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Organizers: George Sperling and Richard Shiffrin
University of California, Irvine, and Indiana University

ABSTRACTS

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Julie Adams
Vanderbilt University

Cognitive Limitations When Humans Interacts With Large Teams of Robots

This presentation will focus on a number of cognitive limitations that occur when humans must remotely supervise and direct large teams of ground and aerial robots. As the field continues to develop robotic systems for real-time, highly dynamic domains, the ability to support the human cognitive capabilities while facilitating system monitoring and human decision-making becomes critical. This presentation will be grounded with examples from our evaluation of the response to Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) device domain (e.g. mass casualty events such as 9-11 ground zero) for which we are developing such systems. The CBRNE response typically differs for each event, is highly stressful, highly dynamic, and places limitations on the human response. Human-robotic interaction for such domains requires consideration of salience, vigilance, fatigue, stress, cognitive workload, situational awareness, memory recall, etc.

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Tina Beard
NASA Ames Research Center

Cognitive Assessment in Spaceflight Analogue Environments
Authors: B. L. Beard, J. Holbrook, & A. J. Ahumada, Jr.

Since the days of Apollo (NSF report, 1971), it has been known that some astronaut cognitive abilities are affected during spaceflight. Recent data collected on the International Space Station (ISS) using the WinSCAT cognitive test battery reaffirm this finding for journeys lasting as long as 6 months (Fiedler, 2007). The factors leading to this cognitive decline have not been determined. The purpose of the proposed research was to identify whether the Constellation ascent environment, including vibration and >1g forces, contribute to the cognitive changes previously reported in the literature.
Participants were presented with computerized cognitive skills sub-tests before and after they participated in vibration and centrifuge familiarization routines (as part of a separate study). Using computerized and paper assessment tools we measured:

subjective stress and fatigue,
learning ability (code substitution),
memory recall (code substitution with delay),
executive functioning (simple mathematics),
visuo-spatial abilities (match to sample), and
measures of attention and executive functioning (running memory).

Results suggest that some aspects of executive functioning are affected by NASA's planned ascent environment in the Constellation Program. Discussion will include issues with the current cognitive test used by the space agency and how monitoring astronaut cognition could evolve in the future. In this presentation we report results from an ongoing study of temporal processing in older adults.

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Angela Brown
Ohio State University

Infant Visual Performance is Primarily Limited by "Mid-Level" Critical Immaturities
Authors: A. Brown and D. Lindsey

Infants do not see as well as adults do: infant psychophysical sensitivity to light, color, and contrast is far below the comparable values in adults, and vernier acuity and stereopsis cannot be measured until after age 3 months, probably because infant contrast sensitivity is poor. Here we address the classic question in the study of infant vision: which of the many known neurological immaturities of infants critically limit infant visual performance?

Neonatal foveal cones are very immature, and probably do not generate strong enough responses to mediate visual performance, suggesting that infant vision should be compared to adult extrafoveal vision. Consistent with this view, the infant CSF can be superimposed on the adult extrafoveal CSF by a simple overall scaling of sensitivity by about a factor of 50. In contrast to the fovea, the infant extrafoveal retina is morphologically much more mature. Analysis of the results of increment threshold experiments suggests that early-stage "low-level" immaturities (e.g., slightly shorter length of infant rod outer segments) cannot explain the 50-fold difference between infant and adult contrast sensitivity. Contrast discrimination experiments indicate that the critical immaturity that limits overall infant contrast sensitivity occurs before the site of the contrast gain control, making it a "mid-level" rather than a high-level immaturity. Strikingly, binocular summation data collected in our lab indicate that infant inattentiveness to the psychophysical task is not a critical immaturity in infant vision.

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Patricia Cheng
University of California, Los Angeles

A Mental Construct of Causation for the Coherent Representation of an Objective Causal World

Associative and causal theories of learning differ with respect to whether reasoners filter events through an a priori mental construct of unobservable causal events. Although assumptions about unobservable events are, ceteris paribus, objectionable, recent work has shown that a core set of assumptions about such events is essential to a coherent representation of the causal world. It is therefore not surprising that humans and rats seem to share the same set of a priori assumptions. This talk will illustrate how this core set enables reasoners to 1) estimate the strength of a cause to influence an effect, 2) generalize coherently to a novel context, and 3) make diagnostic causal inferences. Each of these capabilities poses a challenge to associative theories.

