. In three reading-time experiments, these two factors jointly affected processing of topic sentences. When the new topic was correctly predicted by the transition sentence, topic sentences were read faster if the new concept was marked in the transition sentence; when the new topic was mispredicted, topic sentences were read faster if the new concept was unmarked. The fourth, eye-tracking experiment produced a pattern of look-backs from the topic sentence to the transition sentence, demonstrating that readers interpreted marked transition sentences as predicting a specific change of topics.

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**Using Processing Criteria to Distinguish Optionally Expressed Arguments From Adjuncts.** GAIL MAUNER, BRETON BIENVENUE, & JEAN-PIERRE KOENIG, *SUNY, Buffalo*—A prerequisite for determining the influence of verb argument structure on sentence processing is determining which constituents are arguments. Optional constituents are problematic because there are no unambiguous linguistic criteria for evaluating their argument status. Experiment 1 confirmed the argument status of unexpressed dative complements in verbs of the *provide* but not the *clean* class. We then compared the processing of *provide* and *clean* verbs in filler-gap sentences whose fronted WH-fillers either included a preposition or were prepositionally unmarked (e.g., *(For) Which students did the university provide/clean study halls (for)?*). Only the "clean" sentences whose fronted WH-phrases are prepositionally unmarked should elicit anomaly effects at the matrix verb. This is what we found. Our results suggest that at least one processing methodology known to be sensitive to lexically encoded information may also be used for distinguishing optionally expressed arguments from adjuncts.

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**Levels of Representation for Bridging and Predictive Inferences.** REBECCA FINCHER-KIEFER & PAUL R. D'AGOSTINO, *Gettysburg College*—Previous research (Fincher-Kiefer, 1998) has demonstrated that mental model construction is impaired when readers are given a perceptual memory load but not a verbal memory load. The present research tests the hypothesis that predictive inferences are represented within a reader's mental model. In a lexical decision task, readers showed facilitation to predictive inference targets with a verbal memory load but *not* with a perceptual memory load. This supports the proposal that predictive inferences are generated in a reader's mental model, and construction of this representation may involve perceptual-like processes (e.g., imagery). However, readers showed lexical decision facilitation to bridging inference targets when given either a verbal or a perceptual memory load. This suggests that bridging inferences are constructed at a different level of representation than predictive inferences.

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**Limits of Contextual Constraint on Lexical Ambiguity Resolution.** KIMBERLY METCALF, GEORGE KELLAS, & HOANG VU, *University of Kansas*—Recently, Azuma and Van Orden (1997) reported that in isolation, words with few meanings were identified more quickly when the meanings were related versus unrelated. The results were attributed to the overlap of semantic features for related meanings. In prior research, we have demonstrated that in strongly biased sentences, ambiguous word meanings may be selectively activated, whereas in weakly biased sentences, multiple activation is evident. These results have provided the basis for a feature-based context sensitive model of lexical ambiguity resolution. The present research examined the effects of meaning relatedness on ambiguity resolution in sentences strongly biased toward the dominant and subordinate meanings of the ambiguity. It was predicted that when ambiguous word

meanings are empirically rated to be unrelated, selective activation should be obtained; however, for related meanings multiple activation should occur. The results conformed to the predictions derived from a feature-based model.

• CATEGORIZATION •

(662)

**Categorical Perception of Emotional and ASL Linguistic Facial Expressions.** STEPHEN H. McCULLOUGH & KAREN EMMOREY, *University of California, San Diego*—We investigated whether the observed categorical perception (CP) of emotional facial expressions also extends to linguistic facial actions produced by American Sign Language (ASL) signers. These facial actions not only differ from the emotional facial expressions in function, but also in combinatorial use of facial musculature, timing, and scope. In two separate experiments, deaf and hearing nonsigners performed ABX discrimination and identification tasks on emotional and linguistic facial action continua. These continua were generated from original photo exemplars by a morphing program. Statistical analyses revealed significant CP effects for both types of expressions in hearing subjects, whereas deaf signers show a significant CP effect only for linguistic facial actions. Furthermore, deaf signers performed significantly slower than hearing subjects when linguistic facial actions were presented first (but not when emotional expressions were presented first). These results indicate that experience with ASL can affect the nature of CP for facial expressions.

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**Cross-Cultural Comparisons of the Role of Function in Property Centrality.** CHRISTIAN D. SCHUNN, *George Mason University*, & ALONSO H. VERA, *University of Hong Kong*—What drives property centrality? For a variety of nominal kinds (islands, fathers), natural kinds (cats, coal), artifacts (ovens, robots), and events (picnics, thunderstorms, weddings), American-English speakers and Chinese-Mandarin speakers were asked to rate a list of properties in terms of the property centrality, typicality, role in formal entity definition, role in entity recognition, or role in entity function. Although the entities had different meanings in the two cultures and languages, property function played a very important role in predicting property centrality, for nominal kinds, natural kinds, artifacts, and events. This work is consistent with previous work by Schunn and Vera (1995). However, entity-specific analyses revealed that there were also some interesting cross-cultural differences in weightings within different entity types.

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**Have I Seen That Cat Before? Dissociations Between Categorization and Recognition Memory.** JOHN PAUL MINDA, J. DAVID SMITH, & BARBARA A. CHURCH, *SUNY, Buffalo*—We examined participants' learning of larger, better differentiated categories and smaller, poorly differentiated categories, and their recognition of the old training items at various points during learning. Participants learning larger categories showed no old-item recognition but good categorization performance. This pattern recalled other reported dissociations between categorization and recognition. Participants learning smaller categories showed good old-item recognition but poor categorization performance. This pattern demonstrated a new independence between categorization and recognition. We interpret these results as showing two processes at work. One—a categorization process—depends on category-level information and operated best for the larger, better differentiated categories. The other—a recognition process—depends on specific exemplar traces and operated best for the smaller, poorly differentiated categories.

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**A Causal-Model Theory of Categorization.** BOB REHDER, *Beckman Institute*—It is proposed that categorization decisions are often made

relative to causal models of categories that people possess. According to this causal-model theory of categorization, evidence of an exemplar's membership in a category consists of the likelihood that such an exemplar is generated by the category's causal model. Bayesian networks are proposed as a representation of these causal models. Causal-model theory was fit to categorization data from a recent study, and yielded better fits than either the prototype model or the exemplar-based context model, by accounting, for example, for the confirmation and violation of causal relationships and the asymmetries inherent in such relationships.

(666)

**Prototypes, Rules, and Instances in Category Learning.** THOMAS J. PALMERI, *Vanderbilt University*, & MARK K. JOHANSEN, *Indiana University*—Early theories of categorization assumed that prototypes, rules, or instances were used to mentally represent categories of objects. More recently, various hybrid theories of categorization have been proposed that combine rules and instances (e.g., Erickson & Kruschke, 1998; Palmeri, 1997; see, also, Ashby, Alfonso-Reese, Turken, & Waldron, 1998) or prototypes and instances (e.g., Smith & Minda, 1998). We report a series of experiments that attempted to track the kinds of representations used to categorize objects as a function of learning. Empirical evidence suggests a shift from predominantly rule-based to predominantly instance-based category representations as subjects gained experience, consistent with a general theory of cognitive skill acquisition originally put forth by Logan (1988). Theoretical modeling is used to formally test hypotheses concerning representations by comparing fits of prototype, rule, and instance models to the observed categorization data as a function of learning.

• METACOGNITION •

(667)

**Using Metacognitive Accuracy to Measure Awareness in Implicit Learning.** ANN E. RENKEN & CHARLES A. WEAVER III, *Baylor University*—Implicit learning can be defined as an improvement in performance without awareness of the knowledge underlying that improvement. But how should awareness be measured? Dienes and Berry (1997) proposed that either implicit or explicit knowledge can produce above-chance performance on direct tests (i.e., recognition); however, only explicit knowledge can produce accurate metacognitive judgments about direct test performance. In two experiments, we tested their predictions using the serial response task (SRT), with both incidental (implicit) or intentional (explicit) learning conditions. Both conditions performed above chance on recognition and cued-recall tests, but incidental learners were consistently higher in metacognitive accuracy, contrary to the prediction of Dienes and Berry. Our results are consistent with inferential theories of metamemory (Schwartz et al., 1997), suggesting that judgments are based on indirect cues (i.e., familiarity, retrieval fluency) rather than direct access, and question the use of metacognitive judgments to assess awareness in SRTs.

(668)

**Effect of Humor on Memory and Metamemory.** ZEHRA F. PEYNIRCIOGLU & JENNIFER L. W. THOMPSON, *American University*—We examined the effect of humor on memory and metamemory. Specifically, we presented either single-panel cartoons with humorous or nonhumorous captions or one-line jokes with humorous or nonhumorous punchlines. Participants gave immediate and delayed judgments of learning (JOLs—Experiments 1 and 2) or feeling-of-knowing ratings (FOKs—Experiments 3 and 4). Recall, cued-recall, and recognition were used as criterion tests. Participants remembered immediately tested items and humorous captions and punchlines better. Magnitudes of the immediate JOLs and FOKs, as well as magnitudes of JOLs and FOKs for humorous captions and punchlines, were higher. The accuracy of these metamemory judgments, however, did not differ with respect to delay or humorousness.

(669)

**Practice Increases Mean Metacognitive Accuracy but Not the Reliability of Individual Differences.** WILLIAM L. KELEMEN, *University of Missouri, St. Louis*, & ROBERT G. WINNINGHAM, *Baylor University*—Previous research in metacognition has generally failed to obtain stable individual differences in monitoring accuracy. One possibility is that these differences are masked by participants' unfamiliarity with the experimental task. We performed two experiments, each composed of five weekly testing sessions, to determine whether reliable differences would emerge with practice. In both experiments, mean metacognitive accuracy (bias scores and Gamma correlations,  $G$ ) improved with practice. Individual differences in confidence, recall, and bias were stable across sessions, but differences in  $G$  were unstable. We also examined performance as a function of students' SAT scores. High SAT students tended to recall more items than did low SAT students, and the former group was less overconfident. These results show that mean metacognitive accuracy can improve with practice, but individual differences in  $G$  do not become more reliable.

