CANADIAN ASSOCIATION FOR NEUROSCIENCE SATELLITE SYMPOSIUM

CAPnet-CPS Satellite May 24, 2015

Vision and Movements Order and Disorder: From Bench to Bedside

Westin Bayshore Hotel, Vancouver, BC

Sunday, May 24, 2015

9:00 AM to 4:45 PM

This event is sponsored by Tucker-Davies Technologies (TDT), SR Research Ltd. and Chronos Vision GmbH

Vision and Movement Order and Disorder: From Bench to Bedside

Names with * denote recipients of this year's CPS trainee travel awards. Congratulations!

The two trainees with the best talk or best poster, respectively, will be awarded a $200 price (sponsored by SR Research Ltd. and Chronos Vision GmbH)

Program committee: Miriam Spering (chair, UBC), Eric Accili (UBC), Gunnar Blohm (Queen's), J. Douglas Crawford (York), Jody C. Culham (Western), Andrea Green (Université de Montréal), Kurt Haas (UBC), Chris Pack (McGill University), Paul van Donkelaar (UBCO)

9:00 - 9:15 **Welcome & Acknowledgements**
(Miriam Spering, Eric Accili & Doug Crawford)

9:15 - 10:45 **Talk Session I – Neurophysiology and Computational Models of Vision and Movement**
(Chairs: Douglas P. Munoz & Dinesh K. Pai)

9:15 - 9:30 Development of a primate model of Alzheimer's Disease: Characterization of behavioural phenotype
***Robert G. Wither**, Susan E. Boehnke, Ann Lablans, Robert A. Marino, Brian C. Coe Fernanda G. De Felice and Douglas P. Munoz (Queen's University)

9:30 - 9:45 Subsaccadic FEF microstimulation induces pupil dilation
Sebastian J. Lehmann & Brian D. Corneil (Western University)

9:45 - 10:00 Primary motor cortical neurons reflect vector sum of ipsilateral and contralateral feedback modulation
Ethan A. Heming & Steve H. Scott (Queen's University)

10:00 - 10:15 Phase locking of spontaneously active visual cortical neurons to multiple local field potential frequencies
Nicholas V. Swindale and Martin A. Spacek (University of British Columbia)

10:15 - 10:30 Temporal precision in the neural encoding of linear self-motion by otolith afferents
***Mohsen Jamali**, Jerome Carriot, Maurice Chacron and Kathleen E. Cullen (McGill University)

10:30 - 10:45 A computational model for spatial updating of remembered visual stimuli across eye movements
Yalda Mohsenzadeh and J. Douglas Crawford (York University)

10:45 - 11:15 **Coffee break**

11:15 - 12:30 **Talk Session II – Psychophysics and Neuroimaging Human Movement**
(Chair: Melvyn A. Goodale)

11:15 - 11:30 The Deciding Hand: How an analysis of human reach movements reveals choice biases
Craig S. Chapman (University of Alberta)

11:30 - 11:45 Localizing tool and hand-selective areas with fMRI: Comparing video and picture stimuli
Scott Macdonald, Fiona M. Z. van den Heiligenberg, Jody C. Culham and Tamar R. Makin (Western University)

11:45 - 12:00 The destination defines the journey: Action intent determines kinematic asymmetries in self-directed human prehension
Jason Flindall and Claudia Gonzalez (University of Lethbridge)

12:00 - 12:15 Visual recalibration of head-on-body posture does not influence the spatial transformation of vestibular signals for the control of standing balance
Brandon G. Rasman, Brian H. Dalton, J. Timothy Inglis and Jean-Sébastien Blouin (University of British Columbia)

12:15 - 12:30 Benefits of observational practice for visuo-motor adaptation when interspersed with physical practice
Daniel Ho, Beverley Larssen and Nicola J. Hodges (University of British Columbia)

12:30 - 2:00 Lunch & posters (list of 30 posters following below)

2:00 - 3:15 Talk Session III – Vision and Movement in Clinical Populations (Chair: Jennifer K. E. Steeves)

2:00 - 2:15 Suppression of simple visual hallucinations from occipital stroke using TMS
Sara A. Rafique, John R. Richards and Jennifer K. E. Steeves (York University)

2:15 - 2:30 Increased visual dependency in people with m-iSCI during obstacle crossing is complex and multifactorial
Raza N. Malik, Rachel Cote and Tania Lam (University of British Columbia)

2:30 - 2:45 The relationship between gaze behaviour and mobility deficits on a precision walking task in persons with glaucoma
Andreas B. Miller, Kim Lajoie, David R. Neima, Robert A. Strath and Daniel S. Marigold (Simon Fraser University)

2:45 - 3:00 Visual stimuli induce stronger action-perception coupling compared to auditory stimuli in children
Courtney G. E. Hilderman, Susan R. Harris, Liisa Holsti, Robert Pritchard and Naznin Virji-Babul (University of British Columbia)

3:00 - 3:15 Motion processing deficits in children with amblyopia
Deborah Giaschi (University of British Columbia)

3:15 - 4:00 Coffee break

4:00 - 4:45 CPS Sarrazin Award Keynote Lecture by Kathleen E. Cullen, McGill University "Where are we going? Sensing self-motion for perception and action"
Chair: Eric Accili

The main poster session will be during lunch hours; however, posters should be up for the entire day. We suggest that presenters (names in bold) in Poster Session I should be at their poster from approx. 12:30 - 1:15 pm, presenters in Poster Session II should be at their poster from approx. 1:15 - 2 pm. Poster boards will be numbered and posters are roughly grouped by topic.

