Studying the time course of sensory substitution mechanisms

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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.

30-minute talk

Tactile Enumeration Using One Hand and the Effects of Training

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Subitizing is a fast and accurate process of enumerating small quantities. There are differences in the behavioral results of subitizing among modalities. The literature of 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 a visual presentation, the accuracy rates are lower, and the RT slopes are steeper. In order to increase accuracy, we examined effects 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 a general increase in accuracy rates after training, with the most accurate group being the 7DT group. Importantly, the pattern of RT increase per item remained moderate. These results show that the differences in the RT slopes between modalities are related to the difference in modality sensitivity and not related to the different enumeration processes. Moreover, the results confirm the initial suggestion that tactile subitizing is a fast and accurate process with a range of up to four stimuli when using one hand.

30-minute talk

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

10-min talk (or poster)

An Attention-centered neural marker for shifts in eye position
Brittany J. Dungan, University of Oregon
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.

30-minute talk

Lay Theories of Mind/Brain Relation
Diego Fernandez-Duque, Villanova University
Barry Schwartz, Swarthmore College
Colton Christian, U. of Oregon
Sara Hodges, 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.

30-minute talk

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

John Gaspar, Université de Montréal
Lagroix, Hayley E.P., SFU
Di Lollo, Vincent, SFU
Jolicoeur, Pierre, Université de Montréal
McDonald, John J., SFU

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.

30-minute talk

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

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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.

10-minute talk

Reading ability and top-down attentional control

Jessica J. Green, University of South Carolina
Kristina Drake, University of South Carolina
Mario Liotti, Simon Fraser University
John J. McDonald, 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.

30-minute talk

Self-Awareness and Metacognition in Rats
Timothy Hackenberg, Reed College
Jessica Dennis, Reed College
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.

30-minute talk

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.

30-minute talk

Cummulative cost of short-term consolidation: evidence from the attentional blink
Pierre Jolicoeur, University of Montreal
Roberto Dell'Acqua, U of Padova
et al.

We show that encoding and consolidating two consecutive targets causes a larger delay and attenuation of the P3b event-related potential to a subsequent third target, than encoding a single previous target, as well as a greater attenuation of the P3a amplitude, but not of the P3a onset latency. The results suggest a dissociation between cummulative load effects on attentional selection (P3a) and memory consolidation (P3b), which will be discussed in the context of extant models of the AB.

30-minute talk

Sequential Learning Deficit among Adults with Developmental Dyslexia
Shani Kahta, Bar-Ilan University, Israel
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.

30-minute talk

On the termination of cue processing in the contingent capture paradigm
Ashley C. Livingstone, Graduate Student
Gregory J. Christie, Graduate Student
John J. McDonald, Associate Professor

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.

30-minute talk

Why static decision theory should be replaced by dynamic decision theory
Justin MacDonald, New Mexico State University
J. D. Balakrishnan, California Polytechnic State University

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.

30-minute talk

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

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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 [1], 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 [2], a growing body of literature highlights the existence of a wide range of cognitive deficits, particularly of visual working memory and attention [3, 4, 5, 6]. 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 [7].

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30-minute talk

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

Michael Pitts, Reed College
Juliet Shafto, Carnegie Mellon University
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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.

30-minute talk

The influence of collaboration on attitudes towards English vocabulary learning among Iranian EFL learners

hamid shabankar, Islamic Azad University, Larestan Branch, Iran

This study was conducted to investigate how collaborative vocabulary learning environments impacts EFL students' attitudes towards and motivation in English vocabulary learning, and their ability to use the target vocabulary properly in context. Two treatment groups comprised of 40 advanced level Iranian EFL students completed a vocabulary learning task either individually or collaboratively. Pre-task and post-task surveys were given to students to measure each treatment groups' change in attitudes towards and motivation in vocabulary learning, as well as determine their progress in vocabulary knowledge. The study's findings reveal that no important development occurred in either treatment groups concerning learner attitudes towards or motivation in studying English vocabulary, but that the collaborative treatment group reported a considerably higher raise in vocabulary knowledge over the individual treatment group. More research on the effect of different vocabulary learning styles on learner attitudes and motivation in English vocabulary learning and vocabulary expansion are needed.

10-minute talk

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.

30-minute talk