(670)

**Do Age Deficits Occur in Learning About the Relative Effectiveness of Recall Cues?** GREG MATVEY & JOHN DUNLOSKY, *University of North Carolina, Greensboro*, RAYMOND J. SHAW, *Merrimack College*, & CHRISTOPHER HERTZOG, *Georgia Institute of Technology*—Evidence from previous research suggests that age-related deficits occur in learning about the relative effectiveness of cues given task experience. During two study–test trials, adults studied targets cued by letters (*ch–chair*), rhymes (*hair–chair*), or category labels (*furniture–chair*). Evidence from metacognitive judgments suggests that both older adults and younger adults initially had no knowledge about relative cue effectiveness, but both age groups learned about these effects across trials. Discussion focuses on the inconsistencies between outcomes from the present research and previous outcomes from the literature.

(671)

**Self-Reports About Concepts Are Not Always “Revealing.”** SHARON LEE ARMSTRONG, *La Salle University*—Subjects' self-

reports are frequently obtained to investigate the internal structure of concepts. Yet, people withhold or fail to give information in daily life for a variety of reasons—sometimes in the service of effective communication. People do not abandon habits of communicating just because they have agreed to participate in a study. In fact, in some cases subjects' desire to be good subjects—to give the researcher what they think she wants or needs to know—may lead them to adhere even more strongly to conversational conventions. Studies are presented here in which subjects failed to report what they actually know. These studies indicate that responses are guided by sociolinguistic rules, context, and task specifications. It would appear that a theory of concepts needs to include subjects' theories about concepts as well as their theories of what to say about them.

(672)

**The Influence of a Diminished Fan Effect on Metamemory Judgments.** MICHAEL J. MCGUIRE & RUTH H. MAKI, *Texas Tech University*—Normally, as fan (number of nominal associations paired with a concept) increases, participants' reaction times on a verification task increase. However, previous research has demonstrated that under certain conditions the traditional fan effect (e.g., inverse relationship between fan and verification performance) can be attenuated so that concepts associated with several propositions are recognized as well as concepts associated with fewer propositions. We tested whether the relationship between the magnitude of the fan effect and verification task performance would be reflected in individuals' metamemory judgments. Our results indicated that metamemory judgments are sensitive to changes in the size of the fan effect. These findings call attention to an alternative explanation for the underlying mechanism responsible for making future predictions of memory performance.

(673)

**Research Support From the National Science Foundation.** HAL R. ARKES, *Ohio University*, & FRED STOLLNITZ & JOE YOUNG, *National Science Foundation*—Information about the various programs of the NSF will be available.

## ATTENTION III

Pacific Palisades, Sunday Morning, 8:00–9:30

Chaired by D. Stephen Lindsay, University of Victoria

8:00–8:15 (674)

**Is Selective Attention to Stimulus Dimensions Task Dependent?** DANIEL ALGOM, *Tel-Aviv University*—Is the ability of people to ignore irrelevant information and attend selectively to relevant information task dependent? This research examined the quality of selective attention to a privileged dimension of the same multidimensional stimuli in three tasks: (1) speeded classification, (2) same–different judgment, and (3) comparative judgment. Results showed the mandatory failure of selective attention in the same–different judgment task even when it was successful in the other two tasks. It is concluded that attentional outcome is jointly determined by the stimuli presented and the special characteristics of the judgmental task at hand.

8:20–8:40 (675)

**How Automatic is Intentional Stimulus–Response Translation?** BERNHARD HOMMEL, *Max Planck Institute for Psychological Research, Munich*, & BEATRIX EGLAU, *University of Koblenz-Landau*—In dual tasks primary-task performance is affected by (“backward”) compatibility (BWC) between secondary response and primary stimulus, suggesting that primary and secondary S–R translation proceed in parallel. Two accounts of BWC were tested in four experiments. A transient-link model, assuming concurrent use of S–R rules temporarily implemented in working memory, was rejected since BWC did not decrease when a tertiary memory task was added or the number of primary S–R alternatives was increased. A direct-link model, assuming the emergence of direct S–R associations, was more successful in predicting the decrease of BWC after an inversion of the secondary S–R mapping, and its persistence after fading out the secondary task. Apparently, translating arbitrary S–R pairs is (or can be) mediated by associations between S and R codes; hence, intentional (or intentionally implemented) translation is automatic.

8:45–9:05 (676)

**On Cross-Modal Orienting of Spatial Attention.** JOHN J. McDONALD, *University of California, San Diego*, & LAWRENCE M. WARD, *University of British Columbia* (read by Lawrence M. Ward)—Similar spatial attention orienting and IOR effects in vision, audition, and touch have raised the question of whether stimulus-driven spatial attention orienting and IOR are controlled by supramodal brain mechanisms or by modality-specific ones. For vision and touch, and touch and audition, cues in one modality have been found to trigger orienting in the other. However, for vision and audition the data conflict: with only visual cues orienting auditory attention, the opposite asymmetry, or no effects at all, has been reported. We did seven implicit spatial discrimination experiments with vision and audition to address this conflict. Consistent with other modality pairs, when cue and target modality were certain, cues in each modality triggered attention orienting but not IOR in the other. When target modality was uncertain, attention orienting effects of cues were reduced and cross-modal IOR appeared. Supramodal mechanisms are plausible, but as yet, there are no brain-imaging data supporting such mechanisms.

9:10–9:25 (677)

**Intersensory Integration? Congruity Effects Across the Visual and Auditory Modalities.** PHILIP THOMAS QUINLAN, *University of York*—Experiments are reported that examine two different congruity effects. These effects are defined in terms of responses to simultaneous signals presented in the visual and auditory modalities. Spatial and pseudospacial congruity effects were measured. In the spatial tasks, congruent signals occurred in the same side of space and incongruent in opposite. In the pseudospacial case, the target could be judged high or low according to visual position or pitch. Both effects were measured in the absence of precues and when precues were pre-

sented prior to the target. When precues were presented, the size of congruity effect was generally enhanced but increased particularly when participants classified the auditory signals. Exceptions to this general pattern are also described and the results are discussed in terms of the operation of attentional mechanisms and the notion of visual dominance. The data appear to rule out any simple response competition account.

## PROBLEM SOLVING

Plaza, Sunday Morning, 8:00–10:00

Chaired by Ruth S. Day, Duke University

8:00–8:15 (678)

**Mood Effects in Early and Late Idea Production.** GEIR KAUFMANN & ØYVIND MARTINSEN, *Norwegian School of Management*—The hypothesis that the effects of positive and negative mood on creative problem solving may differ as a consequence of the degree of constraint on the solution space of the task was tested. Sixty-eight subjects were divided into a positive mood, a negative mood, and a control condition. Mood was experimentally induced by way of showing selected film clips, and performance on four different idea production tasks was recorded across a time interval of 4 min for each task. Results showed a significant mood-by-production-time interaction. Positive mood led to the highest number of scores in early idea production and the lowest number in late production, whereas both control and negative mood led to relatively superior task performance in late production. Moderating effects of individual differences in strategy preferences were examined. Alternative interpretations of the results are discussed, and suggestions for further studies are offered.

8:20–8:35 (679)

**The Interplay of Symbolic and Subsymbolic Processes in Anagram Problem Solving.** MICHAEL C. MOZER & DAVID GRIMES, *University of Colorado*—Although connectionist models have provided insights into the nature of perception and motor control, connectionist accounts of higher cognition seldom go beyond an implementation of traditional symbol-processing theories. We describe a connectionist constraint-satisfaction model of how people solve anagram problems. The model exploits statistics of English orthography, but also addresses the interplay of subsymbolic and symbolic computation by a mechanism that extracts approximate symbolic representations (partial orderings of letters) from subsymbolic structures and injects the extracted representation back into the model to assist in the solution of the anagram. We show the computational benefit of this extraction injection process and discuss its relationship to conscious mental processes and working memory. We also account for experimental data concerning the difficulty of anagram solution based on the orthographic structure of the anagram string and the target word.

8:40–8:55 (680)

**Subgoal Learning as a Function of Formal Versus Informal Labels in Examples.** RICHARD CATRAMBONE, *Georgia Institute of Technology*—Participants with “weaker” or “stronger” math backgrounds studied probability examples dealing with the Poisson distribution. Examples contained either no labels or labels—for sets of steps—that were formally correct, meaningful (i.e., tied to surface features of the examples), or less meaningful. Participants then solved transfer problems. Although labels aided subgoal learning, as measured by subsequent transfer to novel problems, it was the formal and less-meaningful labels that seemed most useful for stronger learners, since they were less likely to attach surface features of the examples to the subgoals compared with when they studied meaningful labels. Weaker learners, however, performed best when the examples contained meaningful labels, although they had difficulty on novel problems in which the surface features were misleading. These results sup-

port prior studies suggesting that cues that group steps in examples encourage learners to form subgoals to explain the grouping.

#### 9:00–9:15 (681)

**Selecting Evidence for Limiting Hypotheses.** BARBARA A. SPELLMAN & ALEXANDRA KINCANNON, *University of Virginia*—When people want to generalize a hypothesis, they choose to gather more diverse evidence, which can provide stronger confirmation. But what evidence do people gather when trying to limit a hypothesis? Participants were asked: “Suppose you know for a fact that robins have a condyloid canal. What organism would you examine to test whether *only* birds have a condyloid canal?” Response choices were bluejay, flamingo, bat, and gorilla. We believe that more similar nonbird evidence (i.e., bat) provides stronger confirmation in this case because it can rule out competing hypotheses based on similarity. Surprisingly, participants showed a preference for more diverse nonbird evidence (i.e., gorilla). That preference is eliminated, but not reversed, in a simpler two-choice premise evaluation task. Our results indicate that people do recognize the usefulness of category boundary and similarity when selecting evidence to limit hypotheses, but they do not apply that information as expected.