12:30 - 1:15 Poster Session I – Vision and Eye Movements

1. Synaptic mechanisms underlying contrast coding in the directionally-selective circuit in the mouse retina
   Amanda McLaughlin and Gautam B. Awatramani (University of Victoria)
2. Direction coding in the presence of ambient light dependent changes in global inhibition
   Alex Hoggarth, Kara Ronellenfitch, Amanda McLaughlin, Rishi Vasandani, Kevin Briggman and Gautam B. Awatramani (University of Victoria)
3. Sensory-evoked dendritic activity and somatic firing instruct morphogenesis in the awake brain
   Kaspar Podgorski, **Serhiy Opushnyev** and Kurt Haas (University of British Columbia)
4. Natural scene movie responses are more precise in synchronized than desynchronized cat V1
   Martin A. Spacek and Nicholas V. Swindale (University of British Columbia)
5. Pupil size is modulated by the size of flux-equated gratings
   Juan Chen, Athena Ko and Melvyn A. Goodale (Western University)
6. Multisensory integration in human pupil orienting response
   Jeff Huang, Chin-An Wang and Douglas P. Munoz (Queen's University)
7. Cortical substrates for allocentric vs. egocentric representation of remembered saccade targets in the human
   ***Ying Chen** and J. Douglas Crawford (York University)
8. Plasticity within the vestibulo-ocular reflex circuitry: implications for use of vestibular prostheses
   Diana E. Mitchell, Charles C. Della Santina and Kathleen E. Cullen (McGill University)
9. Accurate smooth pursuit leads to earlier and more accurate manual interception
   Jolande Fooken, Sang Hoon Yeo, Dinesh K. Pai and Miriam Spering (University of British Columbia)
10. Improving manual interception accuracy through eye-movement training
    Kathryn M. Lalonde, Jolande Fooken and Miriam Spering (University of British Columbia)
11. The impact of macula-sparing on single-word reading in hemianopia
    Andrea Albonico, Cristina Rubino and Jason J. S. Barton (University of British Columbia)
12. The effect of pharmacological intervention on contrast sensitivity deficits in phenylketonuria
    Marcus Watson, Nataliya Yuskiv, Christine Chapman, Sylvia Stockler and Deborah Giaschi (University of British Columbia)
13. Asymmetrical medical geniculate body volume in people with one eye
    Stefania Moro, Krista R. Kelly, Larissa McKetton and Jennifer K.E. Steeves (York University)
14. Development of a primate model of Alzheimer's Disease I. Characterization of molecular pathology
    Susan Boehnke, Leticia Forny-Germano, Robert Wither, Ann Lablans, Brian C. Coe, Fernanda G. De Felice and Douglas P. Munoz (Queen's University)
15. Using eye movements to identify early biomarkers of disease progression in Parkinson's patients with and without LRRK2 gene mutations
    ***Julia E. Morris**, Donald C. Brien, Brian C. Coe, Naomi Visanji, Taneera Ghate, Anthony E. Lang, Connie Marras and Douglas P. Munoz (Queen's University)

1:15 - 2:00 Poster Session II – Movement and Cognitive Functions

16. Conscious perception of sway influenced by postural threat
    Taylor W. Cleworth and Mark G. Carpenter (University of British Columbia)
17. Intersensory vestibular control of standing balance
    Myles Shepherd, Patrick A. Forbes and Jean-Sébastien Blouin (University of British Columbia)
18. Do we know enough about motor memories? Savings, consolidation, and interference when adapting to altered visual input during precision walking
    Rodrigo Maeda, Steven McGee and Daniel S. Marigold (Simon Fraser University)
19. The ability of persons with multiple sclerosis to adapt to altered visual input during visually guided walking
    Shaila M. Gunn, Kayla McGowan, Galina Vorobeychik and Daniel S. Marigold (Simon Fraser University)
20. Dissociation of parietal cortex contributions to obstacle memory in walking cats
    Carmen Wong, K. G. Pearson and S. G. Lomber (Western University)
21. Prediction of future sensory states requires self-generated motor commands
    Robert Hermosillo and Paul van Donkelaar (University of British Columbia Okanagan)
22. Cumulative activation effect predicts faster reaction times compared to startle only related activity
    Michael Kennefick, Paul van Donkelaar and Anthony N. Carlsen (University of British Columbia-Okanagan)
23. A secondary motor task modulates action prediction for motor- but not perceptual-trained observers: evidence for motor simulation
    Desmond Mulligan, Keith R. Lohse and Nicola J. Hodges (University of British Columbia)
24. Recruitment of lateral occipitotemporal cortex (LOTC) during observation and visualization of dance and movement of the foot in expert and novice dancers
    Paula Di Noto, Gabriella R. Levkov, Joseph F.X. DeSouza (York University)
25. Changes in functional brain connectivity following concussion
    Jenna Smith-Forrester, Naama Rotem-Kohavi, Colin Brown and Naznin Virji-Babul (University of British Columbia)
26. Prolonged cognitive-motor impairments in children with a history of concussion
    Marc Dalecki and Lauren E. Sergio (York University)
27. Frontal brain activity during a visual working memory task: an fNIRS study
    Shaun Porter, Benham Molavi, Todd Woodward, Mike Van der Loos and Naznin Virji-Babul (University of British Columbia)
28. Differential effects of dopamine and selective dopamine agonists on spatial working memory, attention, learning and reaction time in healthy controls
    Robert A. Marino, A. Bullen and Ron Levy (Queen's University)
29. Neural correlates of dynamic emotional facial expressions in infants
    Naama Rotem-Kovari, Ashley Rose, Courtney G. E. Hilderman, Tim F. Oberlander and Naznin Virji-Babul (University of British Columbia)
30. The positive affective consequences of acting over merely attending
    Nathan Wispinski, Bruce C. C. Nip, James T. Enns and Craig S. Chapman (University of Alberta)

