Nineteenth Annual Meeting

Cognitive Science Association for Interdisciplinary Learning

Hood River Hotel
Hood River, Oregon
July 31 to August 4, 2014

Thursday, July 31

4:30 pm	**Reception and Appetizers**	
4:45 pm	**Welcome and Introductory Remarks**	
5:00 - 5:10 pm	Joseph Wekselblatt	*Brain-wide imaging of neural activity during a visual discrimination task*
5:10 - 5:20 pm	Amy Konyn, Yasu Tanaka, Amanda Gunn, Dare Baldwin, & Don Tucker	*Pulling words from the stream: Electrophysiology of micro language segmentation*
5:20 - 5:50 pm	Ed Awh	*Induced alpha activity tracks the content and quality of working memory*
6:00 - 6:30 pm	David Whitney	*The Continuity Field (CF): a mechanism for perceptual stability via serial dependence*
6:40 - 7:10 pm	Edward Vogel	*The contribution of attentional lapses to individual differences in working memory capacity*
7:20 pm	**---------- Adjourn for Evening ----------**	

Friday, August 1

8:30 am	**Breakfast**	
9:00 - 9:30 am	Shani Kahta & Rachel Schiff	*Sequential learning deficit among adults with developmental dyslexia*
9:40 - 10:10 am	Jessica Green, Kristina Drake, Mario Liotti, & John McDonald	*Reading ability and top-down attentional control*
10:20-10:50 am	Brittany Dungan & Edward Vogel	*An attention-centered neural marker for shifts in eye position*
11:00 am	---------- **Break until 4:15 pm** ---------- 	
4:15 pm	**Appetizers**	
4:30 - 4:40 pm	Gal Dadon & Avishai Henik	*Interaction between list-level control and item-level control in the Stroop task*
4:40 - 4:50 pm	Evan Caldbick & Neil Watson	*Testosterone predicts decreasing contributions in an iterated public goods game*
4:50 - 5:00 pm	Ronit Goldman, Sharon Naparstek, Joseph Tzelgov, & Avishai Henik	*Is 3 faster than 333? The mental architecture of processing numerical values and numerosity*
5:00 - 5:30 pm	Naomi Havron & Inbal Arnon	*The relationship between literacy and spoken language processing*
5:40 - 6:10 pm	Jessica Thomas	*The Song in your head: Decoding the melody of the mind*
6:20 - 6:50 pm	Enriqueta Canseco-Gonzalez, Chris Graulty, Orestis Papaioannou, Phoebe Bauer, & Michael Pitts	*Studying the time course of sensory substitution mechanisms*
7:00 pm	---------- **Adjourn for Evening** ----------	

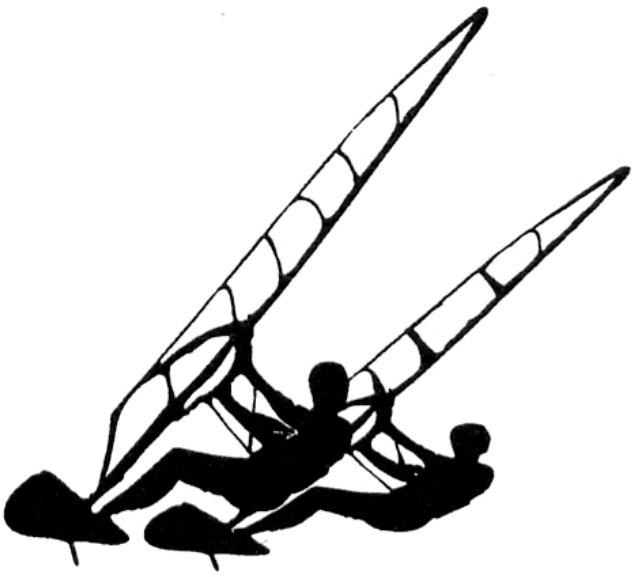
Saturday, August 2

8:30 am	**Breakfast**	
9:00 - 9:30 am	Zahira Cohen & Avishai Henik	*Tactile Enumeration Using One Hand and the Effects of Training*
9:40 - 10:10 am	Bjorn Hubert-Wallander & Geoffrey Boynton	*Domain specificity in integration of visual information across time*
10:20-10:50 am	Kimberly Jameson & Alissa Winkler	*New results on color appearance space and the potential for human tetrachromacy*
11:00 am	---------- **Break until 4:15 pm**---------- 	
4:15 pm	**Appetizers**	
4:40 - 4:50 pm	Ashwin Bhandiwad	*What can we learn from fish psychophysics?*
4:50 - 5:00 pm	Hamid Shabankar	*The influence of collaboration on attitudes towards English vocabulary learning among Iranian EFL learners*
5:00 - 5:30 pm	Carly Leonard & Steve Luck	*Dissecting distraction: Interactions of feature-based attention and spatial attention*
5:40 - 6:10 pm	John Gaspar, Hayley Lagroix, Vincent Di Lollo, Pierre Jolicoeur, & John McDonald	*Observers are unable to suppress salient visual-search distractors during the attentional blink*
6:20 - 6:50 pm	Ashley Livingstone, Gregory Christie, & John McDonald	*On the termination of cue processing in the contingent capture paradigm*
7:00 pm	---------- **Adjourn for Evening** ----------	

Sunday, August 3		
8:30 am	**Breakfast**	
9:00 - 9:30 am	David Sutterer & Edward Awh	*Testing Enhances the Probability but not the Precision of Memory Recall*
9:40-10:10 am	Justin MacDonald & J. D. Balakrishnan	*Why static decision theory should be replaced by dynamic decision theory*
10:20-10:50 am	Summer Sheremata & Sarah Shomstein	*Dynamic Reallocation of Resources in Visual Short-Term Memory*
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	
4:30 - 5:00 pm	Diego Fernandez-Duque, Barry Schwartz, Colton Christian, & Sara Hodges	*Lay Theories of Mind/Brain Relation*
5:10 - 5:40 pm	Robert Goldstone, Paulo Carvalho, & Erik Weitnauer	*Sequencing Examples During Concept Learning*
5:50 - 6:20 pm	Timothy Hackenberg, Jessica Dennis, & Nicholas Kappeyne van de Coppello	*Self-Awareness and Metacognition in Rats*
6:30 pm	---------- **Adjourn for Banquet Dinner** ----------	
7:00 pm	**Banquet Dinner at Cornerstone Cuisine**	