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Edgar (Ted) DeYoe
Medical College of Wisconsin

Neuroimaging Aids for Brain Cancer Treatment

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Edgar (Ted) DeYoe
Medical College of Wisconsin

The Cortical "Window of Attention" and Its Relationship to the Visual Field
Authors: E. A. DeYoe, A. Puckett, J. Brefczynski, & R. Datta

The spatial pattern of cortical activity associated with directed visual attention in humans has been described by a number of labs using fMRI and is itself of some interest. However, the relationship between the cortical effects of attention and their expression within the visual field of the observer is perhaps of more direct interest for understanding the spatial effects of attention on perception and behavior. To help understand this relationship, we previously developed a method for projecting the cortical pattern of attentional effects onto a diagram of the visual field using the empirically measured retinotopy, thereby yielding an Attentional Field Map (AFMap). One empirical observation is that the size of the window of attention scales directly with the size and/or eccentricity of an attended target appearing at different eccentricities in the

visual field but with a scale factor significantly greater than 1. We have modeled this relationship using a theoretical description of the cortical mapping function in V1 (Polimeni, 2006) combined with different assumptions about an ideal description of the cortical attentional pattern. For eccentricities ranging from approximately 5-20 degrees, the scaling of the attentional window in the visual field is consistent with a constant sized cortical "window" of attention. Together, the empirical and theoretical results suggest that the size of the attentional "window" over this eccentricity range reflects known principles of cortical organization rather than presumed qualitative differences between central and peripheral attentional processes.

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Barbara Dosher
University of California, Irvine

Perceptual Learning of Judgment Precision: An Elaborated Perceptual Template Mode
Authors: B. Dosher, W. Chu, & Z.-L. Lu

The discrimination of two stimuli can be measured as a contrast threshold at a constant stimulus difference (i.e., +/- 45 deg orientation) or as an orientation threshold at a given contrast. Both can be understood together within an elaborated perceptual template model (ePTM) that incorporates the effects of judgment precision, or non-orthogonal stimuli for discrimination (Jeon, Lu, & Dosher, 2008). Perceptual learning improvements in contrast thresholds have been studied in different external noise conditions (Dosher & Lu, 1998, 1999, and others), while stimulus difference thresholds have not. Indeed, perceptual learning has not been widely measured for stimulus difference thresholds, except for hyperacuity tasks. Here, perceptual learning of stimulus difference thresholds is investigated for orientation identification. Orientation thresholds were practiced in zero and in high external noise; orientation psychometric functions were measured for orientation difference threshold versus noise contrast (dTvC) functions; and practice effects were measured in the dTvCs. Perceptual learning was measured for foveal and peripheral Gabor orientation. The ePTM provided a good account of the orientation psychometric functions in different levels of external noise. The elaborated perceptual template model predicts accuracy as a joint function of orientation difference, contrast, and external noise, with perceptual learning resulting in reduced impact of external and additive internal noises.

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Mike Goodrich
Brigham Young University

The Right Amount of Robot Autonomy For Humans-In-The-Loop

Fan-out defines the maximum amount number of robots a single human can mange. It is often desirable to maximize fan-out so that human intelligence is leveraged across multiple tasks or applications. However, practical human-robot systems often have inverted fan-out, with many humans managing a single robot. Using notions from adjustable autonomy and case studies in designing robot systems for search and exploration, we discuss how fan-out limitations influence both minimum and maximum robot autonomy levels for human-in-the-loop systems.

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Norma Graham
Columbia University

More About "Buffy" Adaptation and Its Interaction With "Weber" Adaptation
Authors: N. V Graham & S. S. Wolfson

At a talk here 3 years ago I reported some of our first results about a rather surprising (to us anyway) effect of adaptation to visual contrast. As the observer adapts to different levels of contrast, the visibility of some contrast-defined (second-order) patterns dramatically increases and that of others dramatically decreases. Oddly, if a test pattern contains two contrasts - one above and one below the contrast of the preceding adapting pattern - the test pattern is very difficult to perceive correctly. We nicknamed this effect the "*Buffy effect*" for autobiographical reasons and for lack of a better name.