Talk Session I – 9:15 AM, Sunday May 24, 2015

Development of a primate model of Alzheimer's Disease II: Characterization of behavioural phenotype

Robert G. Wither[1], Susan E. Boehnke[1], Ann Lablans[1], Robert A. Marino[1], Brian C. Coe[1], Fernanda G. De Felice[2], and Douglas P. Munoz[1]

[1] Centre for Neuroscience Studies, Queen's University, Kingston, ON
[2] Institute of Medical Biochemistry Leopoldo de Meis and Institute of Biomedical Sciences, Federal University of Rio de Janeiro, Brazil

Alzheimer's disease (AD) is a devastating neurodegenerative disease and there is an urgent need to develop new therapeutics. Promising drugs developed in rodents have failed to work in AD patients in clinical trials. To bridge this translational gap, our laboratory has developed a non-human primate (NHP) model of AD via intracerebroventricular injection of neurotoxic amyloid beta oligomers (AβOs). This model recapitulates the molecular aspects of human AD pathology, such as tau hyperphosphorylation coupled with tangle formation, synaptic loss, and astrocytic activation (Forny-Germano et al., J. Neurosci, 2014; Boehnke et al. at this meeting). To characterize the behavioural deficits associated with these molecular pathologies, we have developed a behavioural phenotyping platform for primates. General home-cage activity levels including circadian rhythms are measured using activity monitors and 24/7 video recording. Cognitive performance is measured using eye movement tasks (including step and memory-guided saccade tasks), as well as performance on classic CANTAB touchscreen-based tasks including self-ordered spatial search, delayed match to sample, and paired associate learning. Here, we present preliminary results of the changes in behavioural parameters from 3 male rhesus macaques before and after AβO administration to provide behavioural validation of our primate Alzheimer's disease model.

Talk Session I – 9:30 AM, Sunday May 24, 2015

Subsaccadic FEF microstimulation induces pupil dilation

Sebastian J. Lehmann[1] & Brian D. Corneil[1]

[1] Dept. of Physiology and Pharmacology, Western University, London, ON

The orienting response is an organism's reaction to changes in its environment in order to heighten perception and prepare for action; this can include changes in gaze, attention, and pupil dilation. The frontal eye fields (FEF) are a part of the oculomotor system known to be involved in the generation of voluntary saccadic eye movements and covert shifts in visuo-spatial attention. While microstimulation of the FEF can evoke saccadic gaze shifts, lower levels of stimulation current can modulate components of the orienting response, such as covert attentional shifts, without evoking saccades. Based on recent results showing that pupil dilation can be evoked by subsaccadic stimulation of the superior colliculus in primates, we investigated the effects of subsaccadic FEF microstimulation on pupil dilation. Two non-human primates performed a fixation task in which we stimulated the right FEF with biphasic pulses. In a total of 101 sites, we parametrically varied stimulation currents (5- 60 µA), frequency (50-300 Hz), and duration (30-200 ms). Site-specific vectors ranged from 5 to 20°. In 44% of the sites, we found a significant increase in pupil diameter after subsaccadic stimulation (2-way-ANOVA, $p<0.05$). The level of the induced response was positively correlated with increasing stimulation factors. Our results imply a contribution of FEF to pupil dilation, presumably mediated through the superior colliculus. They provide an important link for how high-level processes may influence pupil diameter, which could serve as a biomarker for sub-threshold oculo-motor processes.

Talk Session I – 9:45 AM, Sunday May 24, 2015

Primary motor cortical neurons reflect vector sum of ipsilateral and contralateral feedback modulation

Ethan A. Heming[1] and Steven H. Scott[1]

[1] Centre for Neuroscience Studies, Queen's University, Kingston, ON

It is commonly accepted that the primary motor cortex (M1) is involved in controlling the contralateral side of the body, but recent studies have noted some M1 neurons are active during ipsilateral limb movements. We use mechanical perturbations to quantify how M1 activity was related to ipsilateral and contralateral motor activity. A non-human primate (NHP) stabilized a cursor representing the location of its right or left hand at a central virtual target. After 1000-1500ms, flexor or extensor step torques were applied to the shoulder, the elbow, or both (9 load conditions). The NHP had 1000ms to return the cursor to, and stop at, the target. We recorded and examined the activity of 167 M1 neurons using a micro-electrode array and 29 neurons from single electrodes. We found that 73% of M1 neurons modulated their responses to contralateral perturbations, 40% modulated to ipsilateral perturbations and 34% modulated to either. When torques were applied to both arms at once, the modulation of each neuron's activity corresponded to the vector sum of its modulation to torques on either arm alone. When we considered neural activity over time during perturbations, we found that the vector sum predicted modulation throughout the perturbation, even for neurons with very different response onsets to ipsi- and contralateral perturbations. Our results indicate that M1 shows fast and substantial perturbation-related activity from both limbs which interacts in a very lawful manner.

