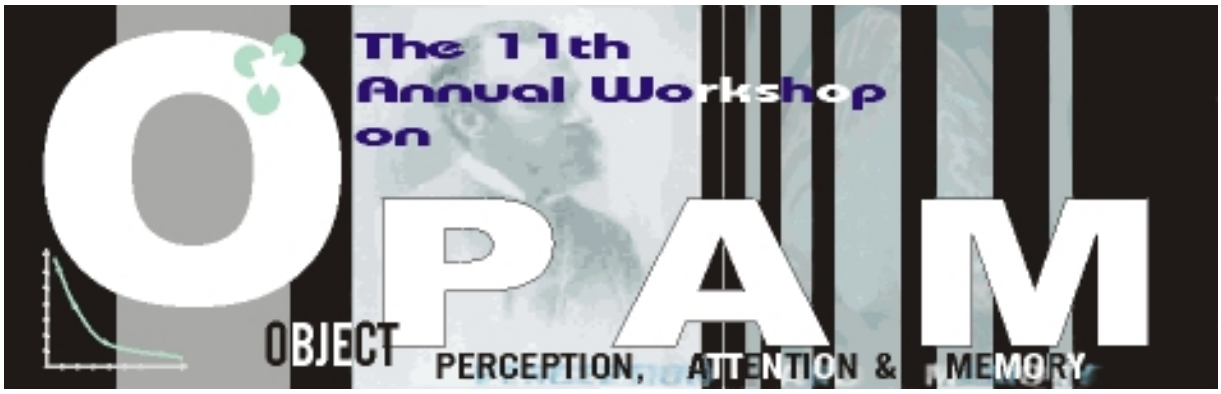

Vancouver, Canada, November 6, 2003

Fairmount Hotel Vancouver

Saturna Island Room (Talks) &
Vancouver Island Room (Posters)

Abstract Book

Organizing committee:

Alejandro Lleras, University of British Columbia
Robert Rauschenberger, University of Arizona
Yaoda Xu, Harvard University

Schedule

7:30	Registration
8:00	Opening remarks
Session 1: Perceptual discriminations	
8:05	*Who's there? Comparing recognition of self, friend and stranger movement* Prasad, Loula, & Shiffrar
8:20	*Perceptual learning depends on interpreted perceptual representations* Garrigan & Kellman
8:35	*Neural network models of visual expertise* Cottrell & Joyce (presented by C. Joyce)
Session 2: Preattentive vision	
9:00	*Hidden meaning: Semantic representations of regions seen as background* Brooks, Rahmatian, & Robertson
9:15	*The spatial dynamics of memory representations formed during visual search* Boot, Peterson, McCarley, & Kramer
9:30	*Simultaneous access to mean sizes within perceptual subsets* Chong & Treisman
Session 3: Attention	
10:05	*Attention, not inhibition of return, tracks objects* Skow-Grant, Rauschenberger, & Peterson
10:25	*A model of spatial and object-based attention for active visual search* Lanyon
10:45	*Conditions to eliminate object substitution masking and its spatial gradient* Mebane & Maki
Session 4: Attentional capture	
11:10	*Do new objects capture attention?* Franconeri, Hollingworth, & Simons
11:30	*Prioritization by transients in visual search: Bottom-up versus top-down control* Belopolsky, Kramer, & Theeuwes
11:45	*It's under control: Top-down search strategies can override attentional capture* Leber & Egeth
Lunch (12:00-12:45)	
12:45	Poster viewing (authors present 12:45-2:00)
2:05	*Keynote address: Domain-specific systems for representing objects? Suggestions from infants* Elizabeth S. Spelke (See page 10.)
Session 5: Repetition effects	
3:10	*The N170 adapts to individual, attended faces* Greene, Mangini, & Biederman
3:30	*Global-form contingent adaptation of color salience is modulated by task* Goolsby, Grabowecky, & Suzuki
3:45	*Effects of distractor repetition on the attentional blink* Dux, Coltheart, & Harris
4:05	*Parallel response selection versus strategic delay in dual-task performance* Watter
Session 6: Object representations	
4:30	*Object-based attention in a non-human primate: How rhesus monkeys enumerate small numbers of visual objects* Flombaum, Junge, Santos, & Hauser
4:50	*Evidence/traces of object-file representation in subitizing phenomenon* Tai & McConkie
5:10	*Perceiving the disappearance of unseen objects in motion-induced blindness* Mitroff & Scholl
5:30	Closing remarks

Abstracts

Talks

Perceptual discriminations

Chaired by: Alejandro Lleras

8:05-8:20 WHO'S THERE? COMPARING RECOGNITION OF SELF, FRIEND AND STRANGER MOVEMENT. *Prasad, S., Loula, F., & Shiffrar, M.* Humans demonstrate impressive visual sensitivity to human movement. What defines this sensitivity? If motor experience influences the visual analysis of action, then observers should be most sensitive to their own movements. To test this, participants viewed point-light displays of various actions performed by themselves, a friend, or a stranger. In an identification task and a subsequent same-different actor discrimination task, sensitivity to one's own motion was highest. Visual sensitivity to a friend's motion was significantly lower, while sensitivity to a stranger's motion was at chance. These results suggest that both motor and visual experience define visual sensitivity to human movement.