Monday, August 4

8:30 am	**Breakfast**	
9:00 - 9:30 am	Joshua J. Foster & Edward Awh	*Distinguishing between true guessing and low-precision representations in visual working memory*
9:40 - 10:10 am	Sandrine Mendizabal, Pierre Jolicoeur, & Sarah Lippé	*Effects of Benign Epilepsy with CentroTemporal Spikes (BECTS) on the development of Visual Working Memory: evidence from neuropsychological testing and human electrophysiology*
10:20-10:50 am	Michael Pitts, Juliet Shafto, & Kathryn Schelonka	*Inattentional blindness for shapes, faces, and words: ERP correlates of attention & awareness*
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

Brain-wide imaging of neural activity during a visual discrimination task
Joseph Wekselblatt
University of Oregon

Visually-driven behaviors engage multiple brain regions in order to convert sensory information into motor output. This includes primary visual cortex and extrastriate regions to extract cues from the visual scene, higher-order association areas involved in decision-making, and motor regions to generate output. Determining the flow of information between these regions is a key goal in understanding how vision is translated into action. In order to analyze brain activity at this scale, we have developed a system that allows functional imaging across large areas of cortex during a visual discrimination task. To facilitate imaging, we have generated a transgenic mouse expressing the fluorescent calcium indicator GCaMP6s in excitatory neurons throughout cortex. Using a widefield macroscope, we can thereby image patterns of neural activity across nearly the entire the dorsal surface of cortex simultaneously. Although this imaging modality does not provide cellular resolution, it allows us to map activity in regions of cortex on ~50um spatial scale with ~100msec temporal resolution.

Using this method, we have delineated cortical areas that are selectively engaged by visual stimulation, whisker stimulation, or locomotion. Furthermore, we have integrated this imaging modality with a visual task, by training head-fixed mice on a spherical treadmill to report their response in an orientation discrimination by running either left or right. Widefield imaging while animals perform this task demonstrates a progression of activity in different cortical regions, including selective engagement of extrastriate and other posterior areas, which are associated with different phases of the task such as stimulus presentation and behavioral response. Importantly, once the cortex-wide patterns of activity are determined, we can "zoom in" on key regions using two-photon microscopy to measure responses during the task at the level of ensembles of individual neurons to study the circuit mechanisms underlying distinct aspects of the task. We expect that this paradigm will also be useful in probing brain-wide networks involved in other sensory or cognitive processes.

Pulling Words from the Stream: Electrophysiology of Micro Language Segmentation
Amy J. Konyn[1,2], Yasu Tanaka[1], Amanda R. Gunn[1,2], Dare Baldwin[1] & Don M. Tucker[1,2]
[1]University of Oregon; [2]Electrical Geodesics, Inc.

When we first hear a new language, we perceive it as a stream of continuous sound. As exposure continues and we begin to acquire the language, our perception shifts. The sounds are still a stream, but we begin to experience them as a series of discrete elements. Much of what we know about this online process of speech segmentation comes from research utilizing artificial language stimuli within a sound stream listening paradigm. Results of this research indicate that listeners segment streams of syllables by implicitly tracking statistical regularities, with naturally occurring dips in transitional probability between words cuing the location of word boundaries. Electrophysiological recording during this paradigm reveals that an N400 develops to word initial syllables relative to word medial syllables. Because the amplitude of this N400 correlates with behavioral measures of segmentation

and attenuates after learning, it has been suggested to index word learning or segmentation. To explore online speech segmentation further in a more naturalistic context, we developed a “micro language”: native-spoken Japanese with a dramatically reduced lexicon. The language could be mastered in about an hour. For the present study twenty-nine adult native English speakers listened to a sound stream of these micro language stimuli while behavioral measures of segmentation and dense-array EEG were recorded. After this task, participants continued for another 40 minutes of language training, then repeated the sound stream listening task as a posttest with the additional instruction to “carefully listen”. Consistent with artificial language research findings, a medial frontal negativity developed to word onset syllables. However the amplitude of this component significantly decreased only for participants who had successfully segmented the stimuli. Additionally this negativity reemerged in the posttest with the attentional manipulation, suggesting that this medial frontal negativity may index not segmentation or learning but rather attentional control or task engagement.

Induced alpha activity tracks the content and quality of working memory

Ed Awh
University of Oregon

Past work has suggested that neuronal oscillations coordinate the cellular assemblies that represent items in working memory (WM). In line with this hypothesis, we show that the spatial distribution of power in the alpha frequency band (8-12 Hz) can be used to decode the content and quality of the representations stored in visual WM. We acquired EEG data during an orientation WM task, and used a forward encoding model of orientation selectivity to reconstruct orientation-specific response profiles (termed channel tuning functions, or CTFs) that tracked the orientation of the memorandum during both encoding and delay periods of the trial. Critically, these EEG-based CTFs were robust predictors of both between- and within-subject differences in mnemonic precision, showing that EEG-based CTFs provide a sensitive measure of the quality of sensory population codes. Experiments 2 and 3 established that these EEG-based CTFs are contingent on the voluntary storage goals of the observer. When observers were given a post-sample cue to store or drop the memorandum, the resulting CTF was sustained in the "store" condition and rapidly eliminated following the "drop" cue. When observers were instructed to store one of two simultaneously presented stimuli, only the stored item was represented in a sustained fashion throughout the delay period. These findings suggest that the oscillatory activity in the alpha frequency band plays a central role in the active storage of information in visual WM, and demonstrate a powerful approach for tracking the precision of online memories with high temporal resolution.