Talk Session I – 10:00 AM, Sunday May 24, 2015

Phase locking of spontaneously active visual cortical neurons to multiple local field potential frequencies

Nicholas V. Swindale[1] and Martin A. Spacek[1]

[1] Dept. of Ophthalmology & Visual Sciences, University of British Columbia, Vancouver, BC

In order for neurons to fire in the complex temporal patterns that underly behaviour, a mechanism may be needed that, when set in motion, will cause a neuron to fire at a predictable time in the future. One way of doing this may be to initiate oscillations of different frequencies and known phases which could cause neurons to fire at a predictable future phase alignments. The existence of such mechanisms might be more apparent during periods of spontaneous activity, when the brain is generating its own signals, than during natural stimulation when signals arrive asynchronously with respect to internal states. Here we report that, during periods of spontaneous activity in cat visual cortex, individual neurons often showed selective, idiosyncratic patterns of phase locking to subsets of local field potential (LFP) oscillations, ignoring some frequencies but phase-locking to several others. Some cells fired the majority of their spikes only during specific phase combinations of particular frequency pairs. The results suggest that frequency combination may be used by the brain to generate temporally structured spike trains.

Talk Session I – 10:15 AM, Sunday May 24, 2015

Temporal precision in the neural encoding of linear self-motion by otolith afferents

Mohsen Jamali[1], Jerome Carriot[1], Maurice Chacron[1] and Kathleen E. Cullen[1]

[1] Dept. of Physiology, Aerospace Medical Research Unit, McGill University, Montreal, QC

Understanding how sensory neurons transmit information about relevant stimuli and deciphering the neural code has intrigued many neuroscientists for decades. To this end, we took advantage of the otolith afferents which are well-defined anatomically and physiologically and encode easily characterized sensory stimuli (i.e., linear self-motion) to higher-order brain areas. Interestingly, a hallmark of these neurons is the heterogeneity in the variability of their spontaneous discharge (from regularly-spiking to more irregular afferents), which makes them particularly suitable for exploring whether spike-timing plays a role in self-motion processing. Accordingly, we recorded from utricular fibers in macaques while stimulating each unit along its preferred direction during linear motions with broadband frequency accelerations. We found that despite a large difference in gain, responses of both afferent types were similarly coherent with the stimuli except for very low frequencies (≤1Hz) at which regular units displayed slightly higher coherences. In response to repetitions of the same noise stimuli, irregular units exhibited coherence in their responses at frequencies beyond those contained in the stimuli indicating higher temporal resolution in their activity. Further, metric-space analysis of spike trains revealed that irregular afferents outperformed regular units in discriminating stimuli using faster timescales signifying that information is contained in the fine temporal structure of irregular afferent spike trains. In contrast, regular units operate over relatively longer timescales and use a rate coding scheme to encode the stimuli. Our findings suggest that regular and irregular afferents function as two parallel channels with different but complementary coding strategies to encode linear self-motion.

Talk Session I – 10:30 AM, Sunday May 24, 2015

A computational model for spatial updating of remembered visual stimuli across eye movements

Yalda Mohsenzadeh[1] and J. Douglas Crawford[1,2]

[1] Centre for Vision Research and NSERC CAN-ACT CREATE, York University, Toronto, ON
[2] Neuroscience Graduate Diploma Program and Dept. of Biology, Psychology, and Kinesiology & Health Sciences, York University, Toronto, ON

Despite the ever-changing visual scene on the retina between eye movements, our perception of the visual world is constant and unified. It is generally believed that this space constancy is due to the brain's ability of spatial updating. Although many efforts have been made to discover the mechanism underlying spatial updating across eye movements, still there are many unanswered questions about the neuronal mechanism of this phenomenon. We developed a state space model for updating gaze-centered spatial information. To explore spatial updating, we considered two kinds of eye movements, saccade and smooth pursuit. The inputs to our proposed model are: a corollary discharge signal, an eye position signal and 2D visual topographic maps of visual stimuli. The state space is represented by a radial basis function neural network and we can obtain a topographic map of the remembered visual target in its hidden layer. Finally, the decoded location of the remembered target is the output of the model. We trained the model on the double step saccade-saccade and pursuit-saccade tasks. Training this model revealed that the receptive fields of state-space units are remapped predictively during saccades and updated continuously during smooth pursuit. Moreover, during saccades, receptive fields also expanded (to our knowledge, this predicted expansion has not yet been reported in the published literature). We believe that incorporating this model can shed light on the underlying neural mechanism for trans-saccadic perception.