#### 9:20–9:35 (682)

**The Laws of Gravity and the People Who Oppose Them.** DOUG ROHRER, *University of South Florida*—Though most people have spent their entire lives on the Earth’s surface, relatively few people possess even an informal understanding of motion in the presence of gravity. Previous studies, for instance, have revealed false beliefs concerning both the direction of gravity-induced motion (e.g., bombs fall straight down) as well as the effects of an object’s characteristics on its speed (e.g., heavier objects fall faster than lighter objects). In the present series of studies, subjects demonstrate false beliefs concerning the speed of an object as it rolls or falls along a known path. The results are consistent with a law of motion that is simple but wrong.

#### 9:40–9:55 (683)

**Do Frequency Frames Make Probability Judgments More Coherent?** JEFFREY M. STIBEL & STEVEN A. SLOMAN, *Brown University* (read by Steven A. Sloman)—Some have argued that people represent probability information as frequencies. As evidence, they claim that frequency frames improve the coherence of judgments relative to single-event probability frames. We used problems that induce conjunction fallacies and base-rate neglect to examine the robustness of these framing effects and to test an older, alternative hypothesis that explains the effects, that frequency frames increase the transparency of the set structure of the target events (nested-sets hypothesis). The results show that frequency frames did indeed improve judgments but not nearly to the extent claimed. Moreover, the alternative nested-sets hypothesis was supported. With conjunction fallacy problems, the benefit of frequency was eliminated by obscuring the relation between the relevant sets. With the other problem, we raised the level of probability judgments to that of frequency by clarifying the set relation. This work brings into relief the value of post hoc evolutionary accounts of psychological phenomena.

### PERCEPTION: WORDS AND OBJECTS Santa Monica, Sunday Morning, 8:00–9:55

Chaired by John H. Flowers, *University of Nebraska, Lincoln*

#### 8:00–8:15 (684)

**Sleuthing for Strategic Effects in Phonological Priming.** MARK A. PITT & LISA SHOAF, *Ohio State University*—Results obtained with the phonological priming paradigm, in which an auditory prime and target overlap in their initial phonemes (e.g., *stick–still*), have been criticized for being caused in part by response bias. We investigated

the extent of this claim by modifying the typical experimental setup by delaying introduction of overlap trials and then measuring the evolution of RT effects across overlap conditions over the course of the testing session. Multiple tasks and various manipulation (e.g., ISI, proportion of overlap trials) were used to determine the nature of strategic influences.

#### 8:20–8:35 (685)

**Spatial Generalization Confirms Shepard’s Law.** KEN CHENG, *Macquarie University*, & MARCIA L. SPETCH, *University of Alberta*—When an organism’s behavior produces a reward in one stimulus situation (called S+), it typically exhibits that behavior in similar but recognizably different situations, the ubiquitous phenomenon of stimulus generalization. On the basis of functional and mechanistic grounds, Shepard (1987, *Science*, 237, 1317–1323) proposed a universal law of generalization:  $y = \exp(-kx)$ , where  $y$  is the proportional response rate, relative to responding at S+,  $k$  is a scaling parameter, and  $x$  is the appropriately scaled “distance” of a stimulus from S+. In spatial generalization, an organism is trained to find a reward at one place, and then is tested without reward at a range of locations. Data from humans, pigeons, and honeybees support Shepard’s law, the first time in the spatial domain, and the first time in an invertebrate animal.

#### 8:40–8:50 (686)

**Spoken Word Recognition: Are Vocalic and Metrical Mismatches Tolerated?** JAMES M. MCQUEEN, *Max Planck Institute for Psycholinguistics, Nijmegen*, & CYNTHIA M. CONNINE, *SUNY, Binghamton* (sponsored by Cynthia M. Connine)—Is a word form activated when the spoken input mismatches with that word by one vowel? In a phoneme monitoring experiment, final consonants in segmental-mismatch nonwords, made by changing vowels in the primary-stressed syllables of WSW words (“su’fficient” → “su’ffocient”) or SS words (“yogurt” → “yagurt”), were detected faster than in control nonwords. This suggests that words are activated given nonwords containing a mismatching vowel. Metrical-mismatch nonwords tested whether vowel mismatches involving metrical changes are also tolerated. When the first syllable schwa in WSW words was changed to a full vowel and given primary stress (“sofficient”), detection times were faster compared with controls. When the first vowel of SS words was reduced to schwa and primary stress was shifted to the second syllable (“y@’gurt”), no facilitation was found. Metrical mismatch therefore appears to be tolerated in lexical access only when the vowel in the normally stressed syllable remains intact.

#### 8:55–9:15 (687)

**Processing Time and Dynamic Cohort Interactions in Spoken Word Recognition.** ARTHUR G. SAMUEL, *SUNY, Stony Brook*—A few studies have examined the role of processing time during spoken word recognition by fixing the amount of phonetic information and manipulating the time to process it (e.g., via speech compression or expansion). Many more studies have explored the effects of variations in a word’s neighborhood structure. The current project reveals an important interaction between processing time and neighborhood characteristics. Listeners monitored for target phonemes in words and matched pseudowords. The words varied in their dynamic cohort properties (the number of competitors as the word progresses); targets were either early or late in these polysyllabic stimuli. The lexical advantage (faster responses to targets in words than pseudowords) was approximately 80 msec for words in dense neighborhoods; neither position nor processing time mattered. For sparse neighborhoods, the lexical advantage strongly depended on time/position. These results demonstrate the importance of examining time and cohorts together, and help to specify the time course of lexical activation.

#### 9:20–9:30 (688)

**Talker Recognition by Preschool Children and Adults.** MELANIE J. SPENCE & SUSAN JERGER, *University of Texas, Dallas* (read by

Susan Jerger)—We assessed children's ( $N=72$ , 3–5 years old) and adults' ( $N=24$ ) ability to recognize 20 cartoon characters from voice information alone. A subsequent confrontational naming task allowed us to delimit the characters into more familiar (named) and less familiar (unnamed) personalities. Familiarity affected participants' abilities to recognize the talker, such that 90% of the more familiar and 70% of the less familiar characters were recognized. Talker recognition improved with age and in a similar manner for the more and less familiar figures. Performance collapsed across familiarity was 60% in 3-year-old listeners and 80% in listeners above 3 years. Talker-recognition skills were adult-like by 4 years of age. Apparently, indexical information about a talker becomes an integral part of the perceptual record in memory and can be exploited efficaciously by a very young age. These data support the idea that age-related change is minimized when tasks emphasize more perceptual types of knowledge representation.

9:35–9:50 (689)

**Object Recognition Is Differentially Affected by Display Orientation and Observer Viewpoint Changes.** DANIEL J. SIMONS, *Harvard University*, RANXIAO F. WANG, *University of Illinois*, & DAVID RODDENBERRY, *Harvard University*—In typical studies of object recognition, observers view simulated objects on a computer monitor and then try to recognize those objects from rotated views. Existing models of object recognition have assumed that object rotation and observer movement are equivalent because they can produce the same retinal changes. However, layout recognition following observer viewpoint changes is superior to performance following display orientation changes (Simons & Wang, 1998). Here we show that this disparity between viewpoint and orientation changes applies to individual object recognition as well. Individual object recognition is better following observer viewpoint changes than equivalent view changes caused by object rotation. Existing models of object recognition need to consider the nature of the view changes in order to account for these findings.

#### LANGUAGE/DISOURSE PROCESSING Beverly Hills, Sunday Morning, 8:00–10:05

Chaired by Shelia M. Kennison, *University of Oklahoma*

8:00–8:15 (690)

**Text Processing, Assistance, and Memorial Representations: A Summing Up.** PHILIP LANGER & VERNE KEENAN, *University of Colorado*—This paper summarizes our findings over an extended period of time. Our research agenda has sought to address the impact of instructional assistance, primarily feedback, on differing text memorial representations. In our studies, reading strategies were controlled by presenting the text one sentence at a time. The memorial representations follow the work of Kintsch, and include surface, semantic, and situation memory. These memorial representations are sensitive to textual differences as well as variations in feedback modality. Our work indicates that (1) changes in feedback modality are not symmetrical, (2) repeated use of the same modality may result in decreased performance, and (3) the initial memorial representation in all cases is surface memory, but that the energizing semantic and situation memory interact in a parallel rather than a hierarchical manner.

8:20–8:35 (691)

**Memory-Based Text Processing: The Effects of Two Kinds of Memory Limitations.** PAUL WHITNEY, TINA JAMESON, & AMY DRIVER, *Washington State University*—Participants read passages with an anaphoric reference to an antecedent that shared features with another word elsewhere in the passage. The correct antecedent appeared either early or late in the passage, with the related term appearing in the opposite part of the passage. Overall, we replicated an earlier finding that reinstatement of the early antecedent can facilitate

access to that term without interfering with access to the related term. However, this general outcome obscured important differences among participants. The facilitative effect of reinstatement on access to the early antecedent was obtained only for those subjects with good long-term memory ability. Reinstatement of the early antecedent did interfere with access to the term related to the antecedent for those subjects high in working memory span. Two aspects of anaphor resolution, accessing potential antecedents and integrating the correct antecedent into the discourse representation, are dissociable processes based on different memory abilities.

