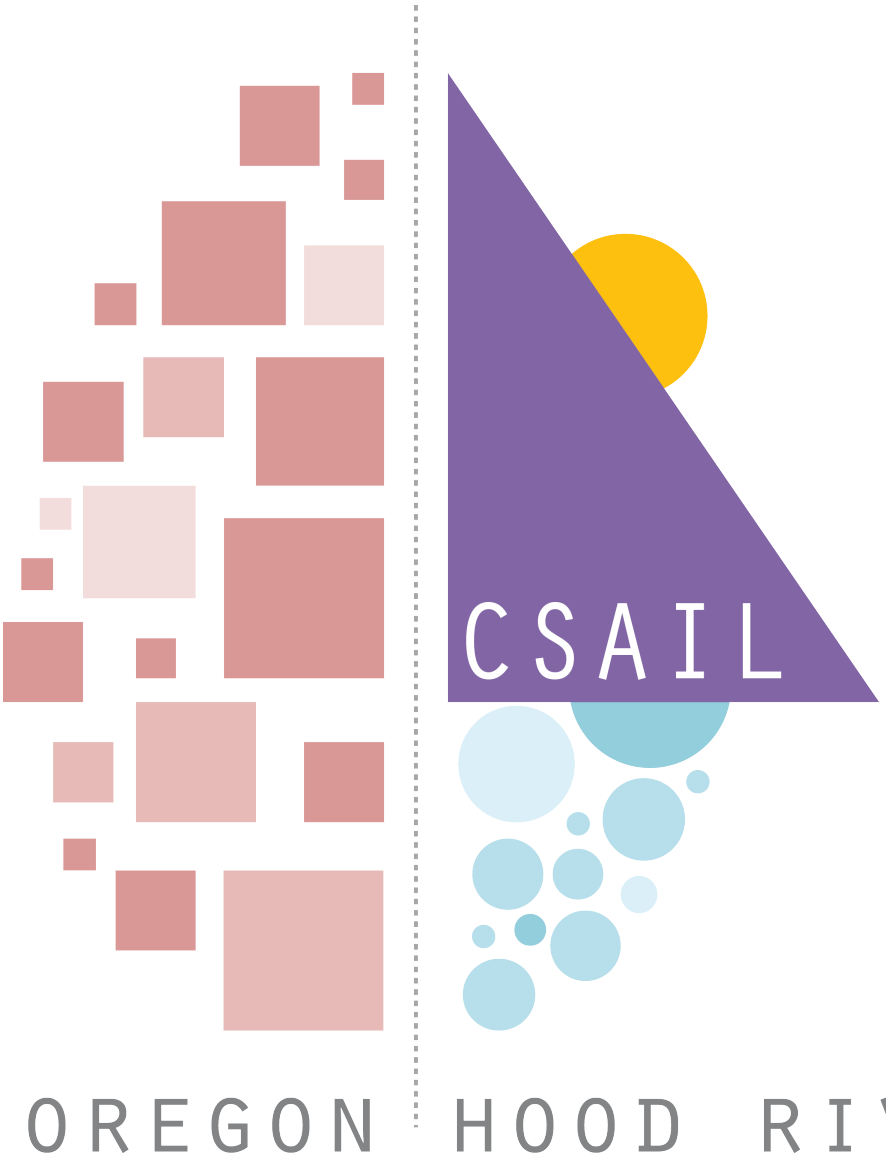
Twentieth Annual Meeting



Cognitive Science Association for Interdisciplinary Learning

Hood River Hotel
Hood River, Oregon
July 30 to August 3, 2015

Thursday, July 30		
4:30 pm	Reception and Appetizers	
4:45 pm	Welcome and Introductory Remarks	
5:00 - 5:30 pm	Michael Pitts	*Progress in the search for the neural correlates of visual awareness*
5:40 - 6:10 pm	Ashley Livingstone, Andrea Smit, Mateusz Michalik, Ralph Mistlberger & John McDonald	*Attention deficits in night owls at sub-optimal times of day*
6:20 - 6:50 pm	Carly Leonard	*Troubles with a taxonomy of (visual) attention*
7:00 pm	---------- Adjourn for Evening ----------	

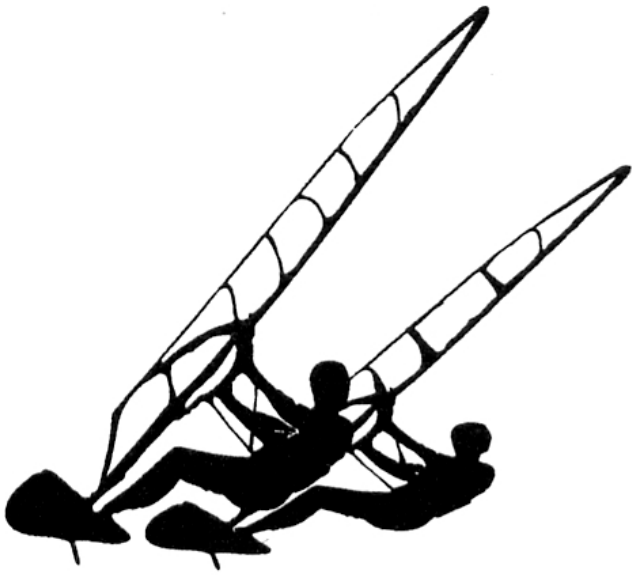
Friday, July 31		
8:30 am	Breakfast	
9:00 - 9:30 am	Diego Fernandez Duque & Sandra Black	*Object recognition and spatial localization: Lessons from neuropsychology*
9:40 - 9:55 am	Phoebe Bauer, Jason Samaha, Sawyer Cimaroli & Brad Postle	*Top-down control of alpha phase as a mechanism of temporal prediction*
10:00-10:30 am	Melissa Vo	*Reading scenes*
10:40-10:55 am	Allison Pierce & Jessica Green	*Cross-modal inhibition of return: Electrophysiological evidence*
11:00 am	---------- Break until 4:15 pm ---------- 	
4:15 pm	Appetizers	
4:35 - 4:40 pm	Introductory remarks	
4:40 - 5:25 pm	**Keynote**: Steve Hillyard	*Cross-modal orienting of visual attention*
5:40 - 6:10 pm	Jyoti Mishra	*Closed-loop attention training across species and across the globe*
6:20 - 6:35 pm	Chris Graulty, Michael Pitts & Enriqueta Canseco-Gonzalez	*Neuronal dynamics of grapheme-color synesthesia*
6:40 - 6:55 pm	Adeola Harewood, Lynn Robertson, Francesca Fortenbaugh & Michael Silver	*Visual field shape and critical spacing in visual crowding*
7:00 pm	---------- Adjourn for Evening ----------	