8:20-8:35 PERCEPTUAL LEARNING DEPENDS ON INTERPRETED PERCEPTUAL REPRESENTATIONS. *Garrigan, P., & Kellman, P.* Many models of perceptual learning have implied that learning mechanisms access early sensory analyzers. We explored the hypothesis that perceptual learning may operate only through interpreted perceptual representations. In most studies, differences in sensory attributes and perceptual representations are correlated. We decorrelated these attributes in three experiments. In discriminations involving size, brightness, and velocity, we found that when basic sensory inputs were made the sole basis of categorization (with perceptual context varying), perceptual learning did not occur. Perceptual learning may be constrained to operate through perceptual representations rather than directly on early sensory encodings.

8:35-8:55 NEURAL NETWORK MODELS OF VISUAL EXPERTISE. *Cottrell, G., & Joyce, C.* (presented by C. Joyce). Through brain imaging studies and studies of brain-lesioned patients with face or object recognition deficits, the fusiform face area (FFA) has been identified as a face-specific processing area. Recent work, however, illustrates that the FFA is also responsive to a wide variety of non-face objects if levels of discrimination and are controlled. We hypothesize that the FFA responds to features that generalize across classes of visually homogeneous stimuli via experience-based tuning.

Preattentive vision

Chaired by: Alejandro Lleras

9:00-9:15 HIDDEN MEANING: SEMANTIC REPRESENTATIONS OF REGIONS SEEN AS BACKGROUND. *Brooks, J., Rahmatian, K., & Robertson, L.* The Gestalt psychologist Rubin articulated some of the key aspects of figure-ground organization. Among these was that figural regions appear to be shaped at their border while ground regions do not. Because of this, ground regions have been assumed to have no representation at the levels of shape description, object recognition, and semantics. Using a semantic priming paradigm, we demonstrate that ground regions are represented at the semantic level. We will integrate our findings with recent evidence of a shape representation of ground regions and discuss the implications of our results for models of figure-ground organization.

9:15-9:30 THE SPATIAL DYNAMICS OF MEMORY REPRESENTATIONS FORMED DURING VISUAL SEARCH. *Boot, W., Peterson, M., McCarley, J., & Kramer*, A. Visual search would be most efficient if memory was used to prevent the reinspection of previously inspected items. A dynamic search paradigm was used to investigate the nature of this memory. By varying the distance between inspected and uninspected items, interference effects were used to determine the size and spatial distribution of memory representations formed during search. Surprisingly, interference effects were observed at distances of up to 12 degrees, suggesting that representations formed during search are coarse. Additionally, representations were found to be graded, with memory performance increasing with increasing distance between inspected and uninspected items.

9:30-9:50 SIMULTANEOUS ACCESS TO MEAN SIZES WITHIN PERCEPTUAL SUBSETS. *Chong, S., & Treisman, A.* The visual system may automatically summarize sets of similar objects with statistical descriptors. We tested the automaticity of statistical processing in two different experiments. In Experiment 1, thresholds for discriminating mean sizes were as accurate for sets of circles segregated by color as for those segregated by location. In Experiment 2, thresholds were about the same when the relevant color was pre-cued, when it was post-cued and when no distractor set was present. These results are consistent with our hypothesis that an automatic mechanism operates on preattentively segregated sets of items to extract their mean size.

Attention

Chaired by: Robert Rauschenberger

10:05-10:25 ATTENTION, NOT INHIBITION OF RETURN, TRACKS OBJECTS. *Skow-Grant, E., Rauschenberger, R., & Peterson, M. A.* It has been proposed that inhibition of return (IOR) comprises a location based and an object based component. Object-based IOR is defined as IOR that moves with an object as it changes location after attention has been withdrawn from it (e.g. Tipper et al., 1991). In two experiments we varied the relationship between the onset of a cue drawing attention away from a previously cued object and the onset and offset of the object's motion. We obtained IOR only at locations occupied by the object when it was attended. Our results indicate that attention, but not IOR, can track objects.