8:40–8:55 (692)

**Eye Movements When Reading Unfamiliar Words in Context.** ROGER CHAFFIN, *University of Connecticut*, & ROBIN MORRIS & RACHEL SEELY, *University of South Carolina*—When readers encounter unfamiliar words, they spend more processing time on regions of text that are more informative about its meaning. In two experiments, eye movements were monitored while readers read context sentences containing target words varying in familiarity (*Joe picked up the GUITAR/ZITHER/ASDOR and strummed a tune*), followed by a second sentence containing a definitional associate of the target word (*He played the INSTRUMENT to relax*). Readers were sensitive to whether the context sentence and the definitional associate were informative about the meaning of the target word. Reading of Sentence 2's definitional associate was unaffected by target word familiarity when the meaning of the target word could be inferred from Sentence 1, and was slower when it could not. When readers encountered an unfamiliar word, they inferred its definitional associates online as the unfamiliar words were encountered.

9:00–9:15 (693)

**Language Comprehension and Memory for Discourse Entities.** PETER C. GORDON, RANDALL HENDRICK, & MARCUS JOHN-SON, *University of North Carolina, Chapel Hill*—Studies of language comprehension have made extensive use of the processing difficulties that can be encountered in understanding sentences with relative clauses. Among other challenges to language comprehension, such structures have been thought to place relatively high demands on working memory, particularly in the case of object relative clauses. Further, it has been hypothesized that creating and maintaining representations for discourse entities is a primary determinant of memory demands in language comprehension. In a series of experiments, we examine how the use of different forms of referring expressions to refer to discourse entities influences the comprehension of sentences with relative clauses. The results show that under some circumstances, the use of pronouns facilitates comprehension as compared with the use of fuller expressions. The implications of these results are discussed in terms of how sentences are integrated dynamically into a model of discourse.

9:20–9:35 (694)

**The Role of Script in Spoken Language Processing.** HIM CHEUNG, *University of Otago*—Previous research has shown that the ability to analyze spoken language into phonemes does not develop spontaneously; it requires support from reading an alphabetic script. Experiment 1 of the present study supported this idea by showing very poor performance of a group of Cantonese speakers (adopting a non-alphabetic writing system) on a sound-matching task, as compared with English speakers. Experiment 2 examined unconscious phonemic activation in the two groups within a phonological priming paradigm (ISI = 500 msec). The typical facilitation–inhibition pattern due to increasing prime–target similarity was found with the English but not the Cantonese speakers. The pattern, however, did emerge in the latter group when ISI was shortened to 0 msec in Experiment 3. Experiment 4 found very similar patterns of phonemic activation in the two groups in a dichotic listening task. It was thus concluded that initial phoneme activation in speech processing is independent of the writing system.

**9:40–10:00 (695)**

**What Numbers Tell Us About Words.** MARC BRYLSBAERT, BERT REYNVOET, & WIM FIAS, *University of Gent*—Our previous work has shown that Arabic numerals always address a magnitude-related semantic number line during processing, irrespective of whether the magnitude information is necessary for performing the experimental task or not. In this talk, we show that Dutch word numerals, contrary to Arabic numerals, can be read without semantic mediation. However, if the semantic system is preactivated by the presence of a tachistoscopically presented Arabic prime, magnitude-related priming is observed in the naming of visually presented verbal numerals. These results suggest that a semantically mediated pathway exists for the naming of visually presented words, but that in a language with a shallow orthography, this pathway is usually outperformed by a non-semantic letter–sound conversion system.

**PICTURE MEMORY/PROCESSING**  
**Westside, Sunday Morning, 8:00–10:00**

*Chaired by Pepper Williams, University of Massachusetts, Boston*

**8:00–8:15 (696)**

**Not All Morphs Are Created Equal: Atypicality Bias in Recognition.** JAMES TANAKA & JESSE LANZ, *Oberlin College*—Using a computer imaging algorithm, two images can be graphically averaged to produce a morphed image. In a series of experiments, images of atypical objects were morphed with images of typical objects. Although the morphed image was the mathematical average of its two parent images, it was judged to bear a stronger resemblance to the atypical parent image than to the typical parent image. The robustness of the atypicality bias was demonstrated across several object classes (e.g., faces, birds, and cars) using tasks involving judgments of similarity and recognition. Collectively, these findings suggest that object recognition is governed not only by the match between the perceived stimulus and its object representation, but also by the broader category structure in which the representation is found.

**8:20–8:40 (697)**

**Contradictory Neurocomputational Properties for Abstract-Category and Specific-Exemplar Object Recognition.** CHAD J. MARSOLEK, STEVE A. JAX, DAVID R. ANDRESEN, E. DARCY BURGUND, CARMEN E. WESTERBERG, & BRADLEY J. HENRICKSON, *University of Minnesota*—The ability to recognize abstract categories of objects (e.g., cups vs. pens) as well as specific exemplars within those categories (e.g., individual pens) poses a dilemma for the visual system: How can it classify two shapes as the same (i.e., as belonging to the same abstract category) yet also different (i.e., as corresponding to different exemplars)? Implementational evidence suggests that the architecture of neurally dissociable subsystems reflects a solution to this dilemma: Dissociable subsystems operate in parallel to accomplish abstract-category and specific-exemplar recognition (contrary to predominant theories of object recognition). We now present neurocomputational evidence that the internal processing strategies used by such subsystems may be contradictory: Neural-network models trained to perform both abstract-category and specific-exemplar recognition of visual forms simulate human performance when they have a subnetwork architecture, but not when they have a unified architecture. Furthermore, the subnetworks discover contradictory mapping strategies (relatively sparse vs. distributed-coding schemes) during training.

**8:45–9:00 (698)**

**An fMRI Study of Mental Rotation Versus Object Recognition.** ISABEL GAUTHIER, *Vanderbilt University*, WILLIAM G. HAYWARD, *Chinese University of Hong Kong*, MICHAEL J. TARR, *Brown University*, & JOHN C. GORE, *Yale University*—Prior neuroimaging studies of mental rotation suggest that activation in super-

rior parietal lobule (SPL) is related to angular disparity between shapes in handedness judgments. Here we investigated whether mental rotation and object recognition use common neural mechanisms. Fifteen subjects were scanned using fMRI in handedness and recognition tasks with identical stimuli rotated around one of three axes. After equating viewpoint effects, differences beyond SPL emerge between the tasks and depend on the rotation axis (e.g., handedness–recognition recruits SPL for *x*-axis rotations and the inferior parietal lobule for *z*-axis rotations). Some areas were also preferentially sensitive to angular disparity: SPL for handedness; precentral and superior temporal gyri for recognition; and fusiform gyrus (BA19) for both tasks. Overall we find significant differences in the neural substrates active between two tasks that elicit similar viewpoint effects. Moreover, rotation axis (and the concurrent changes in the image) appears critical for understanding such differences.

**9:05–9:15 (699)**

**The Time Course of Visual Priming.** SEAN P. MCAULIFFE & BARBARA J. KNOWLTON, *UCLA* (read by Barbara J. Knowlton)—Objects previously viewed (i.e., primed objects) can be processed faster and more accurately than novel objects. In a priming phase, participants viewed objects presented in a rapid stream with a variety of stimulus onset asynchronies (SOAs). In a subsequent probe phase, participants identified objects in a rapid stream of nonobject distracters; display times were gradually increased until the participant could name the object. Although priming increased for SOAs up to 300 msec, no additional priming was observed for SOAs greater than 300 msec. These results suggest that the processes underlying visual priming for object identification can be completed in 300 msec. In addition, these results further support the idea that priming does not rely on episodic representations, because episodic memory traces continue to increase in strength far beyond 300 msec of study.

**9:20–9:35 (700)**

**The Retention and Integration of Scene Information Across Saccades: A Global Change Blindness Effect.** JOHN M. HENDERSON, ANDREW HOLLINGWORTH, & ARUN N. SUBRAMANIAN, *Michigan State University*—Evidence from a number of studies has shown that viewers are insensitive to what would seem to be salient scene changes when those changes take place during a saccade or other visual interruption. We present data from a study designed to investigate the nature of the visual information retained across fixations. In this paradigm, gray vertical bars were superimposed over images of real-world scenes so that half the image was visible and the other half occluded (as if the image were being viewed behind a picket fence). During a saccade within the scene, every pixel in the image was changed by reversing the visible and occluded portions. Detection of these changes was remarkably poor. We will present the results of additional experiments designed to illuminate the nature of this transsaccadic change blindness effect, and will outline a theory of the nature of the representation that is generated during scene viewing.

**9:40–9:55 (701)**

**Scope of the Bridge on Which Vision and Cognition Meet: Scene Priming as a Function of Scene Scope.** THOMAS SANOCKI, *University of South Florida*—How do top-down representations of scene-layout interface with vision when layout is processed? Is the interface limited to an attended object or a few spatial indices, or can it be broad in scope? Observers made speeded judgments about the relative depth of critical object pairs in target pictures. Each target was preceded by either a control prime or a scenic prime (same scene sans critical objects) that induces a representation of layout. The effectiveness of the representation (and the vision–cognition interface) was indexed by its ability to speed judgments relative to control primes. Scope of the vision–cognition interface was manipulated by using an entire scene (7–10 distinct objects and regions) or by delimiting the relevant area to as little as 1 object. The function relating amount of priming to relevant scope will be used to make inferences about the vision–cognition interface.

### IMPLICIT MEMORY AND REPETITION/PRIMING EFFECTS

Century, Sunday Morning, 8:00–10:05

Chaired by Robert A. Johnston, University of Birmingham, England

8:00–8:15 (702)

**Perceptual Identification and the Counter Model.** GAIL MCKOON & ROGER RATCLIFF, *Northwestern University*—The counter model for perceptual identification (Ratcliff & McKoon, 1997) has been criticized recently on two grounds. First, Bowers (in press) failed to replicate R&M's finding, predicted by the model, that in forced choice, prior study of one of the alternatives does not affect performance when the alternatives are dissimilar. We report a new experiment that shows Bowers' failure is due to inappropriate instructions. Second, R&M found that prior study gave no significant improvement to performance, only a bias to respond with a previously studied word. Bowers and also Wagenmakers, Zeelenberg, and Raaijmakers (submitted) claim to contradict the model with experimental results that indicate there is improvement for low-frequency words. However, with one additional assumption, the counter model accommodates performance improvements for low-frequency words; it provides good quantitative fits to Wagenmakers et al.'s data and also explains the results of two new experiments that we report.