The Continuity Field (CF): a mechanism for perceptual stability via serial dependence

David Whitney
UC Berkeley

A critical function of vision is to maintain stable perception of objects so they *look* the same from moment to moment. This is a challenge because visual input is noisy and discontinuous due to, for example, shadows, motion, occlusion, changes in lighting, noise, etc. Though a classic question, the mechanism that links the perception of an object's identity and properties from moment to moment is unknown. Here, we demonstrate the perceptual constancy field (CF), a novel mechanism of object

constancy built on serial dependence. We found that on a given trial, a subject's perception of the orientation of a grating reflected not only the currently viewed stimulus, but also a systematic attraction toward the orientations of the previously viewed stimuli. We found the same serial dependence in the perception of facial expression. This perceptual attraction extended over several trials and seconds, and displayed clear tuning to the difference (in orientation or facial expression) between the sequential stimuli. Furthermore, serial dependence in object perception was spatially specific and selective to the attended object within a scene. Several control experiments showed that the perceptual serial dependence we report cannot be explained by effects of priming, known hysteresis effects, visual short-term memory, or expectation. Instead, there is a systematic influence of recent visual experiences on perception at any given moment: visual percepts, even of unambiguous stimuli, are attracted toward what was previously seen. Our results reveal a novel mechanism-the Continuity Field-that helps maintain stable object and scene representations in the face of a dynamic and noisy environment.

The contribution of attentional lapses to individual differences in working memory capacity

Edward Vogel
University of Oregon

The capacity of visual working memory (WM) is known to be severely restricted and varies considerably across individuals. These inter-individual differences in memory capacity are a stable trait of the observer and are positively correlated with many high-level aptitude measures such as fluid intelligence and academic performance. While they have historically been considered to be the consequence of variability in amounts of online storage space, extensive work from the past 10 years has suggested that much of this variability stems instead from the efficiency of the attentional control mechanisms that help restrict access to this limited representational space. In previous work using behavioral and electrophysiological (e.g., EEG & ERP) methods, we have found that low capacity individuals are poorer at keeping irrelevant items from being stored in WM and are slower to disengage from attentional capture than are their high capacity counterparts. More recently, we have sought to extend these findings by examining how intra-individual variability within a task session may be contributing to our estimates of the inter-individual differences in capacity. To do this, we developed a whole-report procedure that gives us graded information about how many items were accurately remembered on each trial -allowing us to measure the individual's moment by moment fluctuations in capacity throughout the session. This approach allows us to directly test a long standing question: do low capacity individuals have a consistently reduced capacity or is their poorer performance the result of a mixture of "normal" capacity trials with trials in which they were completely disengaged from the task? Using both behavioral and EEG approaches we could successfully track trial by trial fluctuations in the number of items that were successfully maintained in WM. Importantly, while we found that low capacity individuals had roughly double the frequency of complete attentional lapses, this factor alone was insufficient to account for the entire extent of the differences between subjects. Instead, our results suggest that the apparent differences in capacity between individuals is determined by a combination of two intra-individual factors: attentional lapse rate and the consistency with which the individual achieved a maximal number of items stored.

Friday Morning Abstracts

Sequential Learning Deficit among Adults with Developmental Dyslexia

Shani Kahta & Rachel Schiff
Bar-Ilan University, Israel

Developmental Dyslexia (DD) is defined as a reading disorder, and has been traditionally attributed to a linguistic deficit. Over the years, however, studies indicated that DD is in fact a multi-deficiet disability, leading to the suggestion that this disability might originate from a deficit in cognitive processes, particularly in instances requiring sequential learning. The aim of the current study was to explore this suggestion using visual and auditory Artificial Grammar Learning Task (AGLT). Sixty three adults participated in two experiments, 31 were diagnosed with DD since early childhood, and 32 were typically developed (TD) readers. In the visual task the participants were required to look at 20 visual sequences (letters) that shared the same grammar. They then were asked to watch new strings and classify them as either "grammatical" or "non-grammatical" based on the grammar they were exposed to during training. The procedure in the auditory task was identical to the visual, although the stimuli consisted of tone strings rather than letters. Endorsement rates and accuracy were calculated for each group. Results of the TD group showed that learning occurred above chance level for both visual and auditory stimuli, supporting the a-modal nature of statistical learning processes. In contrast, the results in the DD group revealed a superiority of visual sequential learning. While readers with DD exceeded chance level for visual stimuli, they showed no learning when exposed to the auditory stimuli. These results support the sequential learning deficit assumption among individuals with DD, and indicate that this deficit is constrained by the modality in which it is presented. Theoretical and clinical implications are discussed.

Reading ability and top-down attentional control

Jessica J. Green[1], Kristina Drake[1], Mario Liotti[2], John J. McDonald[2]
[1]University of South Carolina; [2]Simon Fraser University

The electrophysiological markers of voluntary visuospatial attention have been well documented - frontal and parietal lobe control processes followed by preparatory modulations of visual cortex in advance of the target, including both enhancement of the to-be-attended location and suppression of to-be-ignored locations. There can, however, be large variation between subjects in these tasks, in both behavior and electrophysiological measures. Based on one prominent theory of dyslexia that postulates that reading deficits stem from abnormalities in the attention system, we hypothesized that some of this variability in attention measures may result from between-subject differences in reading ability. In a series of experiments we show that high-ability readers have larger amplitude ERPs to attention-directing cues than low-ability readers, both in terms of fronto-parietal control processes and visual preparatory activity. Moreover, only high-ability readers show an effect of reading direction on both behavioral performance and EEG measures, including the strong suppression of the to-be-ignored left side of space when shifting attention rightward. Our results demonstrate that even within a high-functioning university student population, variability in reading skills leads to large differences in basic attention skills and their neural correlates.