10:25-10:45 A MODEL OF SPATIAL AND OBJECT-BASED ATTENTION FOR ACTIVE VISUAL SEARCH. *Lanyon, L.* When searching for a target object, object-based attention takes longer than spatial attention to develop in extrastriate cortex. A computational model shows the development of attention in areas IT and V4 of the ventral 'what' stream. In V4, an initial spatial enhancement of responses, due to a parietal bias, becomes object-based as a result of object-related inferotemporal feedback biasing featural competition. The object-based effects in area V4 allow featural information to be conveyed to lateral intraparietal area and influence spatial competition therein so that attention is drawn to areas containing the target color, as found by Motter & Belky (1998).

10:45-11:05 CONDITIONS TO ELIMINATE OBJECT SUBSTITUTION MASKING & ITS SPATIAL GRADIENT. *Mebane, M., & Maki, W.* Object Substitution Masking (OSM) is a relatively newly discovered masking phenomenon. Researchers have claimed that OSM can be observed when the mask is not delayed directly over the location of the target, calling this effect the spatial gradient of OSM. In four experiments, we present evidence that suggest that attention to the delayed mask is necessary and sufficient to produce a spatial gradient of accuracy, even in the total absence of OSM when the mask is delayed over the target. This suggests that OSM might not be the cause of the spatial gradient, as previously claimed.

Attentional capture

Chaired by: Robert Rauschenberger

11:10-11:30 DO NEW OBJECTS CAPTURE ATTENTION? *Franconeri, S., Hollingworth, A., & Simons, D. J.* In visual search tasks, an item that appears later than others receives search priority, suggesting that new objects capture attention. However, other transient events such as motion, looming, and some luminance changes also capture attention. Does the late appearance of a search item capture attention because the visual system is sensitive to new objects or because, like motion, it creates a unique transient? We introduced new objects in search tasks in ways that did not produce a unique transient and found no priority for new objects. Without a transient, a new object is not sufficient to capture attention.

11:30-11:45 PRIORITIZATION BY TRANSIENTS IN VISUAL SEARCH: BOTTOM-UP VERSUS TOP-DOWN CONTROL. *Belopolsky A. V., Kramer, A. F., & Theeuwes, J.* There is an ongoing debate as to whether prioritizing new elements over old elements (the so-called preview benefit) is the result of top-down inhibition of old objects (i.e., visual marking; Watson & Humphreys, 1997) or attentional capture by new elements (Donk & Theeuwes, 2001). In a series of experiments we demonstrate that prioritization by luminance transients (increments and decrements) alone can produce a subset-selective search similar to the preview effect. Additional experiments indicate that these effects are most likely due to bottom-up attentional capture by luminance transients, however further investigation is needed.

11:45-12:00 IT'S UNDER CONTROL: TOP-DOWN SEARCH STRATEGIES CAN OVERRIDE ATTENTIONAL CAPTURE. *Leber, A., & Egeth, H. E.* Bacon and Egeth (1994) proposed that observed instances of attentional capture by feature singletons (e.g., color) were the result of a salience-based strategy adopted by subjects ("singleton detection mode"), rather than involuntary capture, as claimed by Theeuwes (e.g., 1991). They showed that subjects could override capture by adopting strategies based on target features ("feature search mode"). However, Theeuwes (in press) has recently argued that Bacon and Egeth's results arose from experimental confounds. He outlined two essential criteria for examining stimulus-driven capture. First, search latencies cannot increase with display size, as the search must be parallel; second, the irrelevant distractor must possess adequate salience. We provide evidence that involuntary capture can be overridden when both of these criteria are met.

Repetition Effects

Chaired by: Yaoda Xu

3:10-3:30 THE N170 ADAPTS TO INDIVIDUAL, ATTENDED FACES. *Greene, M. R., Mangini, M. C., & Biederman, I.* Stimulus repetition decreases both the magnitude of the fMRI BOLD response as well as the activity of cells in macaque IT, an effect generally attributed to competitive learning. Would repetition also diminish the magnitude of the N170 EEG signal to faces? Subjects viewed a series of faces in which new faces were added continuously during the session, with occasional repetition (mean

lag = 2.5 min) of a face shown earlier. Repetition resulted in a diminished N170, but only if the subjects were attending to the face, consistent with our previous findings that the N170 is modulated by attention.

3:30-3:45 GLOBAL-FORM CONTINGENT ADAPTATION OF COLOR SALIENCE IS MODULATED BY TASK. *Goolsby, B., Grabowecky, M., & Suzuki, S.* Passive viewing of colored items reduced the salience of the previewed color in a subsequent task of color-based stimulus selection (Psychonomics, 2002; VSS, 2002). Here, we report that evaluation of this effect relative to a neutral baseline indicated color suppression at some level of coding. This color suppression effect (CSE) was broadly tuned to color, was relatively insensitive to changes in local image features, but was critically affected by changes in global form. The degree of global-form dependence was modulated by task relevance. We argue that the CSE may be mediated by form-color multiplexing cells in inferotemporal cortex (IT).