8:20–8:35 (703)

**The Influence of Changed Colors on Explicit and Implicit Memory Tasks.** HUBERT D. ZIMMER & ASTRID STEINER, *Saarland University*—Changing sensory qualities from study to test usually impaired performances in explicit memory tasks but not implicit memory tasks. This is opposite of what is expected from considering object recognition as a perceptual test and old/new recognition as a conceptual test. In order to solve this contradiction, the existence of two different memory tokens were suggested. The metric tokens used in recognition represent the perceptual qualities, and the perceptual entry tokens represent the information critical for object recognition, which is usually the shape of the object. From this assumption it follows that color changes should influence object recognition only if color is critical for this process. Our data support this. Changing color from study to test generally impaired recognition memory, but it did reduce the repetition effect in an object recognition task only for objects associated with specific colors. Making perceptual processing more difficult was not sufficient to bring color into effect.

8:40–8:55 (704)

**Implicit Memory for Music in Alzheimer's Disease.** ANDREA R. HALPERN, *Bucknell University*, & MARGARET G. O'CONNOR, *Harvard Medical School*—Young adults, normal older adults, and early-stage Alzheimer's disease (AD) patients participated in a test of implicit and explicit memory for unfamiliar melodies. In the presentation phase, listeners rated melodies on perceived speed, twice. Immediately following, participants heard a list of old and new melodies. For each melody, they rated pleasantness (implicit task), as well as saying whether it was old or new (explicit task). Higher pleasantness ratings for old versus new melodies (mere exposure effect) was the index of implicit memory. Young adults showed good memory in both tasks. Older controls showed poor explicit memory, but preserved implicit memory. AD patients showed poor memory in both tasks. Although AD patients have shown preserved performance on some repetition priming tasks, our result may mean that music is difficult for AD patients to learn, that a rating task is not sufficiently sensitive, or that affective judgments themselves are impaired in AD.

9:00–9:15 (705)

**Divided Attention at Encoding and Retrieval Differentially Affects Conceptual Priming.** DANIELLE CULP & SUPARNA RAJARAM, *SUNY, Stony Brook* (read by Suparna Rajaram)—We tested the processing assumptions of the component process model

(Moscovitch, 1992) that suggests the dissociation between conceptual implicit and explicit memory performance is based on differences between automatic and controlled processes at retrieval. We examined these assumptions using a conceptual implicit memory task of category exemplar production and its explicit version (category cued recall) through a divided attention manipulation (digit monitoring task). In Experiment 1, we replicated previous findings of decreased performance on both tasks when attention was divided at encoding. In Experiment 2, attention was divided at retrieval. This manipulation decreased performance on the explicit task, but did not affect priming on the implicit task. Our results provide support for the processing assumptions of the component process model. Furthermore, the dissociation between a conceptual explicit task and a conceptual implicit task in Experiment 2 supports the assumptions of the transfer-appropriate processing framework (Roediger, 1990).

9:20–9:35 (706)

**Repetition Blindness and Stroop Interference.** VERONIKA COLT-HEART & ROBYN LANGDON, *Macquarie University*—Repetition blindness refers to difficulty in reporting both of a pair of identical or similar words in RSVP sequences. Does repetition blindness merely reflect limits on explicit recall? Coltheart and Langdon (1997) demonstrated that the second critical word semantically primed a subsequent lexical decision target and priming was not reduced by the similar preceding word. We explored the availability of phonological representations of a word in another task. Subjects named the color of a conflicting color name in lists when words followed a similar or an unrelated word. Stroop interference was reduced when the color name, "green," was preceded by the similar "greed," compared with when an unrelated word preceded "green." In recall tasks, these lists yielded repetition blindness. Thus, access to the phonology of the second critical word was reduced without the requirement for recall. Implications for explanations of repetition blindness are considered.

9:40–10:00 (707)

**Applying the Process-Dissociation Procedure to Conceptual Tests of Memory.** DAFNA BERGERBEST & YONATAN GOSHEN-GOTTSTEIN, *Tel-Aviv University* (read by Yonatan Goshen-Gottstein)—The process-dissociation (PD) procedure was applied to two conceptual tests of memory. In the category-exemplar generation task, participants were provided with category names and asked to generate, on half the trials, studied exemplars (the inclusion condition) and to generate unstudied exemplars on the remaining trials (the exclusion condition). In the association-generation task, a list of words was presented, and participants were similarly asked to generate studied or unstudied associates. Evidence for unconscious influences of memory was provided only on the association task, with the estimate for unconscious processes higher than baseline performance. As compared with shallow encoding, deep encoding elevated the conscious estimate, leaving the unconscious estimate unaffected. When applying the PD procedure to the exemplar generation task, however, no support for unconscious influences of memory was obtained. The validity of the assumptions underlying the PD procedure to conceptual tests of memory, and consequent interpretation of the results, will be discussed.

### MEMORY AND ATTENTION Pacific Palisades, Sunday Morning, 9:45–11:30

Chaired by Nelson Cowan, University of Missouri, Columbia

9:45–10:05 (708)

**Is There in Repeated Visual Search No Memory Search?** JULIAN S. JOSEPH, *University of California, Berkeley*, & JAMES MACIOKAS & DANIEL ROWE, *University of Nevada, Reno*—"Inattentional amnesia" is the assertion that "vision has no memory" and that this explains a variety of results, including persistent slopes in repeated

search (Wolfe, 1999), attentional blink for popout (Joseph et al., ARVO96), not “seen but forgotten,” ARVO98, Psychonomics98), explicit-change “blindness” (Rensink et al., 1997), and surprise-change “blindness” (Levin & Simons, 1997). However, even if repeated search observers stored items in memory and conducted memory search, that strategy has its own time-per-item, again giving a persistent slope. We measured asymptotic repeated search and memory search slopes, finding them close (74 vs. 67 msec/item, n.s.) and correlated, suggesting use of a memory search strategy. Surprise memory testing after repeated search revealed significant storage. Explicit-change blindness latencies are serial search  $\times 2$  (entirely attention limited) (ARVO99). In a surprise-change video experiment, an attentional instruction eliminated half the errors (at least partly attention limited) (ARVO99). Memory-encoding limitations are not responsible for all these performance limitations.

#### 10:10–10:25 (709)

**What Are the Units of Visual Short-Term Memory?** DAEYEOL LEE, *Wake Forest University*, & MARVIN M. CHUN, *Yale University*—We investigated whether the capacity of visual short-term memory can be defined by the number of features, objects, or spatial locations. To distinguish these alternatives, we manipulated independently the numbers of features, objects, and spatial locations that subjects had to attend to and report. Subjects made a same–different judgment after viewing a briefly flashed array of multiple elements and a test stimulus. Performance was dependent on set size, and, for a given number of elements, response accuracy was influenced by the number of relevant features and that of relevant objects. These findings suggest that the capacity of visual short-term memory is influenced by multiple factors, including the number of features, objects, and spatial locations. We also modeled the capacity of visual short-term memory on the basis of these data. Attentional selection and short-term memory storage of visual information may be similarly constrained by both object-based and space-based processes.

#### 10:30–10:45 (710)

**Divided Attention in Perception and Memory of Simple Visual Features.** JENNIFER E. MCLEAN, JOHN PALMER, & GEOFFREY R. LOFTUS, *University of Washington* (read by John Palmer)—The effect of divided attention has been attributed to perception, memory encoding, or both. To compare such effects in perception and memory, we measured the effect of increasing set size on matched search and memory tasks. Set-size effects were measured using a yes/no task with stimuli that were small ellipses varying in contrast, orientation, and size. The search and memory tasks differed only in that the target was presented before or after the stimulus set. The observed set-size effect was larger for memory than for search. The magnitude of the effect was described by a theoretical measure that varied from 0 for unlimited capacity to 1 for fixed capacity. By this measure, perception had slightly limited capacity, whereas perception and memory encoding together had nearly fixed capacity.

#### 10:50–11:10 (711)

**A Controlled-Attention View of Working Memory Capacity.** RANDALL W. ENGLE, *Georgia Institute of Technology*, MICHAEL J. KANE, *Georgia State University*, & M. KATHRYN BLECKLEY, *Georgia Tech*—We argue that individual differences in working memory (WM) capacity reflect differences in capability for domain-free controlled attention. Results will be presented from two experiments in which high- and low-WM span individuals performed the antisaccade task. A visual cue appeared either on the same side as a subsequent to-be-identified letter (prosaccade condition) or on the opposite side (antisaccade condition). High- and low-WM subjects were equivalent in the prosaccade condition, but low-WM subjects were differentially slowed in the antisaccade condition. The second experiment repeated the procedure while measuring eye movements. Low-WM subjects were again slowed in the antisaccade condition and they made more reflexive saccades to the misleading cue.

#### 11:15–11:25 (712)

**The Role of Attended Repetition in Negative Priming.** VERONICA J. DARK, PATRICIA A. SCHMIDT, & BRIAN T. CRABB, *Iowa State University*—Although not predicted by theoretical explanations of negative priming (NP), there are suggestions in the literature that inclusion of attended repetition (AR) trials, in which the same target occurs twice in a row, affects the magnitude of NP. A cross-experiment comparison of prior results from our lab confirmed the possible influence of AR trials in that the magnitude of NP increased from 5 to 10 msec when the proportion of AR trials increased from 0% to 7%. The current research directly examined the relationship between the proportion of AR trials and magnitude of NP by varying the proportion of AR trials from 0% to 50% in a continuous word-naming task. Results are discussed in terms of the inhibition, episodic-retrieval, and temporal-discrimination explanations of NP.