Talk Session II – 11:15 AM, Sunday May 24, 2015

The Deciding Hand: How an analysis of human reach movements reveals choice biases

Craig S. Chapman[1]

[1] Faculty of Physical Education and Recreation, University of Alberta, Edmonton, AB

Decision making, or the resolution of competition, is one of the most central components of human cognition: from low-level, brief, sensory events that compete for cortical activation and amplification, to high level symbols and complex objects that compete first for recognition then later for influence over decisions. Despite its centrality to understanding human thought, the science of decision making is usually restricted only to an analysis of what decisions people make. This approach overlooks the very important component of how people execute their decisions. Here, I will show results from a variety of studies demonstrating that an analysis of the physical reach movements people make to indicate a decision, and careful manipulation of the timing of decision stimuli, can be used to reveal subtle aspects of decision making and the precise timelines over which they operate. I will present evidence from studies where decisions are driven by low level visual properties (e.g. luminance), where decisions are influenced by arbitrary, more cognitively driven properties (e.g. reward associations) and finally, where decisions are made based completely on participant driven properties separate from any specific stimuli features (e.g. personal preference). The analysis of the resulting spatial reach trajectories as participants physically interact with the choice options reveals decision biases including: an initial bias toward high luminance that decays with time, a bias toward gain and a delayed bias away from loss, and reaches that reflect an individual's decision difficulty. Notably, these biases would have been invisible using conventional research methods.

Talk Session II – 11:30 AM, Sunday May 24, 2015

Localizing tool and hand-selective areas with fMRI: Comparing video and picture stimuli

Scott Macdonald[1], Fiona M. Z. van den Heiligenberg[2], Jody C. Culham[1] and Tamar R. Makin[2]

[1] Dept. of Psychology, Western University
[2] Dept. of Clinical Neurosciences, Oxford University

Historically, brain areas implicated in tool and hand processing have been localized by contrasting pictures of tools and hands to pictures of objects or scrambled images using functional magnetic resonance imaging (fMRI). The goal of comparing these conditions in a localizer is to reliably and rapidly identify regions of interest. In contrast to the conventional use of static images, dynamic stimuli, such as videos, may have advantages as they are more engaging than pictures and fully depict the interaction between an effector and its target. The purpose of this project was two-fold: (1) to determine whether video stimuli are more effective than picture stimuli at localizing tool and hand-selective regions in individual participants; and (2) to test whether the nature of activity within these regions are comparable. Healthy subjects were scanned with fMRI while they viewed video and picture stimuli in a blocked design. The static stimulus set included pictures of tools, hands, objects, and scrambled images. The video stimulus set included short clips of tools interacting with target objects (but with the hand out of the scene), hands manipulating objects, objects in motion, and moving patterns (akin to a scrambled condition). The results show that the video localizer activates a more extensive network of areas than static pictures, particularly in the dorsal visual stream. Moreover, the robust activation for videos facilitated the localization of regions at the individual subject level. By cross-correlating parameter estimates of the video localizer with the picture localizer, we also validate that the video localizer activates the tool and hand-selective areas in a similar fashion as the picture localizer. In sum, using video stimuli better identifies areas involved in tool and hand processing while remaining consistent with the functional activity evoked by static stimuli.

Talk Session II – 11:45 AM, Sunday May 24, 2015

The destination defines the journey: action intent determines kinematic asymmetries in self-directed human prehension

Jason Flindall[1] and Claudia Gonzalez[1]

[1] The Brain in Action Lab, Dept. of Kinesiology, University of Lethbridge, Lethbridge, AB

Using single-neuron recording techniques in macaques, researchers have identified specific neurons that respond uniquely to the intent of the goal of the action being performed, independent of its mechanical requirements. In stimulation studies, researchers find that two mechanically similar movements, hand-to-mouth and grasp-to-inspect, can be elicited in anesthetised macaques via direct electrical stimulation of discrete regions within the motor and premotor cortices. This evidence suggests that primate neural circuitry is organised not around muscular recruitment, but rather around the production of comprehensive functional movements. In support of this theory, we have identified kinematic differences between two mechanically-identical grasping actions in humans that differ only in their ultimate goals. Furthermore, we have identified a robust kinematic asymmetry in right- and left-handed children and adults using a grasp-to-eat action. When participants grasp an item to eat it with their right hand, peak grip aperture is significantly smaller than when either grasping to eat with their left hand or when grasping to place the item in a container near the mouth with either hand. Our results suggest that not only do independent neural networks produce these types of actions, but that some of these networks are left-hemisphere lateralized. Results from several experiments will be discussed, providing support for the theory that human prehension movements are produced from a repertoire of complete goal-based actions, rather than by simple fulfillment of mechanical requirements.

Talk Session II – 12:00 PM, Sunday May 24, 2015

Visual recalibration of head-on-body posture does not influence the spatial transformation of vestibular signals for the control of standing balance

Brandon G. Rasman[1], Brian H. Dalton[2], J. Timothy Inglis[1,3] and Jean-Sébastien Blouin[1,3,4]

[1] School of Kinesiology, University of British Columbia, Vancouver, BC
[2] Dept. of Human Physiology, University of Oregon, Eugene, OR, USA
[3] Djavad Mowafaghian Centre for Brain Health, University of British Columbia, Vancouver, BC
[4] Institute for Computing, Information and Cognitive Systems, University of British Columbia

Vestibular-evoked balance responses elicited through vestibular stimulation are spatially linked with head-on-body posture. Observations from sustained head-turned postures and illusory head rotations suggest that this vestibular control of balance may also be spatially transformed by conscious perception. We assessed how conscious perception spatially tunes the vestibular control of balance during externally maintained head-turned postures. Volunteers stood on a force plate with the head turned facing the left shoulder and externally supported for a prolonged period (up to 18.5 mins) while being exposed to stochastic vestibular stimuli (SVS; 0-20 Hz, duration = 90 s) to probe the spatial transformation of a vestibular error signal at various intervals. In the first condition, vision was occluded for the majority of the trial which resulted in perceptual drifts of head-on-body posture. A visual recalibration of posture was performed at the end of this trial to distinguish the effects of body perception on the balance response. The second condition involved full vision throughout the trial. In both experiments, the vestibular-evoked balance response shifted away from a craniocentric direction. Visual recalibration (correction) of perceived head-on-body posture did not realign the balance response with actual head position. Theoretically, the same afferent information of head-on-body posture is used to perceive orientation and spatially transform vestibular signals for balance. However, we propose that the two processes are independent, where perception can be erroneous without modulating vestibular balance transformations. We surmise that neck somatosensory inputs largely drive the spatial tuning of the vestibular-evoked balance responses.