3:45-4:05 EFFECTS OF DISTRACTOR REPETITION ON THE ATTENTIONAL BLINK. *Dux, P. E., Coltheart, V., & Harris, I. M.* Observers are less accurate at reporting the second of two targets in a Rapid Serial Visual Presentation task, if it appears within 500ms of the first, a phenomenon known as the Attentional Blink (AB). In two experiments, observers saw two letter targets amongst digit distractors. In half the trials, the items flanking Target 1 were identical (repeat), in the other half different (non-repeat). The AB was considerably attenuated for repeat trials. This suggests that the specific identities of distractors are extracted during the initial processing of RSVP steams. Implications for theories of the AB are discussed.

4:05-4:25 PARALLEL RESPONSE SELECTION VERSUS STRATEGIC DELAY IN DUAL-TASK PERFORMANCE. *Watter, S.* Two experiments encouraged serial Task1-then-Task2 behavior within a PRP paradigm, by reducing Task2 demands to accuracy only and no response, respectively. Single-subject RT1 and inter-response interval distributional data were assessed to exclude subjects suspected of even minor degrees of Task1-delaying behavior. Under these stringent conditions, Task2 response information was observed to influence Task1 response selection. The use of unique Task2 stimuli on each trial suggests that these effects were not due to repeated specific S-R pairs, but that Task2 response information was generated via mappings from more abstract categories to manual responses, in parallel with Task1 response selection.

Object representations

Chaired by: Yaoda Xu

4:30-4:50 OBJECT-BASED ATTENTION IN A NON-HUMAN PRIMATE: HOW RHESUS MONKEYS ENUMERATE SMALL NUMBERS OF VISUAL OBJECTS. *Flombaum, J. I., Junge, J. A., Santos, L. R., & Hauser, M. D.* Recent work suggests that nonverbal enumeration in adult and infant humans as well as non-human primates is supported by two distinct systems: a large number system of analog, magnitude-like representations, and a small number system of discrete object representations. We present 5 experiments exploring the nature of the object representations that rhesus monkeys use to enumerate small numbers (<5) of objects. We demonstrate that these representations operate specifically over discrete objects, as opposed to continuous quantities (e.g. volume, contour length), and that these representations share some of the constraints found in the object representations of human adults in object tracking and neuropsychological experiments.

4:50-5:10 EVIDENCE/TRACES OF OBJECT-FILE REPRESENTATION IN SUBITIZING PHENOMENON. *Tai, Y.-C., & McConkie, G.* In a series of studies, several phenomena have been observed to support the account of object-file type numerical representation for small numerosities. First, we consistently find that increasing the number from 4 to 5 produces a processing time increase that is greater than found with any other single item increment, suggesting a transitional cost of switching processes in this range. Second, subitizing is observed even when objects are briefly presented in visual periphery. Third, peripherally previewing the target display does not facilitate the response; instead, it could produce inhibitory effect when some previewed objects are missing from the target display.

5:10-5:30 PERCEIVING THE DISAPPEARANCE OF UNSEEN OBJECTS IN MOTION-INDUCED BLINDNESS. *Mitroff, S., & Scholl, B.* When certain global moving patterns are added to visual displays, other salient attended objects begin to alternate in and out of conscious awareness – a striking phenomenon termed motion-induced blindness (MIB). Here we demonstrate that observers can consciously perceive the physical offset of an object even when it has been rendered invisible by MIB. This surprising effect involves consciously perceiving visual information which is no longer on the retina, and which has been invisible for over a second. That such unconscious representations of visual information can reenter awareness (even when unconsciously updated) suggests new links between visual memory and awareness.

Posters

[1] Recognition of familiar objects is impaired by contrast reversal. *Peissig, J., Vuong, Q., Harrison, M., & Tarr, M.* Previous research has shown that faces are difficult to recognize when viewed in reverse contrast (Galper, 1970). In a previous study, we demonstrated that the contrast reversal effect can also be found with a set of non-face novel objects (Peissig et al., 2003), and that the effect was significantly greater for faces and novel objects with nonuniform surface texture than those with uniform surface texture. Here, we tested observers in a within-category, same/different sequential-matching task using grayscale images of common objects. We found a significant contrast effect for these common objects, indicating that the contrast reversal effect is not specific to faces or face-like stimuli.

[2] The role of attractiveness and distinctiveness in face memory: Sex matters. *Cheng, Y. D., & Tarr, M. J.* Distinct faces are recognized more accurately than typical faces. Typical faces are more attractive than atypical faces. But, don't we pay more attention to attractive faces and remember them better? We investigated the relationship between attractiveness, distinctiveness, and face memory. We found that attractiveness and distinctiveness were negatively correlated, but only when the sex of the subject and face are the same. Additionally, subjects were better at recognizing faces of the opposite sex, especially when they were attractive. These findings suggest that the sex of the subject and face are important when considering attractiveness, distinctiveness and recognition memory.