### HUMAN PERFORMANCE/MOTOR CONTROL Plaza, Sunday Morning, 10:15–12:20

*Chaired by Mark G. Fischman, Auburn University*

#### 10:15–10:30 (713)

**Unconscious Conceptual Processes Influence Performance on an Unattended Motor Task.** ELIZABETH FRANZ, CARON LAMB, & BARBARA BALLANTINE, *University of Otago*—Across five experiments, we demonstrated that unconscious conceptual processes influence performance on an unattended motor task. One set of experiments employed lists containing nouns naming large (e.g., elephant, building) or small size objects (e.g., toothpick, almond) or abstract words (e.g., honesty, faith), presented in different blocks of trials. Participants were instructed to silently rehearse the items while drawing circles with the right hand “as merely a time-filler task,” followed by recall of the items. A second set of experiments employed the same procedures but replaced the “large” and “small” word lists with numbers from the large or small extremes of a range. Both sets of experiments demonstrated clear effects of conceptual size on the size of the circles drawn. Independent evaluations verified that the circle drawing task was unattended, and participants were not consciously aware that items on the memory lists formed a conceptual category of size.

#### 10:35–10:55 (714)

**Signal Detection Theory and Its Measurement Fallacy.** JERRY D. BALAKRISHNAN, *Purdue University*—Signal detection theory (SDT) statistics are routinely used to test hypotheses about the effects of experimental variables on “sensitivity” while controlling for effects of “response bias.” Many domain-specific theories of human behavior also fall within the scope of SDT. Using new empirical tests that do not depend on the distributional assumptions of SDT, I have recently reported evidence that directly contradicts the fundamental assumptions of this formal model: criteria do not shift, but the encoding distributions change their shapes under standard bias manipulations. In this paper, I review these findings and discuss their implications for human performance assessment. I then discuss the “robustness” of the new tests to potential modifications of SDT that might be proposed to explain the empirical results without dropping the concept of a variable detection criterion. I also propose some new measures and hypothesis testing rules that can replace the SDT indices.

#### 11:00–11:15 (715)

**Influence of Initiating Action on the Up-Right/Down-Left Mapping Advantage.** YANG SEOK CHO & ROBERT W. PROCTOR, *Purdue University* (read by Robert W. Proctor)—When up and down stimuli are mapped to left and right keypresses or “left” and “right” vocalizations in two-choice reaction tasks, performance is often better with the up-right/down-left mapping than with the opposite map-

ping. Adam, Boon, Paas, and Umiltà (1998) reported that the up-right/down-left advantage is obtained when participants initiate each trial but not when the computer does. They interpreted this finding in terms of a dual-strategy hypothesis, which attributes the advantage to use of verbal codes in the former case but not the latter. Our experiments showed the up-right/down-left advantage for both computer-paced and participant-paced conditions. However, the advantage was reduced when the initiating action was left rather than right. These results are consistent with the view that the up-right/down-left advantage is due to asymmetry in coding the alternatives on each dimension, but provide no support for Adam et al.'s claim that this asymmetry is restricted to verbal codes.

#### 11:20–11:35 (716)

**The Accuracy of Finger Pointing Under Illusory Displacement Depends on Its Distance From the Body.** WENXUN LI & LEONARD MATIN, *Columbia University*—The elevation of a target visually perceived at eye level (VPEL) was raised 5° or lowered 13° as a result of viewing a long line (horizontal eccentricity: 25°) in total darkness pitched +30° (top forward) or –30°, respectively. However, with the unseen hand in the midfrontal plane, manual height matches to the target set to VPEL were always at true eye level (TEL), and pointing with the finger from TEL was always horizontal (search coil measurements). As the distance of the arm from the midfrontal plane was increased to 40 cm, the height-match errors were gradually reduced, and with a fully extended arm the pointing direction to VPEL was generally accurate. Thus, the subject's motor behavior relative to the visual target depends critically on the distance of the arm from the body. With the arm close to the body, pointing mirrors the illusory perception; with the arm further from the body, the motor behavior becomes increasingly veridical and independent of the illusory perception.

#### 11:40–11:55 (717)

**Implicit Versus Explicit Learning of Complex Motor Skills.** GABRIELE WULF, *Max Planck Institute for Psychological Research, Munich*, & CHARLES SHEA, CHAD WHITACRE, & JIN-HOON PARK, *Texas A&M University*—Implicit learning in complex motor skill acquisition was examined. Participants were required to balance on a stabilometer and to move the platform in accordance with a pattern presented on a screen. In Experiment 1, the middle third of the pattern was repeated on each trial, whereas the beginning and ending thirds changed. On a retention test, the middle segment was performed more accurately than the other segments, without participants being aware of the repetitions. In Experiment 2, the first and last thirds of the tracking patterns were identical and repeated on each trial, whereas the middle third was random. However, participants were informed that only one segment (first or last) was repeated. On a retention test, errors on the repeated-unknown segment were smaller than those on the repeated-known and on the nonrepeated segments. Thus, providing learners with explicit knowledge about regularities in the environmental information can actually degrade learning.

#### 12:00–12:15 (718)

**Use of Subliminal Temporal Information in Perception–Action Coordination.** BRUNO H. REPP, *Haskins Laboratories*—It is usually assumed that the relevant informational variable in perceptual–motor synchronization tasks is the subjective phase angle (asynchrony) between a periodic stimulus (e.g., auditory metronome) and a motor action (e.g., finger taps). Previous studies have shown that perceptually subliminal perturbations in stimulus timing are rapidly compensated for in motor timing. The present experiments show that this compensation occurs also (1) when the finger taps are out of phase with the metronome, (2) when they are temporarily suspended during the perturbation, and (3) when the compensation is unintended and unnecessary for maintaining synchrony. The results suggest that the compensation is (or can be) based on the phase angle between a timing expectation and the stimulus, and they also confirm that the compensation is not under voluntary control.

### PERCEPTION OF RELATIONS

Santa Monica, Sunday Morning, 10:05–12:25

Chaired by Albert Yonas, *University of Minnesota*

#### 10:05–10:20 (719)

**Learning New Spatial Insights.** JOHN R. PANI, WILLIAM P. NEACE, & SCOTT R. ROBINSON, *University of Louisville*—Competent perception and successful spatial reasoning require understanding numerous spatial relations in terms of various spatial reference systems (e.g., the structure of objects, the environment, the viewer). What is involved in learning such complex sets of relations? In a set of ongoing studies, participants acquire new physical insights by observing and interacting with photorealistic dynamic displays of physical scenes and events (i.e., in a desktop virtual reality environment). In studies of learning about rotation, for example, participants control a conventional rotational mechanism (a transmitter dish) that goes through a variety of motions. Participants learn to predict the outcomes of motions that normally would be confusing for them. We report the effects on learning a variety of tasks (e.g., pure observation or control and observation), learning situations (e.g., prediction with or without explicit feedback), and extended practice in this research environment.

#### 10:25–10:40 (720)

**A Formula for Eliminating Those Stubborn Switch Costs.** AMELIA R. HUNT & RAYMOND M. KLEIN, *Dalhousie University* (read by Raymond M. Klein)—When there is insufficient time to prepare for it, a switch between tasks with incompatible rules results in a cost to reaction time and/or accuracy. Recognized as a potential window into executive control processes, such switch costs have been extensively studied in recent years. “Residual” switch costs, which stubbornly remain despite sufficient time to prepare, have led to the theory that complete preparation of a new task set is not possible until cued exogenously by the arrival of the imperative stimulus. Using a “model” saccadic reaction time task, we disconfirm this proposal and demonstrate that residual switch costs can be completely eliminated so long as three conditions are met: (1) little or no uncertainty about what rule should be active, (2) sufficient time to switch (load the “new” rule into working memory), and (3) little or no uncertainty about when the imperative signal will occur.

#### 10:45–10:55 (721)

**Cortical Localization of Linguistic Expectations.** HOWARD C. NUSBAUM, *University of Chicago*, NOAM ALPERIN, *University of Illinois, Chicago*, VERNON L. TOWLE & ALEXANDER FRANCIS, *University of Chicago*, & NEAL BARSHES & RICHARD YARGER, *University of Illinois, Chicago*—Classical neuropsychological models of language comprehension are structured with a bottom-up flow of processing. Primary auditory cortex feeds Wernicke's area, which connects to Broca's area. This architecture is similar, in general terms, to many bottom-up, modular views of language processing that can include autonomous auditory, phonological, lexical, syntactic, semantic, and cognitive mechanisms. In both cases, listeners' expectations about the nature of an auditory pattern have no role in the processing flow, whereas the acoustic structure of a pattern could determine how the pattern is processed. We presented listeners with three different types of acoustic patterns (sinewave speech vs. time-varying nonspeech patterns vs. natural speech). In addition, we manipulated listeners' expectations (language vs. nonspeech auditory patterns). We measured cortical *bold* responses to these stimuli under different conditions using fMRI. The patterns of cortical activation revealed by the fMRI argue against classical neuropsychological and modular models of language comprehension.

#### 11:00–11:10 (722)

**Are “Perfect Fifths” Perceptual Magnets or Anchors?** E. GLENN SCHELLENBERG, *University of Toronto, Mississauga*—Two experiments examined listeners' ability to make within-category dis-

criminations of musical intervals (pairs of pure tones). The intervals were perfect fifths that were well tuned (7 semitones) or mistuned (by up to 0.4 semitones). Listeners heard a five-tone sequence of alternating pure tones (ABABA) that repeated in transposition; their task was to differentiate a 0.2-semitone change in the top tone from an exact transposition of the original (standard) sequence. Performance was significantly better when the displacement increased rather than decreased the degree of mistuning, but it was unaffected by the nature of the standard interval (well tuned or mistuned). The pattern of results was comparable for musically sophisticated and unsophisticated listeners tested in within-subjects and between-subjects designs. The observed asymmetries are consistent with the view that musical intervals function more like perceptual anchors than like magnets.