An Attention-centered neural marker for shifts in eye position
Brittany J. Dungan & Edward K. Vogel
University of Oregon

Past research from our lab has investigated the potential role of visual working memory (VWM) in perceptual stability. We have previously shown that item representations remain in the initial contralateral, encoding hemisphere following a shift in gaze, with items also being represented in the ipsilateral hemisphere over time (Dungan & Vogel, VSS Poster 2012; 2013). Here we extended these findings by recording event related potentials (ERPs) while subjects performed a change detection task for laterally-presented colored squares. Subjects fixated a central cross at the beginning of each trial and were cued to attend to the left or right visual field before the presentation of a memory array. In Experiment 1, on half the trials subjects were cued to maintain central fixation throughout the trial, while on the other half of trials subjects were cued to shift their gaze to a lateral fixation cross presented 8.71 degrees to the left or right. In a blocked design, this eye movement either was over the attended items or away from them. Following the onset of the eye movement, we observed a large contralateral negativity when the eyes were moved over the attended items and a contralateral positivity when they moved away from them. Thus, the polarity of this activity is determined by the relative position of the attended items and was not determined by the absolute direction of the eye movement. In Experiment 2, we manipulated the distance between the central and lateral fixations crosses (7.94 vs 12.18deg) and found that the amplitude of the deflection was greater for larger shifts in eye position. Together these results reveal a neural marker of eye position shifts that charts the distance of the shift and is centered to the current focus of attention.

Friday Evening Abstracts

Interaction between List-Level Control and Item-Level Control in the Stroop Task
Gal Dadon & Avishai Henik
Ben-Gurion University of the Negev, Beer-Sheva, Israel

The Stroop task, in which participants name the ink color of printed words (Stroop, 1935), is one of the most researched tasks in psychology. The congruency effect (reaction time for incongruent trials minus congruent trials) can be affected by two levels of control: list-level (a general strategy) and item-level (a trial-by-trial strategy). Recent studies suggested that item-level control might be the sole player in the Stroop task. We aimed to examine this suggestion. In the current experiment we divided four colors into two color sets and manipulated the proportion of neutral trials (i.e., a large/small percentage) in one of the sets. We combined the manipulated set with the other color set that had an equal proportion of congruent, neutral and incongruent trials and thereby were able to create a mostly neutral block and a minimally neutral block. The combination of color sets and manipulating the number of neutral trials in the same design allowed us to examine the two control mechanisms. Our findings suggest that both the list-level and the item-level control mechanisms can be manifested in the Stroop task and that they can interact, depending on the context.

Testosterone predicts decreasing contributions in an iterated public goods game

Evan Caldbick & Neil Watson
Simon Fraser University

Intragroup cooperation is a defining characteristic of social animals, but there are conditions under which individuals are incentivized to exploit their social group for greater individual reward. Reproductive and other benefits are frequently awarded to dominant males in hierarchically organized social groups, and increased testosterone (T) is known to reflect a state of victory for males in conflicts that challenge social status. This creates the incentive for selfishness during conflicts where social status is on the line. The public goods game (PGG) is a game theoretical scenario that pits individual and group reward at odds, making it an ideal arena to test the effects of T on group cooperation. In the experiment described here, male participants (n=53) each played 20 consecutive rounds of the PGG with 3 programs that played a balance of heterogeneous strategies ranging from completely selfish to completely altruistic. The programs were perceived by participants to be conspecifics. Results of a hierarchical linear model revealed that participants with relatively high baseline T displayed a greater decrease in personal contributions to the group across the 20 rounds than those with relatively low baseline T. These results suggest that in repeating social dilemmas that pit individual reward against group reward, T promotes exploitative rather than cooperative intragroup behaviour.

Is 3 faster than 333? The mental architecture of processing numerical values and numerosity

Ronit Goldman, Sharon Naparstek, Joseph Tzelgov, & Avishai Henik,
Ben-Gurion University of the Negev, Israel

Numerical information can be conveyed using symbolic (e.g., digits) or non-symbolic (e.g., arrays of dots) representations. The processing of the numerical value and the processing of the numerosity develop separately, and are assumed to be interconnected. The mental architecture of the two processes is of interest. In the current study we used the Millers' inequality and the systems factorial technology (SFT) methods to test the information-processing architecture of the two processes. We used the divided attention paradigm in which participants were instructed to detect a target in either one or two of the information channels. When reporting the mere existence of a magnitude, processing occurred in an independent, parallel fashion (Exp. 1). In contrast, when carrying out comparative judgments of magnitudes, processing occurred through an interaction between the channels (Exp. 2). These results imply that the extraction of an exact cardinal magnitude is conducted separately in each channel where's activation of the mental number line, and the use of ordinal rules, leads to a co-activation in the processing of magnitudes.

The relationship between literacy and spoken language processing

Naomi Havron and Inbal Arnon
Hebrew University of Jerusalem

Why is it harder to learn a second language as an adult? Unlike children, L2 adult learners are usually literate. Literacy leads learner to attend more to individual words (lexical segmentation, Kurvers & Uri, 2006). While generally advantageous, this effect of literacy may hinder learning the relations between words (Arnon, 2010; Arnon & Ramscar, 2012). Here, we test the hypothesis that literacy increases

sensitivity to word boundaries by examining spoken language processing in a group of Arabic-speaking Hebrew-illiterate soldiers - some also illiterate in their L1. We assessed their ability to reverse pairs of spoken words in Hebrew (hear: small-boy, produce: boy-small) before and after an intense literacy course. By looking at this unique population and comparing them not to literate adults (as is often done) but to themselves after a literacy course we are able to better isolate the effect of L1 and L2 literacy on spoken language processing and control for the many other variables distinguishing literate and illiterate adults. The results reveal several interesting patterns: (a) L1 literacy affected performance at the start of the course, even though the task was in the L2. Knowing to read (in any language) led to better lexical segmentation, (b) literacy and task performance improved after the course, with greater task improvement for the L1 illiterates: learning to read in the L2 improved lexical segmentation. The results show a rapid change in spoken language processing with increasing literacy. We discuss implications for models of L2 learning.

The Song in Your Head: Decoding the melody of the mind
Jessica Thomas, University of Washington

In recent years there has been an increasing interest in developing models of brain activity which can be used to decode various features of presented stimuli. Decoding models allow us to determine how much information is potentially present within observed neural activity. Here we present a model for estimating what auditory stimulus was presented over time, based on neural activity within the auditory cortex (AC) as measured by the fMRI BOLD signal. We presented subjects with either pure tone progressions of ascending or descending notes, or pure tone versions of the songs *When You Wish Upon A Star* or *Somewhere Over The Rainbow*. Our goal was to estimate which notes were presented over time in order to reconstruct the progression or song, based solely on neural activity.