To explain the Buffy effect, we suggested a process in which a *comparison level* is continually updated at each spatial position so that it equals the recent weighted average contrast level at that position. The visual contrast at any moment of time is processed relative to the comparison level at that moment; the magnitude of the difference between the current contrast and the comparison level is preserved, but information about the sign of the difference is degraded or lost. Why the visual system would evolve to throw away information is always a puzzle.

We have now investigated a wider range of adapt and test contrasts (and in a simpler kind of experiment than I described here last time). Over this wider range you can see the Buffy effect interacting with a generalized form of Weber-law behavior, which can be explained by a contrast-gain process modeled by a normalization network. We have a simple model including both the Buffy and the Weber processes. This model can account quite well for a range of experimental results but does not attempt to explain the processes' dynamics.

We have begun experiments exploring the processes' dynamics. The resetting of the comparison level in the Buffy process seems fast enough to easily occur within a typical eye fixation. The Weber process seems to be slower. We have a simple model of the dynamics of the Buffy process (but not of the Weber process yet).

The functional significance -- the role in everyday vision -- of the Buffy process and its interaction with the Weber process remains a puzzle.

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David Heeger
New York University

The Normalization Model of Attention
Authors: D. J. Heeger & J. H. Reynolds

Attention has been found to have a wide variety of effects on the responses of neurons in visual cortex. We describe a model of attention that exhibits each of these different forms of attentional modulation, depending on the stimulus conditions and the spread (or selectivity) of the attention field in the model. The model consists of 3 basic components. (1) The stimulation field characterizes the stimulus-selectivity (e.g., for spatial location, orientation, direction of motion, etc.) of each model neuron. (2) Divisive suppression is pooled over a suppressive field that is a larger region of spatial locations and features (e.g., orientations, motion directions) than the stimulation field. (3) The attention field, which represents the attentional feedback signals, scales the stimulation drive of each neuron in the population (and is then inherited by the suppressive field). The attention field is specified in terms of its gain for each neuron in the population, i.e., in terms of its spatial and featural extents. In addition to unifying a range of experimental data within a common computational framework, the proposed model helps reconcile proposals that have been taken to represent alternative models of attention. We argue that the ostensible variety and complexity of the results reported in the literature emerge from the variety of empirical protocols that were used, such that the results observed in any one experiment depended on the stimulus conditions and the animal's attentional strategy, a notion that we define precisely in terms of the attention field in the model, but that has not typically been completely under experimental control.

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Dave Huber
UC San Diego

Investigating Inappropriate Cue Utilization in Own-Race Bias
Authors: K. M. Finklea, D. E. Huber, & C. R. McKenzie

The own-race (ORB) bias in face recognition is the well-known phenomenon that people are generally more accurate at recognizing and discriminating faces of their own race than any other race. The mechanisms driving the bias, however, are unclear. This series of three experiments examined the inappropriate cue utilization hypothesis as the best explanation for the ORB. Experiment 1 investigated the cues that Asians and Caucasians use to describe same-race and cross-race faces. Asians mentioned the presence/absence of an eyelid crease more than did Caucasians, who more often mentioned iris color when describing faces. Further, Asians and Caucasians used these respective cues more frequently to describe same-race than cross-race faces. Experiment 2 employed two recognition memory tasks to examine whether individuals are sensitive to the natural ranges of variability for different aspects of the eye region on different races. Results imply that people are sensitive to the greater range of variability for iris color on Caucasians over Asians and to the greater range of variability

for the presence/absence of eyelid creases on Asians over Caucasians. Experiment 3 used multidimensional scaling (MDS) analyses to determine the facial features that Asians and Caucasians attend to most often when judging the similarity between faces. Results indicate that Asians and Caucasians both rely most heavily on race and gender when comparing faces. Also, all participants place equal importance on iris color, while Asians place greater importance on eyelids than do Caucasians.