Saturday, August 1		
8:30 am	Breakfast	
9:00 - 9:30 am	Trafton Drew	*Evidence for feature-based surround suppression in inattentional blindness*
9:40 - 10:10 am	Frederick Gallun	*Learning From Nature's Experiments: How Studying Impaired Systems Can Shed Light on Normal Function*
10:20-10:50 am	Nirmal Srinivasan, Sean Kampel, Kasey Jakien, Samuel Gordon, Meghan Stansell & Frederick Gallun	*The effects of age, hearing loss, and working memory on spatial release from masking*
11:00 am	---------- Break until 4:15 pm---------- 	
4:15 pm	Appetizers	
4:35 - 4:40 pm	Introductory remarks	
4:40 - 5:25 pm	Keynote: Steve Luck	*Working memory and the computer metaphor for the mind*
5:40 - 6:10 pm	Jessica Green	*Attentional biasing of visual cortex: A simultaneous EEG/fMRI study*
6:20 - 6:35 pm	James Moreland & Jeffrey Boynton	*Contribution of individual elements in the summary statistic of localization*
6:40 - 6:55 pm	Steffen Werner	*User-friendly password systems - a cognitive perspective*
7:00 pm	---------- Adjourn for Evening ----------	

Sunday, August 2		
8:30 am	Breakfast	
9:00 - 9:30 am	Sarah Karalunas & Brittany Alperin	*Cognitive response style in ADHD corresponds to physiological and clinical heterogeneity*
9:40-10:10 am	Shai Itamar & Avishai Henik	*Discrimination of magnitude: A developmental perspective*
10:20-10:50 am	Matthew Finkbeiner	*How do masked primes produce priming?*
11:00 am	---------- Break until 4:30 pm ---------- *Rafters, be packed and ready to go with a sack lunch so you can make it to Zoller's before 12:00pm	
	No Appetizers on Banquet Night	
4:50 - 5:20 pm	Olave Krigolson	*A neural system for human learning*
5:30 - 5:45 pm	Cameron Hassall, Amy Silver, David Turk & Olave Krigolson	*Ownership and feedback processing: The neural basis for selfishness*
5:50 - 6:20 pm	Dasa Zeithamova, Bernard Gelman & Alison Preston	*Reward representation and pattern separation in human hippocampus during motivated encoding*
6:30 pm	---------- Adjourn for Banquet Dinner ----------	
7:00 pm	**Banquet Dinner at Cornerstone Cuisine**	

Monday, August 3

8:30 am	Breakfast	
9:00 - 9:15 am	John Gaspar & John McDonald	*Neural activity associated with the sustained suppression of irrelevant information in visual working memory*
9:20 – 9:35 am	James Patten, John Gaspar, Thomas Spalek & John McDonald	*Reduced attention capture in video game players: improved capture prevention or speeded capture recovery?*
9:40 - 10:10 am	Christopher Koch	*The role of nonverbal stroop tasks in assessing intelligence*
10:20-10:50 am	Naama Katzin, Omer Linkovski & Avishai Henik	*Untangling the interactions of the attentional system*
11:00 am	---------- Have a safe trip home! ----------	



Roll on, Columbia
Woody Guthrie

Roll on, Columbia, roll on,
Roll on, Columbia, roll on,
Your power is turning our darkness to dawn.
So roll on, Columbia, roll on.

Other great rivers lend power to you,
Yakima, Snake, and the Klickitat too,
Sandy Willamette and the Hood River too,
So roll on, Columbia, roll on.

And on up the river is Grand Coulee Dam,
The biggest thing built by the hand of a man,
To run the great factories and water the land,
So, roll on, Columbia, roll on.

Tom Jefferson's vision would not let him rest,
An empire he saw in the Pacific Northwest,
Sent Lewis and Clark and they did the rest.
So, roll on, Columbia, roll on.

Thursday Abstracts

Progress in the search for the neural correlates of visual awareness
Michael Pitts, Reed College

Current debates in the neuroscience of consciousness have helped generate testable hypotheses and progress has been made on some of the long-standing questions concerning the neural basis of perceptual awareness. This talk will focus on two recent debates, 1) the relationship between attention and awareness, and 2) the "3 NCC problem". Recent work in our lab has supported the view that selective attention and perceptual awareness are distinct and separable, but only singularly dissociable. Attention can operate in the absence of awareness, but perceptual awareness without attention is impossible. In a series of experiments, involving inattentional blindness and manipulations of perceptual reporting tasks, we have also begun to address the so-called 3 NCC problem (Aru et al., 2012) by isolating neural correlates of awareness from neural events that immediately precede and follow the establishment of a conscious percept. Results from these experiments are directly relevant to leading theories concerning the neural basis of consciousness, including the Global Neuronal Workspace Theory (Dehaene, 2014) and Attention Schema Theory (Graziano, 2013), and in some cases our results clearly favor one theory over another. While the current work utilizes EEG/ERP as the primary means to measure neural activity, the paradigms we have developed can be easily adapted for various types of neurophysiological techniques (ECoG, fMRI, fNIRS, TMS, tDCS, etc.) and may offer a clear path forward in isolating neural correlates of awareness from other closely related processes such as attention, perception, and working memory.