Our decoding method is based on the population receptive-field (pRF) model (Dumoulin and Wandell, 2008). This method models each fMRI voxel as having a receptive field that is a 1D Gaussian of log frequency. This model is then used to create a predicted time course of BOLD responses to any pure tone. This predicted time course, which is generated across all voxels in the auditory cortex, is then used to guess which frequency was presented at each point in time, by selecting the frequency that best maximizes the correlation between predicted and obtained time courses.

Using this method we were able to not only successfully guess which progression or song was presented, but also to independently estimate the frequency (Hz) of each note presented in the stimulus over time (i.e. recreate the song, note by note). A natural extension will be to apply these methods to more natural and behaviorally relevant stimuli, such as music (Schaefer et al. 2011) and speech (Formisano et al. 2008).

Studying the time course of sensory substitution mechanisms
Enriqueta Canseco-Gonzalez, Chris Graulty, Orestis Papaioannou, Phoebe Bauer, &
Michael Pitts
Reed College

Taking advantage of the superior temporal resolution of ERPs we investigated the time course of sensory substitution mechanisms. We measured brain activity elicited by 'soundscapes' in 31 intact

individuals *before* and *after* they underwent one of two types of training. The 'soundscapes' were translated from visual shapes via an image-to-sound conversion algorithm (Meijer). Our sensory substitution group (SS) was trained to use the rules of the Meijer algorithm to extract visual information from these soundscapes. A control group was trained with identical stimuli, but they were forced to memorize *arbitrary* pairings. Our behavioral results indicate that the training was successful in both groups, but with the SS group performing significantly better. When tested with novel soundscapes, only the SS group was able to perform significantly above chance. For the ERP analysis, we compared neural differences before and after training between the two groups using a novel "triad" paradigm. In this paradigm, the first stimulus was always a soundscape, the second stimulus was always an image and the third stimulus was either a soundscape or an image. On half of the trials, the second *or* third stimulus matched the first. The subject's task was to indicate whether any two of the three stimuli matched. This paradigm allowed us to present identical stimuli before and after training while also keeping the task as similar as possible. We compared the ERPs elicited by the soundscapes (i.e. the first stimulus in each triad) and the ERPs elicited by the visual shapes (i.e. the second stimulus in each triad) before and after training. We found an increase in the auditory P2 and the P3 components post vs. pre-training in both groups (significantly greater in the SS group), likely reflecting general auditory perceptual learning. Importantly, an N2 amplitude difference was only evident in the Meijer group, suggesting this this component as a reflection of specific sensory substitution mechanisms. The visual shapes elicited a larger N1 for both groups post vs. pre-training, but this increase was larger for the Meijer group. This change may correspond to an enhancement of early LOC activity due to cross-modal learning.

Saturday Morning Abstracts

Tactile Enumeration Using One Hand and the Effects of Training

Zahira Cohen & Avishai Henik
Ben-Gurion University of the Negev, Israel

Subitizing is a fast and accurate process of enumerating small quantities. There are differences in the behavioral results of subitizing among modalities. The literature on enumeration in the tactile modality is sparse and the findings are inconclusive.
In the first study we explored various aspects of enumerating small quantities in the tactile modality. Fingertips of one hand were stimulated by a vibro-tactile apparatus (for 100/800 ms). Between 1 and 5 stimuli were presented to the right or the left hand and applied to neighboring (e.g., thumb-index-middle) or non-neighboring (e.g., thumb-middle-pinkie) fingers.

The results showed a moderate increase in RT (response time) up to 4 stimuli and then a decrease for 5 stimuli. Right hand stimulation evoked more accurate performance than left hand stimulation only under short exposures (100 ms). Importantly, when the stimuli were presented to neighboring fingers, the accuracy rate was higher and the RT was faster than when presented to non-neighboring fingers. This study suggests and discusses that when the stimuli are presented to one hand, the subitizing range is 4 rather than 3 (as suggested in earlier studies). Furthermore, the right hand advantage and the efficiency of responding to neighboring fingers support the association between number and spatial arrangement of the fingers.

Although the RT increase per item was moderate, there is still a question whether this RT pattern represents tactile subitizing; it seems that in comparison to visual presentation, accuracy rates are lower and RT slopes are steeper. In order to increase accuracy, we examined the effect of training. There were three training groups: 1) daily training for 7 days (7DT), 2) every-other-day training (4DT), and 3) controls - a single session (1DT). We tested their performance one week and four weeks after the training ended.

The results showed an increase in accuracy rates after training, with the most accurate group being the 7DT group. Importantly, although faster RT was observed, the general pattern of RT increase per item remained moderate. We suggest that the differences in the RT slopes between modalities and the relatively low accuracy rates are related to the difference in modality sensitivity and not related to the different enumeration processes. Moreover, the results confirm the initial suggestion that, when using one hand, the tactile subitizing range is up to four stimuli.

Domain specificity in integration of visual information across time

Bjorn Hubert-Wallander & Geoffrey M. Boynton
University of Washington

Considerable evidence over the past 15 years has shown that, when presented with an array of visual items, the human visual system naturally, efficiently, and accurately represents the mean value of the set along one or more feature dimensions (e.g., size, color, location, orientation). This type of statistical summary representation (SSR) is usually studied in tasks where the entire array is presented at once to the subject, but humans in many ways experience the world dynamically, or across time. While it is known that SSRs **can** be computed when information arrives in a serial fashion, it isn't well-understood **how** the computation is performed in this arguably more naturalistic case. Does the SSR formed in this scenario represent a true average, or do some parts of the information stream contribute more than others? In a series of experiments, we tested subjects' ability to judge the mean of a set of serially presented objects in a variety of feature domains.

In Experiment 1, subjects viewed a sequence of ten serially presented white dots that varied in spatial position and in size. In alternating blocks of trials, subjects reported either the average size (by adjusting a test dot) or average location (by mouse click) of the group. A set of ten weights was obtained for each subject for each task that reflects the average influence that each of the ten dots had on the overall judgments. For mean location, the earlier dots had much more influence on the perceived center (a "primacy" effect), while for mean size, the later dots had much more influence (a "recency" effect). These effects were replicated across several manipulations of stimulus timing and spatial arrangement. The same paradigm was extended to new feature domains in two further experiments, where subjects judged the mean expression in a series of human faces (Experiment 2) or the mean direction of motion in a series of coherently moving dot patches (Experiment 3). Mean judgments for both facial expression and direction of motion showed recency.