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Pam Jeter
University of California, Los Angeles
Authors: P. E. Jeter & B. A. Dosher

Characteristics of Specificity and Transfer in Perceptual Learning: Psychophysical Investigations of Precision and Training

Perceptual learning (PL) is the ability to improve performance in a perceptual task with repeated practice. For perceptual learning to be optimally useful, it must generalize to other similar tasks and attributes. More often, we see evidence of specificity, or the lack of transfer, in the PL literature. Characterizing the conditions under which an observer can optimize performance in training and further generalize to similar tasks with different dimensions is an important step towards understanding the underlying mechanisms involved in PL. Here, we focus on factors that influence specificity (or, conversely, transfer) in a transfer task after extensive training. We employed controlled, psychophysical training conditions and asked how our experimental manipulations contributed to the specificity observed. Observers trained in a 2-alternative forced choice orientation discrimination task using sinusoidal gratings (Gabor patches) to determine the effects in the transfer stage as a result of task precision (orientation difference) and as a result of varying amounts of initial training. We present evidence that task precision in the transfer stage, not task difficulty in the training stage as proposed by Ahissar & Hochstein (1997), is a controlling factor of specificity observed, with the task-precision boundary between transfer and specificity approximately at the bandwidth of the relevant feature. We also present novel data that systematically explored the influence of different amounts of training on the amount of specificity observed and found an unexpected pattern. More training on an initial task appears to impede performance at the initial point of transfer, while less training may provide the most benefit. The patterns of specificity appear to be generally consistent with a feedforward, reweighting model (Dosher & Lu, 1998, 1999; Petrov, Dosher, & Lu, 2005). We conclude that specificity of learning depends on both the precision demands of the transfer task and the amount of training. These results contribute to understanding generalization of practiced improvements that may be key to the development of expertise and for applications in remediation.

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Michael Lee
UC Irvine

A Cyclic Sequential Sampling Model of Bistable Perception
Authors: M. D. Lee & A. Habibi

We describe a model of bistable perception, based on the cyclic sequential sampling approach first developed by Vickers (1972; Perception). The model makes predictions about the distribution of latencies between perceptual reversals in terms of two key parameters: a "drift rate" that is a property of the stimulus, and a "boundary separation" that is a property of the observer. Using recent analytic approximations to first-passage times for sequential sampling processes, we implement our model as a probabilistic graphical model, capable of making fully Bayesian inferences about model parameters and predictions. We apply the model to data from four observers in a series of auditory tasks that manipulate the bistable perception of a series of tones. We show that the model provides a good account of the latency distributions, and infers interpretable estimates of the key parameters.

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Del Lindsey
Ohio State University

Visual Search as a Test of the Special Status of Pink

Authors: D. Lindsey & A. Brown

We are interested in how low-level (cone-level or color-opponent) and high-level (color categorical) processes contribute to human color perception and visual performance. Here, we consider the effects of color differences on visual search. Is search for colored targets faster for colors that have their own Basic Color Terms, as the Whorfians have suggested? Or is visual search based on color differences controlled by lower-level color mechanisms?

Pink is the only desaturated color accorded its own Basic Color Term in English, so we compared search reaction times (RTs) for pink targets to RTs for targets of other desaturated colors, which do not have their own Basic Color Terms. Subjects searched for a desaturated target among 20-40 distractors, which were equally divided between white and saturated colors of the same hue as the target. For instance, subjects looked for a pink target among white and red distractors, or a lavender target among white and purple distractors. RTs were fastest for desaturated reddish and orangish targets ("peach", ~475 msec), and slowest for desaturated purplish targets ("lavender", RT=~800 msec), an effect size of ~170%. Strikingly, a large range of warm, desaturated colors all showed short RTs. We collected color-naming data using these stimuli, and we found that our RT results were not obviously linked to the Basic (or non-basic) Color Terms, so they are not easily accounted for by the Whorfian view. The results of auxiliary perceptual scaling experiments with these stimuli, involving maximum likelihood difference scaling, rule out explanations based on suprathreshold target/distractor color similarities or differences in our displays. Instead, a simple model based on independent L/M- and S-cone color-opponent channels provides a good fit to the average data, with the proviso that the two poles of the S-cone channel behave differently (Nagy & Sanchez, 1990). We will discuss these results in the context of low- and high-level control of visual search for colored stimuli.