Attention deficits in night owls at sub-optimal times of day
Ashley C. Livingstone, Simon Fraser University
Andrea N. Smit, Simon Fraser University
Mateusz J. Michalik, Simon Fraser University
Ralph E. Mistlberger, Simon Fraser University
John J. McDonald, Simon Fraser University

A pattern of rhythmic cognitive performance throughout the day is propelled by an endogenous biological clock. The timing of peak performance differs between chronotypes, and accidents are more likely to occur during "off peak" times (e.g. when evening types are driving to work in the morning or when morning types are working through the night). In the lab, chronotype related performance has typically been assessed using behavioural measures (e.g. reaction times); however, the neural basis for performance decrements is unknown. This study directly examined variability in attentional performance in a visual search task using event-related potential (ERP) components associated with attentional selection (N2pc) and suppression (P_D). Extreme chronotypes were tested at 9 AM and 4 PM, on the hypothesis that the performance of evening chronotypes would improve from the early session to the later session (the performance of morning chronotypes was expected to vary less). Consistent with this hypothesis, the ability to ignore distracting information (indexed by the P_D) was reduced for the evening types during early testing times, while morning types showed no difference. These results are the first to show clear electrophysiological differences during sub-optimal times of day with respect to chronotype. As fitness for duty is often a concern for many essential services (e.g. doctors, paramedics), these results have implications regarding developing safe workplaces when individuals are working during sub-optimal times of day.

Troubles with a taxonomy of (visual) attention
Carly J. Leonard, Center for Mind and Brain, University of California, Davis

Although William James once famously wrote in 1890 that "everyone knows what attention is", the taxonomy of attention that has emerged after 125 years of further research does not suggest a resounding consensus. In this talk, I will discuss the range of ways that attention is conceptualized and the potential pitfalls that popular terminology may hold for scientific progress. Philosophical and historical context will be provided, as well as recent empirical examples from my own work and the broader literature. The focus will be on the visual domain, which is a well-studied system that is heavily investigated in both cognitive psychology and neuroscience. Of particular pertinence is the study of so-called "mid-level vision" which considers how states of the observer alter the transformation of sensory inputs. Topics will include varieties of attention (*e.g,*, spatial, object-based, feature-based), visual working memory, awareness, and the neural activity that is associated with these terms.

Friday Morning Abstracts

Object recognition and spatial localization: Lessons from Neuropsychology
Diego Fernandez Duque, Villanova University
Sandra Black, Sunnybrook Hospital, Toronto, Canada

To explore the relation between object recognition and visuospatial abilities, we recruited the help of two patients, one suffering from Posterior Cortical Atrophy and the other suffering from Split-Brain. In the patient with posterior cortical atrophy, we found that detection and discrimination of two simple geometric figures was relatively spared when the figures were centrally displayed in sequence, but greatly impaired when the figures were displayed simultaneously (simultanagnosia). Consistent with object-based attention, the recognition of complex line drawings was spared for a single object but disrupted by an attention-grabbing small circle. In the patient with split-brain, we assessed the ability to recognize objects and their spatial location. When a set of pac-men was briefly displayed in the right visual field, the patient was able to recognize both shape and location. In contrast, when stimuli were displayed in the left visual field, the patient was unable to report object features either verbally or with his right hand. He couldn't report whether two or four pac-men were being displayed, whether the pac-men were arranged to form an illusory square, and whether the pac-men were facing outward or inward. These data reveal an impaired callosal transfer of object information. In contrast, the patient revealed unimpaired spatial abilities to left visual field stimuli. He was able to locate the cursor at the center of the display using his right hand, and to verbally report the pac-men's location. This ability to localize objects that cannot be recognized seems to be mediated by a covert orienting of attention to the object's location.

Top-down control of the phase of alpha-band oscillations as a mechanism for temporal prediction

Phoebe Bauer, Reed College
Jason Samaha, University of Wisconsin-Madison
Sawyer Cimaroli, University of Wisconsin-Madison
Brad Postle, University of Wisconsin-Madison

The physiological state of the brain prior to an incoming stimulus has substantial consequences for subsequent behavior and neural processing. For example, the phase of ongoing posterior alpha-band oscillations (8-14 Hz) immediately prior to visual stimulation has been shown to predict perceptual outcomes and downstream neural activity. Although this phenomenon suggests that these oscillations may phasically route information through functional networks, many accounts treat these periodic effects as a consequence of ongoing activity that is independent of behavioral strategy. Here, we investigated whether alpha-band phase can be guided by top-down control in a temporal cueing task. When participants were provided with cues predictive of the moment of visual target onset, discrimination accuracy improved and targets were more frequently reported as consciously seen, relative to unpredictive cues. This was accompanied by a significant shift in the phase of alpha-band oscillations, prior to target onset, towards each participant's optimal phase for stimulus discrimination. These findings provide direct evidence that forming predictions about when a stimulus will appear can bias the phase of ongoing alpha-band oscillations towards an optimal phase for visual processing, and may thus serve as a mechanism for the top-down control of visual processing guided by temporal predictions.

Reading Scenes

Melissa Vo, Scene Grammar Lab, Goethe University Frankfurt

When you look around, you will realize that our visual world is complex, but at the same time highly rule-governed. Objects in scenes, like words in sentences, seem constrained by a "grammar" that you understand implicitly and that allows you to process scenes efficiently. The sources that guide attention in real-world environments are manifold and interact in complex ways. In line with classic Gestalt ideas I will argue that a scene is more than the sum of its objects. That is, attention during scene viewing is mainly controlled by generic knowledge regarding the meaningful composition of objects that make up a scene. Contrary to arbitrary target objects placed in random arrays of distractors, objects in naturalistic scenes are placed in a very rule-governed manner. Thus, scene priors - i.e. expectations regarding *what* objects (scene semantics) are supposed to be *where* (scene syntax) within a scene - strongly guide attention. Violating such semantic and syntactic scene priors results in differential ERP responses similar to the ones observed in sentence processing and might suggest some commonality in the mechanisms for processing meaning and structure across a wide variety of cognitive tasks. In one of the studies, we tested whether ERPs during lexical decisions are modulated by task-irrelevant, visual scene backgrounds. Participants were presented with a background scene and a location cue before a string of letters appeared at the pre-cued scene location. The sole task was to decide whether the letter string formed a word or non-word. Words could either be congruent with the scene ('SOAP' on sink), semantically incongruent ('EGG' on sink), or syntactically incongruent ('SOAP' on towel rack - i.e., semantically congruent but it in a wrong relative location). We found that words that were semantically incongruent with respect to the background scene triggered a negative deflection compared to the consistent words about 400ms after word onset. In the language domain, this N400 response is known to signal difficulties in the semantic integration of a word

with its sentence context. Semantically congruent words presented in improbable scene locations, on the other hand, did not significantly affect brain responses. We conclude that scenes semantics are accessed automatically and can interact with linguistic operations on at least the semantic processing level. Therefore, language and visual scene processing may share common, amodal cognitive mechanisms that are efficiently integrated to function as a unitary whole.