Our results show that when forming SSRs from visual information arriving over time, there is a strong temporal order effect that is specific to the relevant feature domain. Accordingly, we will discuss whether the domain specificity observed here reflects separate SSR computation processes operating for different features or a unitary process that manifests differently depending on the domain.

New results on color appearance space and the potential for human tetrachromacy.
Kimberly A. Jameson[1], & Alissa Winkler[2]
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Research during the past decade or so has clarified how differences in the processing of color appearance arise from variations in retinal photopigment classes underlying color perception. We empirically assess and compare the color perception of individuals possessing more than three retinal photopigment genes with those possessing fewer retinal photopigment genes. New results show that observers with four-photopigment genotypes exhibit color appearance space variations that differ from those of trichromat observers. Implications of such results on the accepted photoreceptor-based model of trichromacy are discussed.

Saturday Evening Abstracts

What can we learn from fish psychophysics?
Ashwin Bhandiwad
University of Washington

Fishes represent an interesting avenue in understanding how the brain encodes information from the environment. Though they lack a neocortex, fishes can encode visual, auditory, olfactory, and electric signals with high fidelity and high dynamic range. These can be probed using psychophysical methods adapted to fishes. However, these sensory systems are under selection pressure from the environment and result in a diverse set of morphological and physiological adaptations, leading to evolution of new species. This talk will present the two tracks of my research interests: (1) understanding how acute noise damage affects auditory perception and (2) how perceptual adaptations to different visual environments can isolate individuals and lead to speciation. I will discuss the two methods I've developed to study these processes: prepulse inhibition of the auditory startle and the optokinetic response, respectively. I will also discuss what these processes in fish can tell us about how peripheral sensory systems respond to short-term and long-term pressures.

The Effect Of Task-Based Instruction (TBI) On
Hamid Shabankar
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This study explores the helpfulness of task-based instruction (TBI) in improving students' speaking skills as well as student and teacher perceptions of TBI at a Iranian English institute called MAREFAT. It will be done during a period of three months in which this study will be conducted (January-March) of the academic year 2014. Control and experimental class data will be gathered through questionnaires, interviews and oral tests. Oral pre- and post-tests will be administered to both classes comprising 45 lower-intermediate level students total. The teacher's perceptions of TBI will explored in pre- and post-treatment interviews, and a post-treatment interview will also conducted with a focus group from the experimental class. Questionnaires will be distributed to the experimental group after each of 11 treatment tasks. Data from the oral pre- and post-tests and questionnaires will be analyzed quantitatively while data from the teacher interviews and the focus group discussion will be analyzed

qualitatively. T-tests will be run to compare the improvement between groups and to analyze improvement within groups.

Dissecting distraction: Interactions of feature-based attention and spatial attention

Carly J. Leonard, & Steve Luck
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Attention is critical for effectively processing the enormous amount of incoming sensory input, and current task goals guide limited resources to potentially relevant information. However sometimes attention is captured by peripheral distractors. Our research examines how two different forms of attention, feature-based attention and spatial attention, mediate such distraction. In most of the experiments discussed, participants search for a single target in a rapid serial visual presentation of letters. Distractors were presented at different spatial separations from the relevant information, and could either possess the target feature or not. The results show that attentional capture is gated by feature-relevance, but also strongly modulated by spatial separation. Additional experiments that manipulate the probability of spatially proximal distractors provide further evidence for interactive effects between feature-based and spatial attention.

Observers are unable to suppress salient visual-search distractors during the attentional blink

John Gaspar[2], Hayley E. P. Lagroix[1], Vincent Di Lollo[1], Pierre Jolicoeur[2], & John McDonald[1]
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Recent ERP research has found that an active suppression mechanism can prevent salient, distracting items from capturing visual attention. The present study examined whether this suppression mechanism could operate independently of top-down attention control. To manipulate top-down control, we used an attentional blink paradigm in which the first target (T1) was a number within an RSVP stream of letters and the second target (T2) appeared within a visual search array that also contained a salient distractor. We examined ERPs elicited by the T2 search array at lag 2 (within the attentional blink) and at lag 8 (outside the attentional blink) in order to track distractor and target processing. During the attentional blink interval, an ERP component corresponding to distractor suppression (the P_D) was entirely absent. In contrast, an ERP component corresponding to target selection (the N2pc) was present, albeit significantly de! layed. These results suggest that if the search array appears while the system is busy processing T1, (i) search for T2 is put on hold until after processing of T1 is complete; (ii) distractor suppression is not possible. On this basis, we conclude that the active suppression mechanism is not bottom-up, but rather contingent on top-down control.

On the termination of cue processing in the contingent capture paradigm

Ashley C. Livingstone, Gregory J. Christie, & John J. McDonald
Simon Fraser University

According to the contingent capture visual attention hypothesis, an irrelevant cue will attract attention when it possesses a task relevant feature (such as a target's color). Recent event related potential (ERP) research using a contingent capture paradigm has shown that a task irrelevant cue elicits a

sequence of two lateralized ERP components: a contralateral negativity (N2pc) followed by a contralateral positivity (CP). The N2pc was taken as an index of attention capture, whereas the CP was interpreted as termination of cue processing in order to allow processing of the subsequent target display. However, the CP was observed after the onset of the target array, leaving open the possibility that it was associated with search processing, not termination of cue processing. Here we assessed these alternatives by varying the cue-target stimulus onset asynchrony (SOA). If the CP reflects termination of cue processing, it should be maximal shortly after the cue-elicited N2pc and thus its timing should be unaffected by SOA. Conversely, if the CP is related to processing of search array items, it would be in evidence after target onset, and thus it would onset later (with respect to cue onset) for long-SOA trials than for short-SOA trials. Our results show that the CP is time-locked not to the cue, but to the target. Thus, the present study demonstrates that the CP reflects attentional enhancement of the cued search array item, not suppression of the cue itself.