Talk Session II – 12:15 AM, Sunday May 24, 2015

Benefits of observational practice for visuo-motor adaptation when interspersed with physical practice

Daniel Ho, Beverley Larssen and Nicola J. Hodges[1]

[1] Motor Skills Lab, School of Kinesiology, University of British Columbia, Vancouver, BC

Adaptation to novel environments can occur via non-physical means, such as observation, but it appears to result in a different type of learning (not characterised by after-effects). However, there is some evidence that observational practice interspersed with physical practice trials might play a different role in learning and potentially lead to more robust learning than either practice method in isolation. There are also questions concerning how well skills are retained over a retention interval when acquired through observational practice. Therefore we asked people to practice aiming to visually-rotated targets in a set-up where they could observe videos projected showing a successful person aim correctly. Twenty participants were randomly assigned to one of four groups: Physical practice (PP) or one of 3 types of mixed practice: Interspersed practice (IP), involving alternating practice between physical and observation trials or blocks of either only physical practice before observation (Pro) or the reverse (Retro). All participants received 100 practice trials (such that all or half were physical practice). The IP group showed stronger after-effects (and evidence of more implicit learning) than the other two mixed practice groups. They did not differ from a physical practice group which had twice the amount of physical practice. However, when these groups were tested for retention the following day, differences were no longer present. Although we aim to test more participants, these data show preliminary evidence that the scheduling of observational practice affects the acquisition process, potentially drawing on more implicit learning processes when interspersed with physical practice.

Talk Session III – 2:00 PM, Sunday May 24, 2015

Suppression of simple visual hallucinations from occipital stroke using TMS

Sara A. Rafique[1], John R. Richards[2] and Jennifer K. E. Steeves[1]

[1] Centre for Vision Research & Dept. of Psychology, York University, Toronto, ON
[2] Dept. of Emergency Medicine, University of California, Davis, Sacramento, CA

We present the case of a 31-year old patient who perceived continuous simple hallucinations in a hemianopic field defect immediately following right occipital cortex stroke, which have remained unchanged over 2 years. We performed 1 Hz repetitive transcranial magnetic stimulation (TMS) to the lesioned area for 30 minutes per day over 5 days in an attempt to suppress the perpetual hallucinations. fMRI was performed prior to and after TMS treatment to assess plasticity changes. Pre-TMS, the patient showed greater immediate activation at the boundary of the lesion compared to healthy controls; in the cuneus, lingual gyrus and surrounding areas. The associated “hyperactivity” corresponded to a reported perceptual increase in visual hallucinations. During daily TMS sessions, the perception of hallucinations was greatly reduced. Post-TMS fMRI showed not only a suppression of activity in the previously associated regions of “hyperactivity”, but a redistribution of this activity to surrounding regions, to a level similar to that of controls. A decrease in occipital activation with TMS resulted in a decrease of frontal activity that is consistent with our previous work, indicating connections between ventral regions and the frontal lobe. This case provides evidence of an infarct resulting in excitatory discharges at the border of the lesioned area which stimulate neighbouring areas, and thus result in abnormal visual perception. We causally demonstrate that repetitive TMS provides a valuable method of modulating hallucinations from occipital injury or infarct.

Talk Session III – 2:15 PM, Sunday May 24, 2015

Increased visual dependency in people with m-iSCI during obstacle crossing is complex and multifactorial

Raza N. Malik[1], Rachel Cote[1] and Tania Lam[1]

[1] School of Kinesiology and International Collaboration On Repair Discoveries (ICORD), University of British Columbia, Vancouver, BC

During skilled walking tasks visual input needs to be integrated with other sensory inputs (e.g. proprioceptive sense) and motor commands to complete the task. In people with motor-incomplete spinal cord injury (m-iSCI), the recovery of walking is possible, but the ability to complete skilled walking tasks, such as obstacle-crossing, depend on different clinical factors, such as the extent of sensorimotor impairment. Gaze behavior during obstacle crossing could provide insights into the impact of such sensorimotor impairments on the ability to navigate obstacles. The overall objective of this study was to evaluate gaze behavior of people with m-iSCI during an obstacle-crossing task and to understand how different clinical factors (motor capacity, proprioceptive sense and self-efficacy) impact gaze behavior. Nine individuals with m-iSCI and 10 able-bodied controls were asked to approach and step over an obstacle. An eye tracker was used to determine gaze behavior (number of saccades and total fixation time). In participants with m-iSCI, motor capacity was assessed by tests of strength, balance, and walking speed. Self-efficacy in balance and gait was assessed using questionnaires. Lower limb proprioceptive sense was assessed using the Lokomat and customized software controls. The results indicate that people with m-iSCI rely more heavily on vision: they glanced at the obstacle more often and fixated on the obstacle for longer compared to able-bodied individuals. The increased visual dependency was related to self-efficacy, proprioceptive sense and motor capacity. Further investigation is warranted to understand how these changes in gaze behavior affect skilled walking in people with m-iSCI.