Cross-Modal Inhibition of Return: Electrophysiological Evidence
Allison Pierce, University of South Carolina
Jessica Green, University of South Carolina

Inhibition of return (IOR) is a counterintuitive effect wherein participants are slower to respond to targets that appear at the same location as a previously attended target, relative to targets that appear at novel locations. Within the visual modality, this slowing of responses has been associated with a reduction in the occipital N2pc event-related potential (ERP) component, which is thought to reflect the bias of visual attention away from previously attended locations. In the present study, participants performed a cross-modal auditory-visual target detection task to determine if the previously observed attentional bias is specific to the visual modality or if attention to any sensory modality can produce the same behavioral and electrophysiological effects. Behaviorally, IOR was observed for visual targets regardless of whether the preceding target was visual or auditory. Similarly, a reduced N2pc component for visual targets was observed when the target location repeated across trials, regardless of whether the preceding target was visual or auditory. These results suggest that IOR and the modulation of the N2pc are not restricted to attention within vision, but rather arise from biases in the deployment of attention in a modality-independent manner.

Friday Evening Abstracts

KEYNOTE ADDRESS
Cross-modal orienting of visual attention
Steven Hillyard, University of California San Diego

My talk will review a series of experiments that combined behavioral and electrophysiological recording techniques to explore the hypothesis that salient sounds attract attention automatically and facilitate the processing of visual stimuli at the sound's location. This cross-modal capture of visual attention was found to occur even when the attracting sound was irrelevant to the ongoing task and was non-predictive of subsequent events. A slow positive component in the event-related potential (ERP) that was localized to the visual cortex was found to be closely coupled with the orienting of visual attention to a sound's location. This neural sign of visual cortex activation was predictive of enhanced visual-perceptual processing and was paralleled by a desynchronization (blocking) of the ongoing occipital alpha rhythm.

Closed-loop Attention Training across Species and across the Globe
Jyoti Mishra, University of California San Francisco

Attention modulates sensory responses by enhancing the processing of goal-relevant inputs and suppressing the response to goal-irrelevant distractions. In closed-loop attention training, the user performs adaptive attention tasks in which the task challenge is progressively modulated based on current user performance. The task challenge is increased when the user performs

correctly, and decreased for incorrect responses. In recent work, we developed a novel closed loop attention training task that exclusively adapts the challenge of the distractors in the task. We then deployed this simple training in older animals and humans, who both suffer from deficits related to heightened distractibility. The experiments showed that such training can selectively reduce distractor errors and diminish distractor processing in both animals and humans. This training also generalized to gains in working memory span. Based on this evidence, we expanded the closed-loop attention training to include challenges in the domain of distractors as well as targets, and applied the training in children with Attention Deficit Hyperactivity Disorder (ADHD). A double blind randomized controlled pilot trial of the program was conducted in New Delhi and showed significant efficacy that was sustained at follow-up; a larger multi-site US trial is pending. I will present this translational attention research at the conference.

Neuronal dynamics of grapheme-color synesthesia

Chris Graulty, Reed College
Michael Pitts, Reed College
Enriqueta Canseco-Gonzalez, Reed College

Two primary questions currently debated in synesthesia research are: (1) What is the time-course of neuronal events related to grapheme-color synesthesia? (2) Is attention necessary for synesthetic color perception to occur? To investigate these questions, we recorded event-related potentials (ERPs) elicited by the brains of ten grapheme-color synesthetes (and ten matched-controls) in response to letters and false fonts which were embedded in the attentional blink paradigm. Each false font was generated from the lines of a specific letter, and any false fonts that synesthetes reported as inducing synesthetic color perception were not used. For synesthetes, the seen letters vs false fonts contrast revealed a positive difference over fronto-central scalp sites, beginning approximately 160ms after stimulus onset. This effect has a similar timing, polarity, and scalp distribution to a difference previously observed when comparing ERPs elicited by colored vs achromatic stimuli, the "sensory effect of color". Given these similarities, and the fact that the effect was not observed in matched controls, we suggest that it reflects neuronal activity related to synesthetic color perception. When looking at trials in which the letters and false fonts were rendered unseen by the attentional blink paradigm, we found that the sensory effect of color was eliminated. Taken together, these results suggest that neuronal events related to synesthetic color processing occur fairly early in visual processing (160ms) and that they require attention.

Visual field shape and critical spacing in visual crowding

Adeola Harewood, UC Berkeley
Lynn Robertson, UC Berkeley
Francesca Fortenbaugh, Department of Veterans Affairs, Boston
Michael Silver, UC Berkeley

Behavioral performance is better in the lower than in the upper visual field for a variety of perceptual tasks, including visual crowding. We recently showed that the lower visual field advantage for visual crowding could be accounted for by asymmetry in the shape of the visual field along the vertical meridian. Here, we are continuing this work by studying visual field asymmetries in critical spacing - the minimum distance between a target and its flankers that is needed to enable a certain level of performance on a crowding task. Upper and lower visual field extents were measured in each participant with a Goldmann perimeter. Participants then completed a crowding task in which they discriminated the orientation of a target grating in the

presence of flanker gratings. The target grating was always on the vertical meridian, in either the upper or lower visual field. We found smaller critical spacing in the lower visual field than in the upper visual field when stimuli were placed at the same eccentricity, consistent with a lower visual field advantage. However, when stimulus locations were matched based on percentage of visual field extent instead of visual angle, critical spacing was similar in the upper and lower visual fields.