[3] Adult individual differences in configural and featural face recognition. *McMullen, P. A., Dunham, P., & Dunham, F.* Adults visually recognize upright faces primarily through the use of configural processing and inverted faces through featural processing. Sixty-two adults performed tests with Mooney faces and Overlapping Figures and recognized upright and inverted faces. The time to discriminate Mooney shadow faces from their scrambled counterparts predicted the time to correctly recognize upright faces; the number of objects correctly named from among fifteen overlapping object outlines predicted the number of inverted faces correctly recognized. These results are the first to support configural processing of upright faces and featural processing of inverted faces using an individual differences approach with normal adults.

[4] Effects of expertise on configural encoding of faces. *Schuchinsky, M.* Three experiments investigated the relationship between encoding of configural information (i.e., the relations among face components) and expertise with a class of faces. The effects of expertise were examined in a bizarreness rating paradigm as differences in perception of own-race and other-race faces. Variations in perceived bizarreness as a function of expertise supported the idea that all faces are encoded relative to one norm, leading to impaired sensitivity to configural information with less expertise. It was also speculated that different forms of configural information exist, thus raising further questions about the nature of configural processing in faces.

[5] Perceptual interactions of gender, race and attractiveness. *Smith, E., Grabowecky, M., Cheng, T., & Suzuki, S.* Perrett et al. (1998) demonstrated that raters found digitally feminized faces attractive. We extended these findings by examining natural variations in femininity/masculinity in female and male faces, demonstrating effects of rater gender and stimulus race on how femininity/masculinity influenced attractiveness. Participants rated briefly presented faces on race, gender, or attractiveness. There was an interaction of stimulus race and stimulus gender on attractiveness ratings, with unattractive faces eliciting fastest responses. Data suggest that male faces may more clearly signal race than female faces. These results indicate that perceptions of gender, race, and attractiveness interact, possibly modulated by attributes of the perceiver.

[6] The roles of shape and surface in face processing. *Russell, R., Nederhouser, M., & Biederman, I.* The present study investigates the roles played by shape and surface information in face processing by two means. The first is a comparison of discrimination performance for sets of faces distinguishable by only shape or only surface information. The sets are measured and matched for low-level image similarity, as assessed by a Gabor jet similarity measure, so that the amount, as well as kind, of information can be compared. The second is a comparison of the effects of inversion and negation on these same sets of faces, to determine whether these manipulations disrupt information that corresponds to shape or surface.

[7] Sizeable costs incurred from contrast negation are unique to faces. *Nederhouser, M., Mangini, M. C., & Biederman, I.* Marked costs are incurred (e.g., 30% increase in error rates) when matching faces that differ in contrast polarity, but not when matching blobs with the smooth surface contouring characteristic of faces (Nederhouser et al., 2002). However, faces vary in albedo, while the blobs did not. Albedo variations produced by texturizing faces (preserving the nth lower order statistics of face albedo, Simoncelli NYU homepage) were projected onto the blobs. Contrast polarity differences for these stimuli resulted in costs that were in the order of only 2-5%. Faces appear to be special with respect to their high sensitivity to contrast negation.

[8] LONG RANGE INTERACTIONS AMONG LOCAL COMPETITIONS FOR FIGURAL STATUS. *Kim, J. H., & Peterson, M. A.* We showed previously that a given convex region becomes increasingly likely to be seen as figure as the number of alternating convex and concave regions in the display increases; similar effects were not obtained for alternating symmetric and asymmetric regions (Kim & Peterson, 2001, 2002, 2003). Here, we show that a symmetric region is more likely to be figure when the region on the opposite side of the adjacent asymmetric region is convex rather than rectilinear. We conclude that the cross-border competition at a given edge is affected by the outcome of competitions occurring at other edges in a display.

[9] CURVATURE EXTREMA AND CONTOUR REPRESENTATION: A SEGMENT IDENTIFICATION TASK. *Cohen, E. H., & Singh, M.* The role of curvature extrema in the representation of contour shape was studied using a segment identification task. Subjects were shown a contour segment, and then an entire shape. They indicated whether or not the segment belonged to the shape. Discrimination (d') was substantially better when the segment was bounded by two negative minima, than by positive maxima, of curvature. The results demonstrate that contour segmentation is an automatic process, guided by curvature extrema, with negative minima playing a special role. The task also provides a general, performance-based method for measuring part segmentation, i.e., further segmentation cues and part salience.