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Zhong-Lin Lu
University of Southern California

The Quick Methods: Bayesian Adaptive Estimation of Psychological Functions

Adaptive methods are well known in psychophysics. The idea is to use dynamic stimulus placement strategies based on subject responses to optimize the efficiency of data collection. Development of adaptive methods has mostly focused on estimating properties of psychometric functions. Based on subject responses, these methods target stimuli to pre-specified regions of the empirical psychometric functions (e.g. threshold region). Our goal is to develop and test adaptive methods for characterizing other psychological functions. In this talk, I will review some recent progress in applying the general framework to measurements of TvC functions, d' psychometric functions, contrast sensitivity functions, and forgetting functions.

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Ken Malmberg
University of South Florida

Implications of Recognition Priming for Models of Recognition Memory
Authors: K. J. Malmberg & D. Hayward

For tasks that require many trials on which stimuli require classification, sequential effects have often been reported; the response on trial N is related to the response made on trial N+1. Assimilation is observed when the response on trial N+1 is more likely than chance to be the same as the response on trial N. Currently, no model of recognition memory predicts assimilation. However, I will present the results of several experiments that demonstrate strong assimilation effects on both accuracy and speed of recognition decisions. Finally, I will discuss the implications of these findings within the framework of the REM theory.

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Tim McNamara
Vanderbilt University

Use of Geometric and Non-Geometric Cues in Maintaining Orientation
Authors: J. Kelly & T. McNamara

In this presentation we will review recent experiments on the relative importance of geometric cues (e.g., room shape) and non-geometric cues (e.g., landmark identity) to the maintenance of orientation during locomotion. The results of experiments using immersive virtual reality have shown that navigators update their heading with respect to an environmental reference axis, geometric and non-geometric cues provide qualitatively similar information for maintaining orientation during locomotion, and individuals differ in their abilities to capitalize on ambiguous cues.

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Jeff Mulligan
NASA Ames Research Center

Spatial Disorientation and Space Flight

Under normal circumstances, humans experience a remarkably stable world in spite of the fact that the head and eyes are in nearly constant motion. This is accomplished in part through the cooperative actions of two sensory systems, the vestibular system, which senses accelerations of the head, and the visual system, which senses the motions of external objects resulting from either motions of the objects themselves or motions of the observer. Stable gaze on stationary objects is accomplished by direct vestibular control of the eye movement system, known as the vestibulo-ocular reflex (VOR). The VOR is assisted in the maintenance of stable gaze by visual inputs to the eye movement system, referred to as smooth pursuit (for small targets) or ocular following (for large-field motion).

These systems are disrupted when humans are subjected to altered environments, such as the weightless environment of space. Adaptation to weightlessness occurs over the course of several days, and while readaptation to normal gravity occurs more rapidly, astronauts nevertheless suffer from a variety of spatial disorientation effects upon return to earth's gravitational field. These effects have been hypothesized to be responsible for the observation that manually-controlled landings of the space shuttle exhibit more variability than landings performed in training aircraft or simulators, which is somewhat surprising in light of the fact that real-world performance is usually superior to simulator performance for normal aircraft flight. This talk will review the basic phenomenology of the VOR, and discuss various hypotheses concerning the genesis of spatial disorientation following exposure to hypogravity.

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Angela Nelson
Indiana University

Contextual Effects in Knowledge Development
Authors: A. Nelson & R. Shiffrin

We previously presented data showing that after novel items were trained to differential degrees using a visual search task, frequency effects for these items were found to occur in various memory and perception tasks. We also presented a model that suggested that these effects are in fact highly influenced by the contextual surroundings of the items during training. In the current experiment, we are investigating the extent of these effects by removing (as much as is possible) context differences between high and low frequency items during training. To accomplish this we utilize a training task that on each trial presents a single novel item for a perceptual difference judgment, and places a buffer trial in between each training trial. This design controls for the influence of context both from surrounding items during a trial, and carryover from items on the previous trial. The results of this experiment as well as the implications for the current model will be discussed.

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Erica Okada
University of Hawaii

Green Product Pricing Premium and the Thoughtful Consumer

Authors: E. M. Okada & E. Mais

Does is make economic sense for companies to go beyond what is required by law to promote environmentally sustainable practices? That is, does it pay for companies to be "green?" For the economic system as a whole, the environment is a valuable resource, and the parties in the economic system will collectively benefit from a cleaner environment. However, from the perspective of each individual firm, there may be a disincentive for "cleaning," as it directly bears the full cost of cleaning, whereas the cost of polluting may be diffused throughout the entire economic system or externalized.