Saturday Morning Abstracts

Evidence for Feature-Based Surround Suppression in Inattentional Blindness

Trafton Drew, University of Utah

When engaged in an attentionally demanding task, Observers (Os) often miss stimuli that would otherwise be perfectly obvious, like a dancing gorilla or a clown on a unicycle, a finding known as Inattentional Blindness (IB). Previous work has shown that noticing rates for unexpected stimulus increase as the similarity to the target increases: when tracking white items, Os are much more likely to notice an unexpected white stimulus than a black one. Most and colleagues (2001), showed that noticing rates follow a simple linear relationship with the similarity of the attended stimulus, even for unexpected items of novel color (e.g. a grey item when tracking white items and ignoring black items). We wondered whether the presence of distractors in these intermediate positions would change the pattern of results. The presence of the distractors that share a similar color to the attended objects may result in this color being actively inhibited in feature-space. Recent behavioral and electrophysiological work has suggested that feature-based suppression operates on colors that are similar (~30° in hue space) to the attended color (Störmer et al., 2014). Os in the current study attended objects of color X while ignoring an equal number of distractors of color X+15° and X+180°. As expected, IB rates were much higher for an unexpected stimulus far from the attended color (X+180) than the attended color (X). IB rate for stimuli near the attended color (X+15 or X-15) were dramatically influenced by the presence or absence of irrelevant distractors of the same color. IAB rates for unexpected stimuli that were identical to distractors (X+15) were dramatically higher (56%) than that the rate for stimuli that were the same distance away in color space (X-15), but did not share colors with any distractors (17%). The results suggest that feature-based suppression is finely sensitive to the current needs of the attentional system.

Learning From Nature's Experiments: How Studying Impaired Systems Can Shed Light on Normal Function

Frederick Gallun, VA Portland Health Care System and Oregon Health and Science University

Cognitive science has a long history of using studies of patients and patient populations to inform what is known about the ways in which a healthy system functions. In addition, by comparing the impaired and the healthy systems it is often possible to improve the diagnosis and rehabilitation of those patients or others with similar dysfunction. Data collected from "nature's experiments" are often harder to analyze than when the groups and interventions are assigned randomly, but the payoff is that it is possible to learn things that would be impossible to know if we were only willing to study phenomena that can be carefully controlled. Furthermore, there are often insights to be gained from observational or correlational data that can then be examined using a more systematic approach. Examples will be presented from several ongoing studies of the impacts of aging, hearing loss, and brain injury on auditory function.

The effects of age, hearing loss, and working memory on spatial release from masking
Nirmal Kumar Srinivasan, Oregon Health & Science University
Sean D. Kampel, Oregon Health & Science University
Samuel Gordon, Oregon Health & Science University
Meghan M. Stansell, Oregon Health & Science University
Frederick J. Gallun, Oregon Health & Science University

While listening to a target talker in the presence of masking talkers, the overlap of sound energy at the cochlea (energetic masking) and confusions among speech sounds (informational masking) can reduce speech intelligibility. Improvement in speech intelligibility can occur when the target speech is spatially separated from competing speech, thus encouraging spatial release from masking. It is well documented that elderly listeners have more difficulty understanding speech in the presence of competing talkers. This reduction in performance in complex listening environments may be due to two major factors: 1) a reduction in an individual's hearing ability and 2) a reduction in an individual's working memory capacity. Two experiments were conducted to investigate the relationship between spatial release from masking and age, hearing loss, and working memory capacity. In experiment one, spatial release from masking was measured in a selective attention task by comparing target-to-masker ratios (TMR) obtained with a speech target presented directly ahead of the listener (at 0 degrees azimuth angle) and two speech maskers presented either from the same location (co-located) or in symmetrically placed (separated) spatial configurations in an anechoic chamber. In experiment two, working memory capacity was estimated based on a divided attention version of the spatial release task. Consistent with many previous results from our laboratory, older hearing-impaired listeners obtained the least benefit from spatially separating the target source from maskers compared to younger and older normal hearing individuals. New results will be presented showing the influence of hearing impairment on working memory capacity relative to the effects of age. The implications of these data will be discussed along with the relationships between speech perception in complex listening environments and age, hearing loss, and working memory capacity. [Work supported by NIH R01 DC011828].

Saturday Evening Abstracts

KEYNOTE ADDRESS
Working Memory and the Computer Metaphor for the Mind
Steven Luck, University of California Davis

In the early days of cognitive psychology, it was common to draw analogies between minds and digital computers. Although these analogies are no longer fashionable, I will argue that a careful consideration of the memory systems used in computer systems is actually helpful for understanding the complex concept of working memory. The Von Neumann computer architecture—which is used in almost all modern computers—includes three main types of memory: nonvolatile storage that can persist for very long periods of time (e.g., hard drives), volatile storage external to the CPU that holds information that might be used in the near future (RAM), and a small number of memory registers inside the CPU that are used to hold the data being used for ongoing computations. Cognitive psychologists have not usually considered the distinction between RAM and memory registers in computers, but these appear to correspond to two distinct components of working memory. One component of working memory involves the

active maintenance of a small number of representations that are currently being processed, and this is analogous to the CPU registers in a conventional computer. Another component of working memory involves the passive maintenance of a larger number of representations, and this is analogous to RAM. I will present recent ERP, EEG decoding, and psychophysical evidence supporting the existence of these two components of visual working memory.