[10] SEMANTIC CONSISTENCY EFFECTS IN OBJECT AND BACKGROUND PERCEPTION. *Davenport, J.L., & Potter, M. C.* Does knowledge about which objects and settings tend to co-occur affect our perception? In three experiments, color photographs were manipulated to include a foreground object semantically consistent or inconsistent with its setting. Pictures were presented for 80 ms followed by a mask. Semantically consistent objects and scenes were reported more accurately whether the task was to report the object (Experiment 1), the background (Experiment 2), or both the object and background (Experiment 3). Consistency information seems to be available early in processing, and the results suggest that objects and their settings are processed interactively, not in isolation.

[11] FUNCTIONAL INTERACTIONS IMPROVE OBJECT DETECTION IN NON-SCENE DISPLAYS. *Green, C., & Hummel, J. E.* An experiment explored the influence of functional relations among objects on the processing of those objects. Subjects performed a visual search and object location task for briefly-presented target objects in non-scene displays. Participants were more accurate at target location and target detection when targets were engaged in functional relations than when they were not. This result suggests that functional relations between objects may affect the allocation of visual attention and, as a consequence, the processing of structured visual stimuli, possibly including natural scenes. It also suggests that functional groups are explicit units of visual representation.

[12] WHAT THE VISUAL SYSTEM 'SEES' DURING A SEARCH TASK IN REAL-WORLD SCENES. *Mack, M. L., Castelhano, M. S., Henderson, J. M., & Oliva, A.* During scene perception, fixation locations are not random, but guided towards informative and interesting scene regions. In the present study we looked at what type of information is selected by the visual system during a search task in real-world scenes by examining the relationship between four image properties and fixation selection. The eye movements of eight participants were tracked while they searched for people in real-world images. Participants showed a tendency to fixate on image regions with lower intensity, and with greater contrast, edge density, and decorrelation of grayscale levels.

[13] SPATIOTEMPORAL PROPERTIES OF CONTEXTUAL CUEING. *Ogawa, H., Takeda, Y., & Kumada, T.* The repetition of spatial layouts of search items implicitly facilitates visual search (contextual cueing effect; Chun & Jiang, 1998). We investigated spatiotemporal properties of the contextual cueing effect, using a hybrid paradigm of visual search and probe-dot detection. The results showed that for the repeated layouts, detection of a probe dot was facilitated at a search target location and was inhibited at distractor locations. These effects were obtained at short display-probe SOAs (100 ms). These results suggest that the contextual cueing modulates attentional processing in a spatially parallel manner and affects an early stage of visual processing.

[14] THE PERCEPTUAL AND COGNITIVE DISTRACTOR-PREVIEWING EFFECT. *Ariga, A., & Kawahara, J.* Visual search for an oddly colored target is faster at trial N when the distractor color versus the target color is previewed at trial N-1 (the distractor-previewing effect: DPE). Goolsby and Suzuki (2001) suggested that the DPE is due to a perceptual adaptation that increases target saliency. The present study tested and extended this hypothesis with visual search experiments using color, face, motion, and word stimuli. We found that the DPE can be obtained with all of these stimuli, and we suggest that high-level processing, such as semantic activation, elicits the effect with words stimuli.

[15] THE ROLE OF ATTENDED OBJECTS IN PICTURE RECOGNITION MEMORY. *DiMase, J., Oliva, A., Horowitz, T., & Wolfe, J.* We propose a two-component memory model for encoding novel scenes: memory for preattentive visual properties, and memory for attended objects. Observers viewed novel scenes or distinctive visual textures lacking objects. Visual search stimuli (2s and 5s)

were superimposed on images. Observers studied images under dual- (encode and search) or single-task (encode only) instructions. Single-task texture performance (d' = 0.7) was poor compared to scenes (d' = 2.38). Scene memory dropped to texture level under dual-task conditions (d' = 0.69). An auditory task interfered less with scene memory (d' = 1.52). Robust picture recognition memory may require selective attention to objects.

[16] PERCEIVING AREA IN A SET OF RANDOM DOTS: HUH? *Jewell, S., & Pomerantz, J. R.* We report four experiments in which Ss were briefly shown a random set of point-like dots which were then masked, and subsequently reappear with a possible added or deleted dot. Subjects detected deletions more accurately than additions and detected changes to the most peripheral dots more reliably than changes to interior dots, even those much closer to fixation. The most peripheral points appear to be objectized in a process that might be analogized as shrink wrapping and that the circumscribed area is memorable and easily recallable despite brief presentations. The data are consistent with the view that the fastest of the perceptual processes is a global system which proceeds from the periphery inward toward fixation and that a separate slower local analytical sequence starts at fixation and works outward.