Recent years have seen a heightened awareness of the environment among other parties with whom such firms transact. Consumers show an increasing preference for purchasing from "green" companies, and in the capital market there is a growing interest in socially responsible investments (SRI). Such movement may be born in part out of the principle of altruism, but it actually makes economic sense for the system as a whole to reward green companies, whether it be by purchasing from green companies, or investing in green companies.

In this paper, we examine how consumers respond to green versus nongreen companies. Nongreen companies are not in violation of any environmental regulations, nor do they fall short of required standards. Green companies contrast with nongreen companies in the extent to which they take proactive measures toward environmental sustainability, and position themselves based on this management philosophy.

We conducted a series of experimental studies on actual consumers who have made purchases from "green" companies. In our Study One, we presented a hypothetical scenario where they were comparing two digital cameras: one manufactured by a "green" company and another by a "nongreen" company. The two camera models were otherwise identical. The dependent measure was how much the consumers were willing to pay ("WTP") for the green camera versus the nongreen camera. We manipulated two experimental factors: 2 levels of framing and 2 levels of reference, for a total of 2 x 2 = 4 experimental conditions. The 2 levels of framing were positive and negative. We also measured the extent of the study participants' knowledge of, and interest in, environmental topics in general. We summarize the findings below.

(1) Overall, the premium that people were willing to pay for the green versus nongreen camera was almost 20%.

(2) Those with higher levels of knowledge of and interest in environmental topics in general, i.e. the more "thoughtful" consumers, were more likely to pay more for the green camera.

(3) In the positive (negative) framing condition, we first asked the participants to provide reasons why consumers should prefer (avoid) purchasing from "green" ("nongreen") companies. We did this before they indicated their relative WTP for the green versus nongreen camera. There was no overall difference in the premium they were willing to pay between the positive and negative framing conditions. However, the positive (negative) framing resulted in a relatively higher price premium for the green camera among the more (less) thoughtful consumers.

(4) In the green (nongreen) reference condition, we elicited the participants' willingness to pay for the nongreen (green) camera, given a green (nongreen) camera price of $200. Between the green and nongreen reference conditions, there was no overall difference in the percent premium that they were willing to pay for the green versus nongreen camera. However, the percent price premium for the green camera was relatively higher when the reference price was the green (nongreen) camera among the more (less) thoughtful consumers.

We will discuss the theoretical bases for the two experimental factors, as well as the interaction of the two factors with the general level of knowledge of and interest in environmental topics. We will also discuss the results of other ongoing studies involving actual consumers from green companies.

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Thomas Palmeri
Vanderbilt University

Neural Basis of Stochastic Accumulator Models of Perceptual Decision Making
Authors: T. J. Palmeri, B. Purcell, J. Schall, G. Logan, R. Heitz, & J. Cohen

Visual and movement neurons in the frontal eye field (FEF) contribute to decisions about where and when to make a saccadic eye movement. A database of activity of visual and movement neurons in the FEF of three monkeys performing visual search with homogeneous distractors was used to guide the development and testing of stochastic accumulator models of saccade decisions. We used the activity of FEF visual neurons when the target or a distractor was in the neuron's response field as input to stochastic accumulator models designed to account for saccade response times. This represents a hybrid approach combining neurophysiological recordings with a computational mechanism in order to predict observed behavior. A series of architectures of stochastic accumulator processes fed by visual neuron activity were investigated. The models varied on whether model movement units (1) accumulated visual evidence independently or competitively, (2)

were subject to tonic self-inhibition, and (3) the onset of accumulation was gated. Accumulator models with different architectures could account equally well for the distributions of response times. However, by comparing the dynamics of the model accumulator units to the dynamics of FEF movement neurons, we could address this model mimicry. Accumulation of visual evidence that combines tonic self-inhibition and gated onset provided the best account of both behavioral and neural data. The complexity necessary to account for both response times and the form of neural activity indicates that simple diffusion or race models of perceptual decision processes may be inadequate.