Attentional biasing of visual cortex: A simultaneous EEG/fMRI study
Jessica Green, University of South Carolina

Both electroencephalography (EEG) and functional MRI (fMRI) have independently demonstrated that shifting attention in space produces lateralized differences in visual cortical activity that vary with the direction of attention in anticipation of a stimulus. However, the relationship between the results of the two methods remains equivocal. Functional MRI studies have consistently shown increases in BOLD signal contralateral to the direction of attention, whereas EEG studies observe either contralateral or ipsilateral modulations by attention depending on which aspects of the EEG signal are examined. Here, we examined single-trial covariations of concurrently recorded EEG and fMRI to capitalize on the temporal and spatial precision of each method, respectively, and to link the neural activities of the two methods. Early covariations between EEG and fMRI activity were observed in the pulvinar nucleus, a region thought to be involved in the filtering of irrelevant information. Subsequently, alpha-band EEG covaried with decreases in fMRI activity in regions of ipsilateral visual cortex, consistent with the idea that alpha plays a role in actively suppressing the unattended region of space. This was followed by gamma-band covariation that was more closely tied to the observed fMRI patterns, with increases in activity contralateral to the attended location. Together, these results demonstrate that the enhancement of contralateral visual activity by attention is most closely related to modulations of gamma-band EEG on the scalp. In addition, the use of combined EEG/fMRI recording provided evidence that the scalp-recorded alpha reflects thalamocortical connections between the pulvinar nucleus and visual cortex that mediate the suppression of the irrelevant region of space, a result not possible using either method alone.

Contribution of Individual Elements in the Summary Statistics of Localization
James C. Moreland, University of Washington
Geoffrey M. Boynton, University of Washington

People naturally make a saccade toward the center of object when asked to determine its center of mass. We are interested in what physical properties of the object determine the location of the saccade, and whether that saccade reflects the perceived center of mass of an object. To assess this, subjects were presented with arrays of 10 dots drawn from a bivariate Gaussian distribution and were asked to estimate the center of mass with a mouse click. Eye movements were tracked during each trial, allowing us to measure both the end location of the first saccade and the reported estimate of the center of the array. An ideal observer should weigh each dot equally to determine the center of mass. However, we found that dots within regions of lower dot density had the greatest influence on the perceived center. The perceived center was also more strongly influenced from dots farthest from the center of the distribution. Saccades were also more strongly influenced by dots located in less dense regions. However, saccades were not overly influenced by dots furthest from the center. Our results support a strategy in which, when asked to determine the center of an object, subjects make initial saccades to regions of lower density, perhaps in order to foveate where information is more difficult to extract. The reported center of the dots, made after saccades, are more strongly influenced by outlying dots, which may reflect a

tendency to treat the outline, or 'convex hull' of the array as a uniform object instead of a sample of discrete dots.

User-friendly Password Systems – a Cognitive Perspective
Steffen Werner, University of Idaho

Over the last 15 years there has been a growing awareness among computer security experts that traditional password systems are failing modern security demands. The mismatch between system requirements and the users' resources has lead to numerous approaches to optimize the security, efficiency, and acceptance of new authentication strategies. Cognitive authentication relies on the user to provide information residing in the individual's memory to authenticate their identity when challenged by a computer system – most commonly implemented through alphanumeric passwords that need to be recalled when probed. Recognition-based authentication represents a more recent attempt to optimize password security by taking performance characteristics of human memory into account. The most promising cognitive authentication systems focus on graphical authentication methods, which rely at least in part on visuo-spatial memory. This presentation will give a brief overview of currently existing technologies and promising applications of basic cognitive psychology research to optimize password authentication for human users. Research on our lab's Composite Scene Authentication (CSA) approach confirms both the importance of basic psychological models to solve applied problems, as well as the useful guiding effects of applied problems on basic research.

Sunday Morning Abstracts

Cognitive response style in ADHD corresponds to physiological and clinical heterogeneity
Sarah Karalunas, Oregon Health & Science University
Brittany Alperin, Oregon Health & Science University

Existing psychiatric diagnostic categories group together individuals with distinct underlying etiologies. To resolve this problem, the NIH Research Domain Criteria (RDoC) initiative seeks to identify dimensional measures that can be used to elucidate biological mechanisms of disorder and revise existing nosology. Within ADHD, reaction time (RT) measures are of particular interest in that they are thought to be related to core neurobiological mechanisms of the disorder. However, standard RT measures rely on multiple underlying processes, including speed/efficiency of information processing, speed-accuracy trade-offs, and motor output. Deficits in each of these components have been hypothesized to characterize a subgroup of children with ADHD. Here, we combine a drift diffusion model of RT performance with a latent grouping analysis to examine individual differences in response style and their correspondence to differences in physiological functioning within ADHD. Diffusion model parameters for 377 children with ADHD who completed a simple forced-choice RT task were used as input in a latent grouping (community detection) analysis. Results indicated three distinct cognitive profiles: 1) a cognitive healthy group (n=140); 2) a group with slow/inefficient information processing, but fast motor response (n=119); and 3) a group with slow/inefficient information and slow motor response (n=118). Each group was characterized by unique patterns of executive functioning and cardiac physiology. In particular, Groups 2 and 3 were associated with poor working memory and less RSA suppression during cognitive tasks than typically developing controls, whereas Group 1 was generally similar to typically-developing children on all measures. In a subset of children for whom EEG data were available (n=25), groups with slow/inefficient information processing had

longer P3 fractional area latencies, but did not differ from controls in P3 mean amplitude. In contrast, the cognitively healthy ADHD group had larger P3 amplitudes, suggesting they maintain performance only with greater exertion of attentional control and effort than other groups. The current study illustrates an approach to clarifying mechanisms of impairment in ADHD that is multi-modal yet straightforward. By separating the multiple processes contributing to RT variability, we identified three distinct groups of children who were characterized by important differences in executive functioning and physiological response. We conclude that this approach can be successfully applied to achieve RDoC aims, including elucidating individual differences in biological mechanisms and, eventually, informing development of novel, mechanism-based treatments.