#### 11:15–11:35 (723)

**Understanding the Bisection Psychometric Function.** LORRAINE ALLAN, *McMaster University*—In a temporal bisection task, the subject is familiarized with a pair of referents, S and L. On probe trials, a duration  $t$  is presented, and the subject is required to indicate whether  $t$  is more similar to S (RS) or to L (RL). The data are summarized as a psychometric function relating P(RL) to  $t$ . The bisection point is the value of  $t$  at which RS and RL occur with equal frequency (i.e.,  $P(RL) = .5$ ). Some studies have reported that bisection is at the geometric mean of S and L, but other studies have reported bisection closer to the arithmetic mean. There are also conflicting results regarding the effect of the L-to-S ratio and the spacing of  $t$  on the psychometric function relating P(RL) to  $t$  normalized by the bisection point. Human bisection data will be reported from experiments conducted to address these conflicting findings.

#### 11:40–11:55 (724)

**Estimating Egocentric and Exocentric Distances.** KARL F. WENDER, *University of Trier*—In a previous study by Loomis et al. (1992), a striking difference was found between matching of two exocentric distances and estimating egocentric distances by walking without vision. In a series of experiments, we tried to determine the cause of this difference. The first experiment tested whether memory for locations might be separated from distance estimation. This was not the case. Two further experiments examined whether the results by Loomis et al. might have been caused by different response procedures. Again, this was not found. In a final experiment, we are investigating whether estimation of egocentric and exocentric distances involves different processes and thereby leads to different results. This is not implausible since we always have to estimate egocentric distances while navigating through our environment. The necessity to estimate exocentric distances occurs much less frequently and, hence, may be a less sophisticated skill.

#### 12:00–12:20 (725)

**The Unbearable Lightness of Theory? An Illusion of Explanatory Depth.** LEONID G. ROZENBLIT & FRANK C. KEIL, *Yale University* (read by Frank C. Keil)—Causal explanatory knowledge pervades much of our everyday cognition. In the study of concepts, the “theory-theory” argues that almost everything we do with concepts is heavily influenced by how those concepts are embedded in implicit or naive theories of the world around us. Demonstrations of the influences of theory are many and seem irrefutable, yet a closer look at such theories points to huge gaps and inconsistencies. We argue that people labor under an illusion of explanatory depth, wherein they think they have much richer and more complete understandings of the mechanism for most devices than they do. This illusion is demonstrated in a series of studies that document a marked discrepancy between what people think they know and what they really know. Reasons for the illusion are explored. Finally, we describe how our more limited and skeletal explanatory knowledge is not only bearable, but also more appropriate in most cases.

### PSYCHOLINGUISTICS: SYNTACTIC EFFECTS Beverly Hills, Sunday Morning, 10:15–12:25

*Chaired by Matthew J. Traxler, Florida State University*

#### 10:15–10:30 (726)

**Lexical Encoding of Syntax: PP Arguments Versus PP Adjuncts.** JULIE BOLAND, *Rutgers University*, ALLISON BLODGETT, *Ohio State University*, & KIM AINSWORTH-DARNELL, *Georgia State University*—Within the debate regarding the lexical representation of syntactic knowledge, we have maintained that only argument structure information is encoded lexically. Thus, as syntactic structure is developed during sentence comprehension, (lexically specified) arguments and (nonlexically specified) adjuncts are attached via different mechanisms. Argument sites are accessed during word recognition and weighted by frequency. Thus, attaching a frequently occurring argument is easier than attaching a less frequent argument. In contrast, adjuncts are attached using categorial phrase structure rules, and therefore are relatively insensitive to frequency effects. We measured eye movements as people read sentences containing four types of prepositional phrases: verb phrase arguments, verb phrase adjuncts, noun phrase arguments, and noun phrase adjuncts. First-pass reading times reflected an advantage for argument attachments. Furthermore, reading times for arguments (but not adjuncts) were correlated with argument/(adjunct) frequency, as predicted, although noun attachments patterned somewhat differently than verb attachments.

#### 10:35–10:55 (727)

**Children’s Use of Syntactic and Pragmatic Factors During Sentence Processing: Evidence From Listeners’ Eye Movements.** JOHN C. TRUESWELL, IRINA SEKERINA, MARIAN L. LOGRIP, & NICOLE M. HILL, *University of Pennsylvania*—The moment-by-moment language processing strategies of children and adults were examined by using a head-mounted eye-tracking system as subjects acted on spoken instructions that contained temporary syntactic ambiguities. The eye movement and action data revealed that children, ages 4.5–6 years, rely more on local linguistic factors than pragmatic factors (e.g., the referential principle, Crain & Steedman, 1985) to resolve ambiguities. Children showed a strong preference to interpret ambiguous phrases as verb arguments regardless of context, but exhibited some sensitivity to verb-specific syntactic constraints when making initial parsing commitments. Moreover, children were unable or unwilling to revise these commitments, based on later disambiguating material. In contrast, adults were able to take into account pragmatic factors during the earliest stages of processing and were able to revise incorrect parsing commitments. Implications for theories of language processing and language acquisition will be discussed.

#### 11:00–11:15 (728)

**Processing Cataphoric Pronouns.** SIMON P. LIVERSEDGE, *University of Durham*, & ROGER P. G. VAN GOMPEL, *University of Glasgow*—Cowart and Cairns (1986) argue that gender and number information is used to guide cataphoric pronoun assignment. We conducted two eye-movement experiments using sentences like (1) and (2) to test this claim.

1. When she was waiting, the man noticed the woman.
2. When he was waiting, the men noticed the boy.

Readers experienced disruption to processing shortly after reading the first noun phrase in the main clause for both types of sentence suggesting that they initially attempted to form a referential link between the cataphor (she/he) and the first noun phrase despite a morphological mismatch. In a third experiment, we investigated whether readers prefer to assign pronouns to a preceding noun phrase in the text (anaphoric assignment) or to a following noun phrase (cataphoric assignment). Our results indicate that readers assign pronouns both forward and backward.

**11:20–11:35 (729)**

**Sentence Comprehension Is Mediated by Content-Addressable Memory Structures.** BRIAN D. McELREE, *New York University*—Studies of working memory (WM) demonstrate that some forms of information are retrieved by a content-addressable mechanism, whereas others require a slower search-based mechanism. The nature of the WM system that mediates sentence comprehension was explored in a series of studies that examine the processing of sentences with long-distance filler-gap dependencies. Measures of speed and accuracy derived from the speed-accuracy tradeoff procedure demonstrate that the probability of maintaining a representation of a filler item decreases as additional material is processed, but that the speed with which a preserved representation is accessed is unaffected by the amount of interpolated material. These results suggest that basic binding operations in sentence comprehension are mediated by a content-addressable memory system: Syntactic and semantic constraints provide direct access to relevant representations without the need to search through potentially irrelevant memory structures.

**11:40–11:55 (730)**

**Theta-Roles Assigned Along the Garden Path Linger, Part 2.** KIEL CHRISTIANSON, ANDREW HOLLINGWORTH, & FERNANDA FERREIRA, *Michigan State University* (read by Fernanda Ferreira)—Last year, we reported that participants given garden-path sentences such as “While the man hunted the deer ran in the woods” and then asked whether the man hunted the deer often said “yes.” Our new data make three new points: First, the misinterpretation is much less likely to occur when participants are shown “The deer ran in the woods while the man hunted.” Second, when garden-pathed, participants answer correctly that the deer is running in the woods at the same time that they think the man is hunting the deer; thus, the phrase “the deer” is serving both as object of the first clause and subject of the second. Finally, the misrepresentation occurs even with a specific class of verbs that syntactically force a reflexive interpretation of implicit objects. Thus, the initial interpretation constructed from an incorrect syntactic parse is not always purged when a new parse is constructed.

**12:00–12:20 (731)**

**Grammatical Processing of First and Second Languages Acquired After Childhood.** RACHEL I. MAYBERRY, *McGill University*, ELIZABETH LOCK, *Dalhousie University*, & PATRICK BOUDREAULT & CHARLENE CHAMBERLAIN, *McGill University*—Does age of acquisition affect language processing uniformly? If language exposure during early childhood is essential for all subsequent language processing, then second languages acquired after childhood should be processed differently from first languages acquired at the same old ages. The results of three experiments support the hypothesis. Tasks were grammatical judgments of ASL and English sentences. Participants were deaf adults who either did or did not have exposure to language in early childhood and normally hearing adults who acquired English as a first or second language. Marked deficits in grammatical processing of both ASL and English were shown by deaf adults who had little or no language in early childhood. Near-native grammatical processing was shown by the second-language learners, both hearing and deaf, who had acquired language in early childhood. These findings suggest that early language experience is necessary for the complete development of all subsequent linguistic processing.

**COMPREHENSION/REASONING**  
Westside, Sunday Morning, 10:15–12:25

*Chaired by Steven H. Schwartz, University of Massachusetts, Boston*

**10:15–10:30 (732)**

**Guilty or Not Guilty: Courtroom Cognition.** RUTH S. DAY, *Duke University*—Jurors must understand criminal law well enough to decide whether defendants are guilty. However, legal codes are often

hard to understand. Participants studied a brief, widely used criminal code, then decided whether defendants in various scenarios were guilty or not guilty. Overall performance in initial experiments was poor—about 40% of the time, people gave the wrong verdict. Subsequent experiments examined factors potentially responsible for this dismal performance, including the amount of deliberation time allowed, presence or absence of the legal code during deliberation, visual format of the code, linguistic aspects of deciding guilt, prior knowledge of criminal law, ability to evaluate evidence in the scenarios, and the logical structure of the law. Performance was remarkably resistant to improvement across variations in most of these factors. This research holds implications for understanding complex cognition in both the laboratory and everyday settings.