Sunday Morning Abstracts

Testing Enhances the Probability but not the Precision of Memory Recall
David Sutterer & Edward Awh
University of Oregon

Numerous studies have demonstrated that retrieval from long term memory (LTM) can enhance subsequent access to that memory, a phenomenon labeled the testing effect (Carrier & Pashler, 1992; Roediger & Karpicke, 2006). However, the testing effect has been primarily b**e**en studied with verbal/categorical stimuli. Consequently, it has not yet been determined whether the testing effect impacts the *probability* of successful memory retrieval or the *quality* of the retrieved representation.

To answer this question, we conducted three experiments in which we examined LTM for the color of 400 unique images. After every 10 images, subjects either recalled each of the ten colors or were given a chance to restudy the items, or were not tested on the items. After a 30-minute delay, subjects selected the color of each of the previously learned images from 360 degrees of continuous color space. Using a mixture model analysis we determined the probability and quality of the recalled color. A robust testing effect was observed; subjects recalled a significantly higher proportion of items that they had previously retrieved relative to items that were untested or that they had restudied. Interestingly, this boost in storage probability was not accompanied by an increase in precision. The same effects were observed when the delay was extended to delays greater than 24 hours. Thus, retrieval practice increases the probability of successful memory retrieval but does not improve the quality of the retrieved memories.

Why static decision theory should be replaced by dynamic decision theory
Justin MacDonald[1], J. D. Balakrishnan[2]
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Over the past fifteen years we have demonstrated that classical Signal Detection Theory (SDT), arguably the most dominant model of decision-making in psychophysics, is fundamentally incorrect. Using a straightforward test for response bias based on the assumptions of SDT, we and others have consistently failed to find empirical evidence for the criterion-shifting mechanism that is so integral to

the model. Of course, it is difficult to validate a statistical measure of a quantity that does not vary when it is expected to. Consequently, some defenders of SDT have argued that our bias measure is not sufficiently sensitive to identify response bias when it in fact exists. During the first half of the talk we will present the results of an experiment meant to force a response bias using the Mueller-Lyer visual illusion. The bias test easily identifies the response bias due to the perceptual illusion, but once again fails to identify any response bias due to a baserate manipulation. These results demonstrate that our bias test does work as promised when there is response bias to be found, and that the criterion-shifting that is fundamental to SDT does not occur under baserate manipulations. During the second half of the talk we will present new data demonstrating that response preferences manifest from biases about *when* to respond rather than *how* to respond. The experiment involved tracking eye movements during a numerosity discrimination task. During each trial an integer was sampled from one of two distributions that differed in their means. A number of asterisks equal to the sampled integer were displayed on the screen, and the subject was asked to determine if the sample of asterisks came from Distribution A or Distribution B. The eye tracking data demonstrate that response preferences do not come about from a biased decision rule (as posited by SDT), but rather by a biased stopping rule. Subjects are willing to stop sampling the stimulus sooner if the evidence favors their preferred response. These results cannot be accounted for with static, fixed-sample models such as classical SDT. Instead, the results suggest that the decision process is better captured by the other major class of decision models, the dynamic sequential sampling models.

Dynamic Reallocation of Resources in Visual Short-Term Memory

Summer Sheremata & Sarah Shomstein
George Washington University

Visual short-term memory (VSTM) is a capacity-limited system for maintaining visual information across brief durations, and is thought to be subserved by the parietal cortex. Hemispheric asymmetries occur in parietal cortex, resulting in the representation of remembered items in the right hemifield by both the left and the right hemisphere as memory load increases. Because parietal activity is modulated by the number of remembered features per object, we predicted that behavioral performance should reflect biases across the visual field and do so in a feature-load dependent manner. In a series of experiments, subjects performed a change detection task in which they remembered a single feature (color or shape) or both features. Our results demonstrate feature-load dependent changes in hemifield bias consistent with dynamic reallocation of VSTM resources, evidenced by left hemifield advantage for one-feature and right hemifield advantage for two-feature memory. Importantly, hemifield asymmetries were then induced by manipulating task-mode, providing direct evidence for dynamic reallocation of resources in VSTM. These experiments, in conjunction with the neuroimaging findings, demonstrate feature-load dependent dynamic reallocation of resources across the visual field in VSTM.

Sunday Evening Abstracts

Lay Theories of Mind/Brain Relation

Diego Fernandez-Duque[1], Barry Schwartz[2], Colton Christian[3], & Sara Hodges[3]
[1]Villanova University; [2]Swarthmore College; [3]U. of Oregon

Across three projects, we explored common-sense beliefs about the mind and brain and about the disciplines that study them.

Act 1. No Ghost in the Machine. We probed people's understanding of the mind/brain relation as it pertains to their personality and self-concept. Brain dependence was deemed less significant for traits thought to be morally relevant, under willful control, and/or likely to change over time. When the mind/brain relation was probed at a higher level of self-construal, participants deemed their 'core' self to be largely brain-based, more so than their peripheral self.

Act 2. The Allure of Neuroscience lies in the Brain. The presence of irrelevant neuroscience information makes research arguments more appealing (Weisberg et al., 2008). We replicated this effect and showed it occurs regardless of whether fMRI images are presented along with the neuroscience information. Preliminary findings suggest the effect is specific to mentions of neuroscience, failing to generalize when irrelevant information from other 'hard' sciences (e.g., genetics, math) is mentioned.

Act 3 The Warmth and Competence of the Sciences of the Mind. We assessed students' attitudes toward the sciences to show that neuroscience is aligned with the natural sciences (e.g., chemistry) in its perceived scientific rigor. Furthermore, behavioral neuroscientists are stereotypically seen as high in masculinity and competence but relatively low in warmth and agreeableness.