Discrimination of magnitude: A developmental perspective

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According to the Approximate Number System (ANS) theory, non-symbolic magnitude dimensions (discrete and continuous) are represented in a noisy manner that results in an approximation of a given magnitude. Moreover, in the ANS, discriminability of magnitudes complies with Weber's law so that in a magnitude comparison task, the relationship between the magnitude ratio and reaction time (RT) should be linear. The assumption that discriminability of all magnitudes complies with Weber's law has being questioned. It was found that when using a power function, in magnitude comparison task the relationship between discriminability and size ratio is not always linear. Namely, this relationship is modulated by the type of the stimuli. While physical magnitude comparison results in a curve-linear fit, symbolic magnitudes comparison results in a linear fit. In this study we explored the developmental changes that occur in the ability to discriminate magnitudes in young children (1st, 3rd and 5th graders). We employed a power function to describe the relationship between magnitude ratio and RT in different magnitude comparison tasks (symbolic, continuous and discrete). Results indicated that for physical comparison, the linear-curvature pattern decreased with age (yet it remained curve-linear). For discrete comparison, the linear-curvature pattern increased with age (it changed from linear to curve-liner). For symbolic comparison, the pattern remained linear regardless of age. These results support previous findings indicating that the relationship between discriminability and magnitude ratio is not always linear. Furthermore, it can be argued that experience with symbolic magnitudes creates a change in non-symbolic magnitude representation.

How do masked primes produce priming?

Matthew Finkbeiner, Macquarie University

The masked congruence effect (MCE) is characterized by faster response times (RTs) and higher accuracy rates to congruently primed targets than to incongruently primed targets. According to one general set of "head-start" accounts (direct parameter specification, action trigger, rapid-chase), prime processing is thought to begin influencing the response formulation process before the target has been presented and consciously perceived. In contrast to the head-start accounts are the "integration" accounts, where it is argued that the accumulation of evidence for the correct response is integrated across the prime and target, almost as if visual system has been "tricked" into treating the prime and target as a single perceptual object (cf. Norris & Kinoshita, 2008). While both sets of accounts correctly predict the observed RT differences, they make distinct predictions in terms of how responses are formulated early on in stimulus processing. In this

study, we sought to distinguish between these two general sets of accounts by using the reach-to-touch paradigm to establish how the MCE emerges within the first 150ms of stimulus processing.

Sunday Evening Abstracts

A Neural System for Human Learning
Olave Krigolson, University of Victoria

How do we learn? Over the past 20 years a multitude of studies have used EEG to examine the signals evoked when response errors are made or when people are provided with performance feedback. In particular, studies in humans using EEG have revealed two key signals thought to relate to learning: (1) the error-related negativity (ERN) evoked by erroneous responses and (2) the feedback related-negativity / reward positivity (RP) evoked by performance feedback. One prominent theory has gone as far as to suggest that the ERN and RP reflect the functioning of a reinforcement learning system within the human medial-frontal cortex (Holroyd & Coles, 2002). Sadly, to date little experimental evidence has associated the ERN / RP with actual learning. In the present research, we had three groups of participants learn three different experiment tasks. First, our analysis of the behavioral data provided strong evidence of learning. Second, our analysis of changes in the ERN/RP with learning mirrored theoretical predictions. Specifically - we noted a decrease in the evoked response to feedback with learning and increases in the evoked response to participant errors responses and/or predictive cues with learning. Third, analyses examining the relationship between the behavioral and the ERN/RP suggest a causal relationship, one that is further strengthened by a myriad of other converging evidence. In sum, these experiments provide firm support for the Holroyd and Coles (2002) model and more importantly firmly relate it to actual human learning.

Ownership and feedback processing: The neural basis for selfishness?
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David J. Turk, School of Experimental Psychology, University of Bristol
Olave E. Krigolson, The Neuroeconomics Laboratory, University of Victoria

When you think something belongs to you, your brain treats it differently - even if the sense of ownership is completely artificial. In particular, you are more likely to remember and attend to objects you are told belong to you. Here, we present electroencephalographic evidence from two studies suggesting that gains and losses for oneself are processed differently than gains and losses for someone else. In each study, participants made decisions that resulted in either winning or losing everyday objects or points. Critically, the imagined gains and losses were either for oneself or for someone else. We measured a feedback-sensitive component of the human event-related brain potential called the reward positivity, and observed an enhanced response for self versus other gambles. Interestingly, we also observed an ownership-dependent effect of value on the reward positivity - in other words, whether gains were large or small mattered more when gambling for oneself. Taken together, these results add to a growing literature on the self-ownership bias, and may have implications for those who gamble with other people's money for a living (e.g. investment bankers).

Reward representation and pattern separation in human hippocampus during motivated encoding

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Bernard D. Gelman, University of Texas
Alison R. Preston, University of Texas

Memory is influenced by motivation, such as a promise of future monetary reward for successfully remembering an event. High monetary reward cues preceding or immediately following an event have been shown to enhance activation within dopaminergic midbrain and the hippocampus, resulting in better memory for the associated event. Furthermore, distributed hippocampal patterns differentiate between events encoded under different reward cues, supporting the view that information about reward context is incorporated into stored memory representations. However, prior studies addressing this topic have confounded the reward value with the visual appearance of reward cues, leaving unanswered whether hippocampal responses reflect the visual image of the reward cue or an abstract representation of reward value. Here, we employed a novel reward manipulation to dissociate between these accounts. Participants underwent functional MRI while encoding pairs of objects, with each pair being preceded by a cue indicating the monetary reward the participant would receive if they successfully remembered the pair. Reward cues could represent one of three values (dollar, dime, penny), each presented in one of two visual forms (word, picture) across different trials. After scanning, participants were given a cued recall test for the associations. Behaviorally, participants remembered pairs associated with the highest reward (dollar) more often than pairs preceded by low reward cues (dime or penny), irrespective of the visual form of the reward cue. We then tested which aspects of the cue (reward value, visual form) are represented in encoding activation patterns in different brain regions using multivoxel pattern analysis and pattern similarity analysis. In visual cortices, we found that encoding patterns differentiated between the visual form of the cues (words vs. pictures) but not the reward value represented by those cues (dollar, dime, penny). In contrast, hippocampus and midbrain encoding patterns did not distinguish between the cues with different visual form but rather differentiated trials based on their abstract reward value. In both regions, visually different cues of the same value were represented similarly while visually similar cues of different values were more distinct. Furthermore, in the hippocampus only, representations of two cues were most distinct when they differed in value but shared the same visual form (e.g., word "dime" vs. word "dollar") rather than when they differed in both value and form (e.g., picture of a dime vs. word "dollar"). This pattern was most pronounced in participants who showed the greatest behavioral sensitivity to reward-better memory for high value than low value trials. These results provide a novel demonstration of abstract value representation and pattern separation in human hippocampus where representations of visually similar cues are made especially distinct to reflect different behavioral relevance. More broadly, our data illustrate that contextual representations within hippocampus go beyond spatial and temporal context to include information about the motivational salience of events, which may in turn facilitate encoding and subsequent remembering.