[17] EXPLORING THE FACTORS INFLUENCING DETECTION OF SHAPE CHANGES IN SINGLE OBJECTS. *Chai, Y. C., Nguyen, P., & Hillstrom, A. P.* We explored whether object complexity and motion energy affect change detection. Motion energy was varied by manipulating the degree of the bend and object complexity was varied by varying the number of visible colors in the object. Pictures of single objects were used as visual stimuli, presented in a change-blindness flicker paradigm. The results suggest that when objects are not moving, detection of changes in complex objects requires attention to be directed to parts rather than the entire object. In addition, the object complexity affected people's ability to detect the changes, but only when motion energy was low.

[18] NONVERBAL ARITHMETIC. *Cordes, S., Gallistel, C. R., Gelman, R., & Latham, P.* Both animals and humans count nonverbally using noisy magnitudes. Evidence suggests that these magnitudes are frequently subject to arithmetic computations as a means of learning about the environment. To investigate the impact of these computations on the precision and accuracy of nonverbal magnitude representations, we had adult humans participate in psychophysical experiments in which they reproduced, added and subtracted nonverbal counts. Within- and across-task variance analyses revealed differing patterns of results for the two arithmetic operations while subtraction variability was comparable to predictions, the addition data revealed significantly more scalar variability.

[19] OBJECT INFLUENCES ON SPATIAL LANGUAGE. *Kenny, R., & Carlson, L.* Three experiments are reported that explore how the functional interaction of two objects impacts judgments about their spatial relations. Experiment 1 demonstrated that the located object influenced which part of a reference object was considered functionally important, resulting in a significant bias in the interpretation of the spatial terms above, below and more strongly near. Experiments 2 and 3 used a video depicted interaction to emphasize a given functional part. Subsequent placements of a neutrally related located object were biased toward the highlighted part for the term near, but not for above or below, implying varying sensitivity to functional information.

[20] QUALITATIVE MODELING OF SPATIAL ORIENTATION PROCESSES USING A LOGICAL NETWORK OF NECESSARY AND SUFFICIENT CONDITIONS. *Riecke, B. E., & von der Heyde, M.* In this paper, we attempt to model spatial orientation processes by analyzing their logical and functional relations. This leads to a network of necessary prerequisites and sufficient conditions for spatial orientation, spatial presence, and spatial updating. More specifically, the logical structure of the framework allows to clearly disambiguate between complementary spatial orientation processes like continuous vs. instantaneous spatial updating. The framework proved especially well-suited for analyzing situations where certain processes related to spatial orientation were impaired, as is often the case in Virtual Reality applications. It further enables us to derive new hypotheses and testable predictions.

[21] VISUAL AND PROPRIOCEPTIVE REPRESENTATIONS IN HUMAN SPATIAL MEMORY. *Yamamoto, N., & Shelton, A.* Orientation dependence of spatial memories acquired through vision and proprioception was explored in order to investigate how spatial information from different modalities is represented in the brain. After determining that proprioceptive learning alone yielded orientation-dependent spatial memory, we investigated competition and/or integration of different modalities when different orientations of the same layout were learned visually and proprioceptively. Results suggest that participants established two different reference systems based on each type of learning experience and interpreted the layout in terms of these two reference systems. These results provide some initial clues to how different modalities might yield different representations.

[22] TASK SWITCHING AND TASK SIMILARITY IN SPATIAL RELATIONS JUDGMENTS. *Arrington, C., & Logan, G.* Effects of task similarity on task switching were examined in tasks involving judgments of spatial relations between objects. In four tasks, similarity was defined in terms of necessary computations within the reference frame. Above/below and left/right involve specifying orientation but not scale

of the reference frame. Near/far and next to/away involve specifying scale but not orientation. Tasks occurred in a cueing paradigm with cue-target SOAs of 200 or 1000 ms. Responses for repetitions were fastest (M = 644 ms) followed by switches from similar (M = 710 ms) and dissimilar (M = 725 ms) tasks. Similarity facilitated switching, but only at short, not long SOAs.

[23] LEARNED SPATIO-TEMPORAL SIGNATURES ARE USED FOR OBJECT RECOGNITION. *Vuong, Q. C., & Tarr, M.* The relative motion between observers and objects produces structured changes to the retinal input. To what extent do we use such spatio-temporal signatures for recognition? This question was addressed by testing observer's recognition of visually-similar or visually-dissimilar objects moving with characteristic motions. An identification task assessed whether observers relied on the object's spatio-temporal signatures, 3D shapes, 2D views, or combination of the three. We found that altering an object's motion pattern following learning impaired identification. However, these new motion patterns only changed spatio-temporal signatures from study to test. Thus, observers appear to use these signatures as one cue to object identity.