Talk Session III – 2:30 PM, Sunday May 24, 2015

The relationship between gaze behaviour and mobility deficits on a precision walking task in persons with glaucoma

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Glaucoma leads to loss of peripheral vision, resulting in mobility deficits that manifest as falls and collisions. How the loss of vision impacts visual sampling behaviours during walking, and how these behaviours contribute to mobility problems remains unclear. We investigated the pattern of fixations and saccades in older adults with glaucoma and normal-sighted controls to identify gaze behaviours that relate to poor mobility in a precision walking task. Subjects stepped as accurately as possible to four sequential targets while walking under single- and dual-task (i.e., counting) conditions. The target locations were varied trial-to-trial. We quantified foot placement accuracy and variability, fixation frequency and duration on the targets, and the relationship between the timing of saccades away from targets and heel contact on the targets. We found that people with glaucoma step onto targets with less accuracy and greater variability. These deficits were accompanied by increased fixation frequency and duration to targets. In addition, older adults with glaucoma looked away from targets they then made heel contact with sooner than controls. These differences were exacerbated in the dual-task condition. These findings suggest that visual field loss associated with glaucoma leads to mobility and gaze-related changes during walking. Importantly, the nature of these changes increases the risk for missteps and injurious falls. This research will contribute to future gaze- and mobility-training programs to help those with glaucoma move more safely in their environment.

Talk Session III – 2:45 PM, Sunday May 24, 2015

Visual stimuli induce stronger action-perception coupling compared to auditory stimuli in children

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BACKGROUND: The mirror neuron system (MNS) is a neurological network associated with action-perception coupling, and is influenced by previous experiences. Visual, auditory and multi-modal action-related stimuli have been shown to modulate the response of the MNS throughout the various stages of human development, however they have not yet been studied in pre-adolescent children.
PURPOSE: To compare the response of the MNS in children during exposure to auditory, visual and multi-modal action-related stimuli.
METHODS: This study compared the responses in the MNS (measured by the Mu Suppression Index) of ten children aged 10-12 years old, during exposure to auditory (drum beats), visual (treadmill walking), and multi-modal stimuli.
RESULTS: We found significant mu suppression in the left sensorimotor cortex only during visual observation of action. In contrast, we observed significant mu suppression during auditory, visual and multi-modal conditions within the right sensorimotor cortex. Overall, visual stimuli showed significantly greater mu suppression than auditory stimuli. The covariates of age, musical experience and dance experience were identified to have significant interactions with conditions.
CONCLUSIONS: This pilot research study provides the first evidence that visual stimuli result in stronger mu suppression in comparison with auditory stimuli in typically developing children, similar to that found in adults. These results provide support for domain specificity within the action-perception network.

Talk Session III – 3:00 PM, Sunday May 24, 2015

Motion processing deficits in children with amblyopia

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In addition to the spatial vision deficits that characterize amblyopia, deficits in motion processing have been reported in both the amblyopic and the clinically normal fellow eye. These motion deficits include: oscillatory movement displacement, motion-defined form, motion aftereffects, maximum motion displacement, global motion, optic flow, attentive motion tracking and structure-from-motion. The deficits in motion-defined form and global motion perception are tuned to specific stimulus attributes such as slow speeds or small spatial displacements, respectively, which also show later maturation in typically-developing children. This is consistent with the view that aspects of vision that normally mature later in development are more susceptible to damage during sensitive periods of neural plasticity. It has become common to interpret psychophysical findings on typical and atypical visual development in terms of the underlying cortical ventral and dorsal processing streams. The hypothesis of dorsal stream vulnerability during early childhood has been put forward to account for the prevalence of motion processing deficits in developmental disorders. Children with amblyopia, however, show ventral stream deficits as well. In addition, functional MRI results implicate ventral and dorsal stream cortical regions in motion-defined form and global motion processing at fast and slow speeds. The stimulus selectivity of motion processing deficits in amblyopia has improved our understanding of sensitive periods in development, but the implications of these deficits for brain development have still to be determined.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #1**

Synaptic mechanisms underlying contrast coding in the directionally-selective circuit in the mouse retina

Amanda McLaughlin[1] and Gautam B. Awatramani[1]

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Our ability to perceive the direction of moving objects depends both on the contrast and size of the stimulus, owing to synaptic processing of motion signals beginning in the retina itself. To investigate the cellular basis for contrast and size coding, we examined the response properties of the directionally selective ganglion cells (DSGCs) in the mouse retina using electrophysiological techniques. We found that the contrast response function (CRF) of DSGCs varied with stimulus size. For spots matching their receptive fields (~200µm diameter) the DSGC's peak spike response increased sharply with contrast and quickly reached a plateau. However, when smaller stimuli were used (25 to 100 µm), a higher contrast was required to evoke responses, which then increased through the contrast range but did not exhibit saturation. To understand how excitation (glutamatergic and cholinergic) and inhibition (GABAergic) shape the CRF, we next used voltage-clamp to directly monitor the inputs to DSGCs. Light-evoked EPSCs in DSGCs followed a similar trend as the spiking responses. Blocking, GABA receptors (SR95531 and TPMPA) greatly increased the peak EPSC amplitude but did not change the general shape of the CRF. In contrast, blocking cholinergic receptors (curare) abolished responses to small spots and tended to linearize the CRF evoked by optimal sized spots. Interestingly, TTX, a voltage-gated Na+ channel blocker had a similar effect as curare. Thus, our preliminary conclusion is that spike activity, likely in cholinergic amacrine cells shape the CRF of DSGCs, while inhibition plays a minor role.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #2**