Sequencing Examples During Concept Learning

Robert Goldstone, Paulo Carvalho, & Erik Weitnauer
Indiana University

The efficiency of inductive concept learning can be substantially affected by changing the sequence of the presented examples. In one series of experiments (Carvalho & Goldstone, 2014), we manipulated whether examples taken from different categories were most frequently interleaved (e.g. interleaving) or were most frequently taken from the same category (e.g. blocking). We found that interleaving improved learning accuracy and generalization when the categories to be acquired were similar, but that blocking led to better learning when the categories were dissimilar. Further experiments show that interleaving is more effectively combined with active learning while blocking is more effectively combined with passive learning (Carvalho & Goldstone, 2013). Finally, in a difficult concept learning task requiring creative and novel descriptions of category examples, we find that the similarity of spatially and temporally adjacent examples has opposite influences depending on whether the examples come from the same or different categories (Weitnauer, Carvalho, Goldstone, & Ritter, 2013, 2014). Similarity promotes category learning when the examples come from different categories but interferes with category learning when the examples come from the same category. These results are integrated by a model of category learning based on exemplar encoding that emphasizes shared/distinctive features of examples from common/different categories.

Self-Awareness and Metacognition in Rats
Timothy Hackenberg, Jessica Dennis, & Nicholas Kappeyne van de Coppello
Reed College

In studies of metacognition, animals typically are given a discrimination problem, and on some trials, are provided an opportunity to escape (terminating the trial with a smaller but certain reinforcer). In the present study, rats produced two distinct patterns of behavior and were then asked to report on their most recent behavioral pattern. Accuracy of this self-discrimination varied inversely with retention interval-the delay between the behavioral pattern and the self-report. When given an opportunity to escape, rats did so more frequently on trials with longer retention intervals. Accuracy also tended to be higher on free-choice trials (with escape option present) than on forced-choice trials (without escape option). Both of these outcomes-differential escape on low-accuracy trials and differential accuracy on free vs. forced-choice trials-are commonly accepted criteria for metacognition. By including a self-discrimination component, the present research makes explicit the relationship between metacognition and self-awareness.

Monday Abstracts

Distinguishing between true guessing and low-precision representations in visual working memory
Joshua J. Foster & Edward Awh
University of Oregon

There has been considerable debate regarding the nature of the resources that limit working memory (WM) capacity. Flexible resource models posit a pool of resources that can be divided among an unlimited number of items. In contrast, discrete resource models posit that WM capacity is constrained by an item limit. Thus, discrete resource models predict that once putative item limits are exceeded, observers will be forced to guess when recalling the items that were not stored. Zhang and Luck (2008) provided evidence for guessing by showing that response error distributions are well described by a mixture model that includes a flat distribution that is random with respect to the target value. Nevertheless, the existence of guessing remains controversial because it is also possible to fit these error distributions by presuming contributions from very low (virtually random) quality representations in working memory (e.g., van den Berg & Ma, 2012). Recently, Rouder and colleagues (submitted) reported findings from a new procedure that may provide more traction for distinguishing between guesses and very low quality memories. Rouder and colleagues showed that when the possible orientation values for the memoranda were restricted to a narrower range (±75 degrees around vertical), guessing responses tended to cluster in the center of the right and left regions of the possible orientation space. Critically, a model presuming low quality memories (without any guessing) cannot explain this bimodal response distribution. Here, we extend this new method to orientation stimuli that span a full 360 degrees of orientation values (i.e., the position of a "clock hand" within each circular stimulus). When the separate quadrants of these orientation stimuli were highlighted with different colors, guessing responses clustered in the center of the highlighted regions while showing no relationship with the target angle. The prevalence of these "guessing bands" was linked with subjects' own judgments of whether they were guessing, and correlated strongly with guessing estimates from a standard WM procedure. Thus, these data support a clear prediction of discrete resource models; observers resort to guessing when relatively small item limits are exceeded.

Effects of Benign Epilepsy with CentroTemporal Spikes (BECTS) on the development of Visual Working Memory : evidence from neuropsychological testing and human electrophysiology.

Sandrine Mendizabal, Pierre Jolicoeur, & Sarah Lippé
University of Montréal

1. Purpose: BECTS is the most common form of childhood epilepsy. It occurs, caused by the hyperexcitability of a system of neurons in only one hemisphere without apparent brain injury or cerebral structural abnormalities, it is usually well controlled by medication and seizures disappear by adolescence. Although BECTS is still officially considered as a benign syndrome without cognitive impairments, a growing body of literature highlights the existence of a wide range of cognitive deficits, particularly of visual working memory and attention. The aim of this study was to investigate a link between the hemisphere encompassing the epileptic focus and a specific pattern of cognitive deficits and electrophysiological abnormalities.

2. Method: 12 children suffering from BECTS in the active phase, 12 control children, paired by age and sex, 8 children suffering from BECTS in the remission phase, and 8 control children, paired by age and sex, were tested in neuropsychology, in our visual matching-to-sample task, coupled with electroencephalography.

3. Results: We found specific cognitive deficits for the clinical populations, and some attenuations of the electrophysiological activity related to the visual working memory of these BECTS patients.
4. Conclusion: We found specific cognitive deficits linked to the epileptic focus localization in BECTS. We propose that the epileptic activity possibly inhibits specific functions that are supported predominantly by certain cerebral areas and we conclude that those children are suffering from a "not so benign" disease.

Inattentional blindness for shapes, faces, and words: ERP correlates of attention & awareness

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Neural correlates of conscious perception (NCCs) refer to patterns of brain activity that are both necessary and sufficient for a particular visual percept. Most NCCs proposed so far have turned out to be either necessary but not sufficient (pre-conscious) or sufficient but not necessary (post-perceptual). Here, we will introduce a paradigm that helps distinguish NCCs from pre-conscious and post-perceptual processes. Using a variant of Mack & Rock's (1998) inattention paradigm in three separate experiments (shapes, faces, and words), we compared event-related potentials (ERPs) and event-related oscillations across three conditions: unaware, aware but task-irrelevant, aware and task-relevant. In all three experiments, a mid-latency ERP component (~200-300ms) was found to uniquely index awareness. Importantly, two previously-proposed NCCs, the P3b and induced gamma oscillations, were found to be sufficient but not necessary for awareness (i.e. post-perceptual). While this mid-latency ERP negativity is a leading candidate for a true-NCC, we will also consider the possibility that it reflects object-based attentional selection leaving open the question of whether an ERP correlate of visual awareness exists.

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