[24] MULTISTABILITY AND BIASING EFFECTS IN THE PERCEPTION OF POINT-LIGHT FIGURES. *Vanrie, J., & Verfaillie, K.* When being repeatedly presented with a point-light figure lacking explicit depth cues, observers report seeing the figure in two different orientations in depth, either as being oriented towards them or oriented away from them. However, they also exhibit a strong perceptual bias to interpret the figure as facing towards them. We investigated the extent of these findings and the possible underlying mechanisms in a series of experiments looking into the effects of various stimulus manipulations (involving both the point-light configuration and the movements), the presence of perspective reversals and possible differences in the pattern of eye movements, including initial fixations.

[25] CONSISTENCY IN INVOLUNTARY ORIENTING OF ATTENTION TO INDIRECT CUES. *Bryant, T.,& Gibson, B.* Gibson and Bryant (2003) have recently showed that involuntary orienting in response to indirect cues depends on processing the shape of the cue. The present research provides strong evidence that this involuntary orienting does occur, but such orienting may not occur consistently (Experiment 1). This inconsistency does not appear to be due to either changing effects over time (Experiment 2) nor occasional voluntary orienting (Experiment 3). These findings suggest that within the context of indirect cues, involuntary may need to be redefined.

[26] TIME'S UP FOR CONTINGENCY: CONTINGENT CAPTURE EXPLAINED BY TEMPORAL CONFUSION. *Brockmole, J. R., Boot, W. R., Simons, D. J., & Alexander, A. L.* Attention capture in the additional singleton and irrelevant feature paradigms was modulated by the availability of attention resources. However, the contingent capture paradigm was immune to such variations. We explain this difference by showing that contingent capture reflects temporal confusion of the cue and target displays rather than attention capture per se. Temporal confusion was greater when the cue and target had matching than when they had mismatching features, regardless of variations in attention resources. Contingent "capture" may occur when participants mistake the cue for the target due to their similarity and temporal proximity.

[27] INHIBITION OF RETURN IS CONTINGENT UPON LOCATION REPETITIONS. *Chao, H.-F., & Yeh, Y.-Y.* It takes longer time for people to revisit recently examined locations. This effect is named inhibition of return (IOR). A related phenomenon of IOR is negative priming (NP). In NP, people tend to respond slowly to prior distractors. This effect is at least partially attributed to the inhibitory process of selective attention. According to the studies of NP, only competitive distractors are inhibited. High-activation stimuli, due to being repetitively used, can produce NP. This study demonstrates that, like NP, IOR can be found on repetitively used locations (stimuli). This finding shows a similarity between NP and IOR.

[28] THE RETURN OF OBJECT-BASED ATTENTION: SELECTION OF MULTIPLE-REGION OBJECTS. *Matsukura, M., & Vecera, S. P.* Uniformly connected (UC) regions are the basic representation from which object-based attention selects because objects containing multiple regions do not produce object-based effects: Object-based effects occur for single-UC objects but not multiple-UC objects (Watson & Kramer, 1999). Because most objects have multiple regions, we explored the generality of the single UC findings. We found that manipulations that prevented contour grouping of multiple regions abolished object-based effects. Nevertheless, when the contours of different regions grouped, object-based effects were observed. Object-based attention can select multiple UC objects.

[29] PIGEONS PERFORM OBJECT DISCRIMINATION USING BOTH LOCAL AND GLOBAL CUES. *Lazareva, O. F., Vecera, S. P., & Wasserman, E. A.* Humans can selectively attend to individual objects in cluttered scenes. How do non-mammalian animals segregate a visual scene into candidate objects? To find out, we trained two pigeons to discriminate a pair of differently colored shapes that had two targets either on the same object or on different objects. Follow-up tests disclosed stimulus control by the color, but not the shape of the objects. Furthermore, a colored region surrounding the dots was critical, but not adequate to support the discrimination, suggesting that the pigeons attended to both local and global cues.

[30] VISUAL CUES THAT CONTRIBUTE TO PERCEIVING THE GROUP CENTER-OF-ATTENTION. *Morgan, S. E.* This study examines the contribution of static and dynamic cues used to perceive group center-of-attention (COA). Participants viewed randomly ordered static silhouette images or video clips of human point light figures. Each stimulus contained head and body orientation cues (eye gaze cues only present in controls) for an individual or a group. Participants indicated the individual and collective COA for each figure. With dynamic stimuli, participants indicated the motion path and eventual destination . Accuracy of COA location and orientation accuracy increased with increased group size, and the addition of motion information. Group COA appears to be a salient scene feature.

KEYNOTE ADDRESS:

DOMAIN-SPECIFIC SYSTEMS FOR REPRESENTING OBJECTS? SUGGESTIONS FROM INFANTS

Elizabeth S. Spelke

Does human perception and cognition depend in part on specialized systems for representing different kinds of entities such as people, places, and predators? Studies of human infants and of non-human primates provide evidence for a small number of specialized systems for representing inanimate objects, places in the spatial layout, and numerosity. These studies provide little evidence, however, for more specific systems of object representation.