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Misha Pavel
Oregon Health and Science University

Auditory Fusion – Theoretical Implications of Empirical Results in Speech Recognition.
Authors: M. Pavel, M. Slaney, & H. Hermansky

Information fusion plays a significant role in most human and machine pattern recognition tasks, including speech recognition. Among the most influential perceptual studies were those of H. Fletcher that led to the development of the articulation index and significantly influenced the design of many voice communication systems. The empirical results and their mathematical interpretations in terms of the "product of errors" have strong implications on how information from different frequency bands is integrated to enable speech recognition. A similar relationship results from combining acoustic and contextual information. This presentation will address several issues in reconciling optimal Bayesian fusion with the empirical evidence in speech recognition.

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Diane Pecher
Erasmus University Rotterdam

The Testing Effect: Lowering the Rate of Forgetting

Long-term retention can be enhanced by intermediate testing compared to additional study. The most interesting finding is that, at short retention intervals, performance is better for materials that received additional study than for materials that were tested, but at long retention intervals (e.g., one week after study) performance is better for materials that were tested than for materials that received additional study. Thus the forgetting rate is lower in the test condition than in the additional study condition. We studied this testing effect for various materials (unrelated word pairs, foreign languages, geographical knowledge). We found slower forgetting even when the final test was different from the intermediate test. We also found that the more difficult the intermediate test was, the lower the forgetting rate. These findings clearly have implications for education.

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Roger Ratcliff
Ohio State University

Insights from Physiological Measures into Modeling Simple Decision Processes
The diffusion model for simple decision making can decompose a group of response times (RTs) and their accuracy into components of processing that reflect the quality of evidence used in the decision, the amount of evidence required to make a decision, the duration of stimulus processing and response production, along with the variability in these components across trials. Research using single and multiunit recordings in primates and neuroimaging studies in humans has recently begun to identify where and how the relevant neural computations are carried out. In the first study we show for the first time how a measure derived from single-trial analysis (Sajda and Philiastides) of the EEG can index the quality of evidence used in the decision process even within a class of nominally identical stimuli. The second study examines simultaneous recordings in neurons corresponding to two response targets from opposite sides of the superior colliculus in rhesus monkeys in a simple two-choice brightness discrimination task. The functional role of inhibition was examined by conditionalizing firing rate on a high rate versus a low rate in target neurons 90-30 ms before the decision and examining the firing rate in competing neurons. Two models with racing diffusion processes were fit to the behavioral data and the

same analysis was carried out on simulated paths in the diffusion processes which were found to represent firing rate. Results showed no evidence for inhibition across the colliculi in either the models or the neural firing rate data.

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Matthias Scheutz
Indiana University

Useful Mobile Robots. A Review.

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Matthias Scheutz
Indiana University

The Need for Situated Embodied Natural Language Processing in Robots

Situated embodied artificial agents like robots that interact with humans in natural language need to be aware of and responsive to both human ways of processing language and different modes of human interaction. Converging evidence from psycholinguistics suggests that humans typically process language in an incremental fashion integrating multiple constraints as they become available. Moreover, humans also exhibit other non-linguistic responses that signal their intentions and their understanding of the linguistic discourse, including "back-channel" responses such as head nods, gestures, vocalizations, and even interruptions. Many of these behaviors require incremental processing and understanding of an utterance and also demonstrate that language processing and action execution are intrinsically intertwined in humans.
In this talk I will point to various challenges that theories and algorithms of natural language processing have to face if language processing is supposed to be implemented on autonomous robots and occur in real-time with human speakers and listeners co-present in the same environment. I will illustrate some of these challenges with examples from human natural language processing and also describe our first attempts at defining an integrated robotic architecture that can handle a few of them.

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Shihab Shamma
University of Maryland

Encoding of Task Rules and Objectives in the Auditory and Prefrontal Cortex
Authors: S. Shamma, J. Fritz, & S. David

This talk will review the role of behavior and attention in inducing plasticity in auditory cortical STRFs that reflect task performance and objectives as an animal learns to perform auditory detection and discrimination tasks. I shall also describe the dependence of responses in cortical frontal areas on behavioral task rules and stimulus meanings.

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Richard Shiffrin
Indiana University

Model Selection for Dummies

Model selection (a generalized form of statistical inference) has undergone a modern transformation with many advances. Unfortunately, these advances have not been promulgated to the general scientific public (our fields of psychology and cognitive science in particular) in a form that promotes conceptual understanding. Rather the advances are disguised in a flood of formal mathematical justification (argued about endlessly by proponents of various systems), computationally complex algorithms, and impenetrable terminology (e.g. transdimensional Markov chain Monte Carlo). Thus today's talk is designed to present a conceptual overview trying to bring some clarity to non-experts (and perhaps bring some new ways

to look at matters even to experts).