**10:35–10:50 (733)**

**Proof Recognition in Conditional Reasoning.** JOHN B. BEST, *Eastern Illinois University*—Although explanations of modus tollens (MT) difficulty abound, scant attention has been paid to those who can actually do it. Here, subjects solved a series of conditional reasoning problems tapping MT, affirming the consequent (AC), and denying the antecedent (DA) responses. Then they read a set of problems accompanied by complete or partial “proofs” of the problems’ conclusions. Complete proofs consisted of a standard four-line argument and justification. Partial proofs consisted of only the important first line (a counterfactual supposition) and justification. The reasoners evaluated the proofs’ convincingness. Subjects who were MT competent (i.e., no MT errors) were more likely than less competent reasoners to find complete proofs of MT convincing and to find bogus “proofs” of AC and DA reasoning unconvincing. However, competent reasoners were no more likely than less competent reasoners to find partial MT proofs at all convincing, raising questions concerning their deductive mechanism.

**10:55–11:15 (734)**

**Estimating Conjunctive Causal Power.** LAURA R. NOVICK, *Vanderbilt University*, & PATRICIA W. CHENG, *UCLA* (read by Patricia W. Cheng)—Cheng’s (1997) power PC theory accounts for the induction of simple causes. According to this theory, covariation is defined by probabilities that are estimable by observable events, whereas causal power is a theoretical entity that cannot be observed. To estimate unobservable causal powers, which is the tacit goal of causal inference, reasoners bootstrap by explaining observable covariation in terms of these theoretical powers. We have developed an extension of this theory to account for the induction of conjunctive causes—that is, causes that interact to produce an effect. This extension uses the concept of independent influence (no interaction) adopted in the original theory. The resulting conjunctive power measures differ from measures of interaction in conventional statistics for categorical data. We argue that, for testing causal hypotheses, our conjunctive power measures are both more descriptive of untutored causal reasoning and more normative than conventional statistics.

**11:20–11:35 (735)**

**Contrasting Illnesses Promotes Both Differential and Multiple Diagnoses.** LESLIE J. ROBISON & CARLA C. CHANDLER, *Washington State University* (read by Carla C. Chandler)—Teaching format can influence how learners gather and use information in order to reach either a differential diagnosis (the patient has illness X but not illness Y) or a multiple diagnosis (the patient has both illnesses). Young adults learned about heart attacks and panic attacks, either in succession or by contrasting their symptoms. Those who learned by contrasting the symptoms (1) chose to ask more questions about symptoms that could distinguish between the illnesses, (2) arrived at the appropriate differential or multiple diagnosis more often, and (3) cited more diagnostic symptoms to justify their diagnoses. By contrasting two illnesses, people acquire a better knowledge of which symptoms are informative, and they use this knowledge in a flexible way to make either a differential diagnosis or a multiple diagnosis.

**11:40–12:00 (736)**

**Tests of a Process Model of Human Visuospatial Reasoning.** JESSE M. CHOPLIN & JOHN E. HUMMEL, *UCLA* (read by John E. Hummel)—Numerous researchers have proposed that people reason about transitive relations by mapping objects to locations in a mental array (e.g., DeSoto et al., 1965; Huttenlocher, 1968; Johnson-Laird, 1983). Hummel and Holyoak (in press) proposed a computational model of transitive inference based on this idea. Given comparative statements such as  $A > B$ , and  $B > C$ , the model maps A, B, and C onto locations in a mental array and uses those locations to draw inferences about which is greatest, which is least, and so on. The model assigns A, B, and C to different locations in the array depending on how the relations are stated (e.g.,  $A > B$  vs.  $B < A$ ) and in what order. The location assignments constitute specific predictions about human judgments of magnitude and proximity as a function of how the relations between elements are expressed. We report several experiments supporting these predictions.

**12:05–12:20 (737)**

**Role of Cognitive Load in Multimedia Learning.** RICHARD E. MAYER & JULIE HEISER, *University of California, Santa Barbara*—How do people form mental models from multimedia presentations? In two experiments, students viewed an animation and listened to concurrent narration explaining the formation of lightning. When students also received concurrent on-screen text that summarized (Experiments 1 and 2) or duplicated (Experiment 2) the narration, they performed worse on tests of retention and transfer than students who received no on-screen text. These results reflect a *redundancy effect* in which receiving identical information via two modalities (i.e., narration and on-screen text) is less effective than receiving the information via one modality (i.e., narration). Adding seductive details to the narration and text (Experiment 1) and focusing on low-spatial ability learners (Experiment 2) also resulted in lower test performance. The results are consistent with a dual-channel theory of multimedia learning in which on-screen text can produce a cognitive overload of the visual information-processing channel.

**WORKING MEMORY/SHORT-TERM MEMORY**  
**Century, Sunday Morning, 10:15–12:00**

*Chaired by Thomas D. Wickens, UCLA*

**10:15–10:35 (738)**

**A Semantic Component in STM: Experimental Results and Computational Study.** HENK HAARMANN, *University of Maryland*, & MARIUS USHER, *University of Kent* (read by Marius Usher)—A standard view of verbal working memory is that it is exclusively phonological and that semantic encoding necessarily results in permanent traces in long-term memory. We report results from an experiment that demonstrates transient semantic activation and, together with recent neuropsychological studies (Martin et al., *J. Memory & Language*, 1994), indicates a separate semantic system of working memory associated with the frontal lobes. We tested free recall with lists of words consisting of pairs of (semantically related) associates. The distance between the associates was either short or long, and the recall was either immediate or delayed by an interpolated distractor task. The short-term memory component was computed and found to be higher in the short (than long) distance condition. Moreover, the effect was located at the recency area, exactly as predicted in our computer simulations of a model for short-term retention of lexical/semantic information within the frontal lobes.

**10:40–10:55 (739)**

**An Explicit Model of Verbal Working Memory in Serial Recall.** THAD A. POLK, SCOTT A. WALLACE, & BRAHM M. WINDELER, *University of Michigan*—We present a computationally explicit model of verbal working memory that provides a unified account of a range of phenomena in serial recall. The model is based on three simple and

biologically plausible assumptions: massive, bidirectional connectivity, continuous-valued activation, and Hebbian learning. Together these assumptions give rise to continuous attractor nets that settle into stored patterns of distributed activity but that decay when input is removed. We show that this architecture naturally accommodates many of the major phenomena associated with serial recall, including both low-level phenomena (e.g., time-based effects that arise from attractor decay; similarity-based interference/confusion that arises from cross-talk among similar distributed representations) as well as high-level strategies (e.g., sequential rehearsal of individual items that is naturally modeled as moving through a sequence of attractor states).

**11:00–11:20 (740)**

**The Episodic Buffer: A Fourth Component of Working Memory?** ALAN D. BADDELEY, *University of Bristol*—Baddeley and Hitch proposed a three-component model of working memory (WM) comprising two slave systems and the central executive. The model continues to be very useful, but fails, however, to address such important issues as (1) the interaction between WM and LTM and between different slave systems, (2) the nature of chunking and limitations on WM span, and (3) the role of conscious awareness. A fourth component, the *episodic buffer*, is proposed. Using temporary storage capacity, it integrates information from LTM and the slave systems, under the active control of the central executive. Conscious awareness plays a focal role in retrieval. The episodic buffer serves as a modeling space for representing the current environment, recollection from episodic memory, and the development of future plans. Similarities with other models of WM will be discussed, as will methods of empirical investigation.

**11:25–11:40 (741)**

**Memory Span Modulates Serial-Position Effects in Comparative Judgments With Middle Reference Points.** JERWEN JOU, *University of Texas, Pan American*, RAVISHANKAR VEDANTAM, *Ericsson Inc.*, DANEE R. WILSON, *University of Texas, Pan American*, GARY E. LEKA, *Charter Palms Behavioral Health System*, & RUBY A. ISLAS, *University of Texas, Pan American*—Subjects memorized linear orders of varied lengths and made comparative judgments on pairs of items using the middle item as the reference point (“choose the one closer to or farther from the middle item”). The RT/serial-position function could have either a single peak or multiple peaks. The length of the linear order and the distance between the two comparison items jointly determined the shape of the serial-position curve. These two factors modulated the serial-position effects through the limiting mechanism of memory span. A reference point that was located more than the memory span’s distance from either comparison item was not an effective reference point and tended to lose the function as a reference point. This could change the shape of the serial-position curve. This study provided a coherent theory of serial-position effects in linear order memory.

**11:45–11:55 (742)**

**The Effect of Phonological Redundancy on Immediate Recall.** ELISABET SERVICE & SINI MAURY, *University of Helsinki*—A previous study (Service, 1998) showed that adding phonemes to pseudowords based on Finnish (e.g., /tepa/ vs. /tepal/) impaired recall for them, whereas replacing them with variants that took longer to pronounce (/tepa/ vs. /te:p:a/) had a negligible effect. This could have happened because the longer variants had a more redundant structure, which supported redintegration. This process is thought to use all available knowledge to repair parts of the memory trace that have suffered damage. We tested a redundancy explanation by adding the same syllable (/ne/) to all pseudowords to be memorized—either to the middle (/tepa/ vs. /tenepa/) or the end (/tepane/). The syllable was perfectly predictable in its position in the stimuli and should therefore be available for redintegration. Short pseudowords were the easiest to remember, items with a redundant end were intermediate, and items with a redundant middle syllable were not different from nonredundant three-syllable items.