Monday Abstracts

Reduced attention capture in video game players: improved capture prevention or speeded capture recovery?

James Patten, Simon Fraser University
John Gaspar, Simon Fraser University
Thomas Spalek, Simon Fraser University
John McDonald, Simon Fraser University

Action-oriented video game players (VGPs) appear to show reduced distractor interference than non-video-game players (NVGPs) when searching for a target singleton and attempting to ignore a more salient colour singleton. Two contrasting hypothesis have been offered to account for this difference. According to the improved-capture-prevention hypothesis, VGPs are better able to suppress salient distractors, thereby preventing them from diverting attention from the task at hand. According to the improved-capture-recovery hypothesis, VGPs are better able to disengage attention from the location of a salient distractor once that item has captured attention. The present study evaluated these hypothesis using event-related potential components associated with attentional selection (N2pc) and suppression (P_D). Participants searched for a known colour singleton (target) that was accompanied on most trials by a more salient, but task irrelevant, colour singleton (distractor). Lateral distractors were found to elicit the P_D in both VGPs and NVGPs, indicating that the majority of individuals managed to suppress the distractor to prevent attention capture. Critically, the P_D was found to be larger and to onset earlier in the VGP group than in the NVGP group. Thus, consistent with the improved-capture-prevention hypothesis, these results indicate that processes associated with distractor suppression are facilitated in VGPs.

Neural activity associated with the sustained suppression of irrelevant information in visual working memory

John Gaspar, Simon Fraser University
John McDonald, Simon Fraser University

The ability to hold and manipulate visuospatial representations in memory is fundamental to the way in which we interact with our surrounding environment. The visual working memory (vWM) system enables the temporary storage and processing of these representations but has a strict capacity limitation. Recently, it has been proposed that individuals can conserve this limited capacity by preventing irrelevant objects from consuming resources in vWM. Although there is mounting evidence for this idea, very little is known about the precise manner in which this is accomplished. Here, we asked whether the mechanism that prevents distractors from consuming vWM capacity acts early, at the stage of attentional selection, or whether it continues to operate in a sustained fashion while information about relevant objects is actively maintained. We isolated both early attentional components as well as the CDA - a sustained posterior contralateral negativity associated with the active representation of stimulus information in vWM - to distractor stimuli. We found distractor stimuli were actively suppressed early on and showed no sustained contralateral negativity (indicating they were not stored in vWM). Instead, lateral distractors were found to elicit a sustained positivity throughout the CDA time interval. We hypothesize that the presence of this positive-going CDA (which we refer to as the CDA-P) reflects the maintenance of distractor suppression while relevant information is being actively stored in vWM.

The Role of Nonverbal Stroop Tasks in Assessing Intelligence
Christopher Koch, George Fox University

Due to changing demographics, test developers have been interested in minimizing the impact of language on assessment in an attempt to find culturally fair measures of intelligence. As a result, some test developers have created nonverbal intelligence tests (e.g., Columbia Mental Maturity Scale). The Stroop task is often used to assess inhibitory control and has been found to be related to intelligence (Helode, 1982). Carroll (1993) argued that naming speed and reading speed are the underlying factors that link Stroop performance and intelligence. Language processing among bilinguals shows that reading ability clearly influences Stroop interference (Coderre et al., 2013; Tzelgov, Heni, and Leiser, 1990). Therefore, test developers have recently created different versions of nonverbal Stroop tasks (e.g., Koch and Roid, 2012). Although these tasks produce findings similar to the standard color-word Stroop test, there are some important differences. In particular, the nonverbal Stroop task included in the Leiter 3 consists of congruent and incongruent color pairs presented in a cancellation task (Roid, Miller, Pomplun, Koch, 2013). Therefore, it is possible that the nonverbal Stroop task in the Leiter 3 may be more related to search than to color-word Stroop performance. This presentation includes two studies conducted to address what nonverbal Stroop interference is associated with. In one study, participants completed the Attention Sustained (i.e., search) task in addition to the nonverbal Stroop task. The results show that performance on the two tasks is positively correlated. A second study compared nonverbal Stroop, the Color and Word Stroop Test, and search task similar to Treisman and Gelade (1980). Search performance was related to the nonverbal Stroop task but not with the color-word Stroop task. These results indicate that nonverbal Stroop performance is related to visual search. Implications for intelligence testing and understanding attentional mechanisms are discussed.

Untangling the Interactions of the Attention System
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Omer Linkovski, Ben Gurion University of the Negev
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In the beginning of the 90's Posner and colleagues suggested attention is composed of three sub-systems: alerting, orienting, and executive functions. They hypothesized that these systems are independent and do not interact. To examine this hypothesis they designed the ANT (Attention Network Test). To better examine the interactions among attentional systems the Attentional Networks Test- Interactions (ANT-I) task was designed. Typical results of the ANT-I show that the three sub-systems interact with each other and they are not independent. Importantly, both ANT and ANT-I employed the flanker task as a measure of executive functions. The current study employed a Stroop task instead of the flanker task. Our results suggest that the task used to measure executive functions might bias our conclusions regarding interactions among attentional sub-systems. For example, the flanker task gives rise to all three two-way interactions whereas the Stroop task produced only one interaction between orienting and alerting. This difference between Stroop and flanker tasks is probably due to the spatial nature of the flanker task.

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