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George Sperling
University of California, Irvine

Trapezoidal Illusions: Windsurfers and Runways
Authors: G. Sperling, J. Gobell, & C.-h. Tseng

We demonstrate here a windsurfer illusion, a naturally occurring trapezoidal illusion in which the small end of a sail viewed at a distance appears to be pointed away from the observer even when it is closer. This naturally occurring illusion is so compelling that observers are both unaware of their gross perceptual misinterpretation and unable to perceive the scene veridically. The windsurfer illusion is largely context-free; we demonstrate that context can be critical: the same 2D shape on different walls, ceilings or floor of a room produces vastly different shape interpretations. Four experiments further investigate the joint effects of object shape, retinal orientation, head position, relative motion, and the direction of gravity on automatic depth perception on white outline trapezoids that are depicted as rotating in depth, 20 deg back-and-forth, on a black background. The trapezoids are perceived as rotating in 3D, observers report the side that appears to be nearest. Left- and right- pointed trapezoids are perceived mirror-equivalently, the longer edge of the trapezoid is reported in front 74% of trials (traditional trapezoidal illusion, "windsurfer effect"). When the same display is rotated 90 deg in the picture plane to produce a runway retinal configuration, there is striking perceptual asymmetry: the long edge is perceived in front 97% when it is on the bottom but only 43% when it is on top ("runway effect"). The runway effect also occurs when the head is tilted 90 deg or when displays on the ceiling are viewed from the floor. The strikingly different 3D perceptions produced by the same 2D screen trapezoid are quantitatively explained by a model that assumes there are just three bias factors that contribute additively to perception: Implicit linear perspective, assumed viewing from above in head centered coordinates, and relative height in the retinal field. The model accounts for 93% of the variance of the data.

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Bosco Tjan
University of Southern California

A Developmental Theory of Crowding
Authors: B. S. Tjan & A. S. Nandy

Crowding, the marked inability to identify shapes in peripheral vision when a target is flanked by other objects, has been widely studied. Recent findings have linked crowding to many form-vision deficiencies in the periphery (Levi, 2008; Pelli and Tillman, 2008). Three gross characteristics of the zone of crowding have been consistently replicated and there is growing consensus that these represent the hallmarks of crowding: (a) the spatial extent of crowding scales with eccentricity; (b) the zone is elliptic with its major axis pointing towards the fovea; and (c) an outward flanker is more effective at crowding than an inward flanker. Currently, no computational model exists to account for these characteristics of crowding.

We propose a developmental model of crowding by assuming that the developments of classical and nonclassical receptive fields in the early visual areas are gated by spatial attention and depend on natural image statistics. We show that because the deployment of spatial attention precedes saccadic eye movements, the attention-gated image statistics in the periphery have a significant motion component in the radial direction connecting the fovea with the peripheral location. Within the scheme of Hebbian learning, this property of the input, along with the known cortical magnification factor in V1 and the assumption that the initial spatial pooling is isotropic on the cortical surface, qualitatively and quantitatively account for all three hallmarks of crowding.

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Rene Zeelenberg
Erasmus University Rotterdam

Emotion Improves and Impairs Early Vision

Recent studies indicate that emotion enhances early vision, but the generality of this finding remains unknown. Do the benefits of emotion extend to all basic aspects of vision or are they limited in scope? Our results show that the brief presentation of a fearful face, compared to a neutral face, enhances sensitivity for the orientation of subsequently presented low-spatial-frequency stimuli, but diminishes orientation sensitivity for high-spatial-frequency stimuli. This is the first demonstration that emotion not only improves but also impairs low-level vision. The selective low-spatial-frequency benefits are consistent with the idea that emotion enhances magnocellular processing. Additionally, we suggest that the high-spatial-frequency deficits are due to inhibitory interactions between magnocellular and parvocellular pathways. Our results suggest an emotion-induced trade-off in visual processing rather than a general improvement. This trade-off may benefit perceptual dimensions that are relevant for survival at the expense of those that are less relevant.
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