Direction coding in the presence of ambient light dependent changes in global inhibition

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In receptive fields of retinal ganglion cells (GCs), the inhibitory surround is most effective in bright illumination, and weak in dim light. Recently, a class of wide-field amacrine cell (WAC), which provides direct GABAergic input to GCs, was shown to confer ambient light-dependent inhibition. If or how specialized GCs maintain their computational abilities during changes in inhibition is not clear. We examine the impact of wide-field inhibition on the well-established direction coding circuit, which relies on the balance of inhibitory and excitatory inputs. Small moving spots (8 directions, 1 mm/s) triggered DS responses over a wide range of background intensities, which spanned rod and cone thresholds (10-3 to 103 rod isomerizations per second; R*/s). When presented with stationary spots under photopic conditions, direction selective GCs were found to have a preference for stimuli which matched their dendritic fields (~200 µm). However, under scotopic conditions (10-3 to 10-1 R*/s) spatial selectivity was greatly reduced. To understand the circuit mechanisms responsible for size selectivity, we analyzed light evoked synaptic inputs in voltage-clamped DSGCs. We found that both inhibitory and excitatory currents exhibited similar size preferences, suggesting that size selectivity must be formed presynaptically. Size selectivity was lost when GABA receptors or spiking mechanisms were blocked, implicating WACs. Finally, we found that modulating wide-field inhibition either pharmacologically or with ambient light impacted the spatial tuning properties of DSGCs without effecting directional tuning. These results provide insights into the intricate functional arrangement of inhibitory interneurons that underlie spatial and directional tuning within a single computational module in the retina.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #3**

Sensory-evoked dendritic activity and somatic firing instruct morphogenesis in the awake brain

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Sensory activity is essential during normal development of neural circuits. However, the role that patterned sensory activity plays in the detailed structural reorganization of the dendritic arbor remains unknown. Using a custom made random-access microscope that allows rapid simultaneous activity sampling throughout the entire 3D dendritic arbor in awake Xenopus Laevis tadpoles, in combination with targeted single cell electroporation to label single neurons with selected receptive field properties, we characterized the learning rules that neurons follow to modify their detailed morphology in response to sensory activity. We found that neurons' somatic firing and plasticity patterns were associated with the patterns of dendritic growth and pruning. The observed motility was determined by the combination of evoked calcium transients at filopodial tips and adjacent shafts in response to sensory stimulation. Our data show that sensory stimulation evoked activity passing through dendrites guides the specific filopodial growth and retraction patterns, shaping how the developing brain processes the environment and how individual neurons integrate into functional networks.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #4**

Natural scene movie responses are more precise in synchronized than desynchronized cat V1

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We recorded spiking responses simultaneously from dozens of single units across most layers of isoflurane-anesthetized cat V1 using silicon polytrodes. Unlike responses to more artificial visual stimuli, responses to short repeated natural scene movie clips consisted of temporally precise, sparse, reliable events. Each unit had a distinct temporal pattern of such response events, some precise to within as little as 20 ms. Cortical state was quantified by the power ratio of low and high frequency bands of deep-layer local field potential. Cortical state spontaneously switched between synchronized (1/f distribution) and desynchronized (broadband). Contrary to reports in anesthetized rodent cortex [Goard, 2009; Marguet, 2011; Zagha, 2013; Pachitariu, 2015], responses were more precise, sparse and reliable during the synchronized than desynchronized state. This is surprising, because the synchronized state under anesthesia is thought to correspond to quiescent periods in awake animals, and the desynchronized state to alert attending periods. Neural responses are known to be more precise and reliable to attended than unattended stimuli. Our results therefore complicate the analogy between cortical states in anesthetized and awake animals. One possible reason for this conflicting result may be the greater columnar organization of stimulus features in cat V1 than in rodent V1. Travelling waves of activation (UP phases) in the synchronized state may interact differently with incoming stimuli in the two species. This explanation predicts a similar result in anesthetized ferret and primate V1.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #5**

Pupil size is modulated by the size of flux-equated gratings

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Pupil size changes with light. For this reason, researchers studying the effect of attention, contextual processing and arousal on pupillary response have matched the mean luminance of their stimuli across conditions to eliminate the contribution of differences in light levels. Here we argue that the match of mean luminance is not enough. We presented a circular sinewave grating on a gray background for 2 s. The diameter of the grating could be 2°, 4° or 8°. The mean luminance of each grating was equal to the luminance of the gray background, such that regardless of the size of the grating, there was never a change in flux between presentations of the gratings. Participants were asked to fixate the center of the grating and passively view it. We found that in all size conditions, there was a pupil constriction starting at about 300 ms after stimulus onset, and the pupil constriction increased with the size of the grating. To explore to what extent this effect was due to attention, we replicated this experiment but had the subjects perform an attention-demanding fixation task in one session, and passively view the stimuli in the other. The main effect of size was significant but the main effect of attention was not. This suggests that the effect of stimulus size on pupil size cannot be attributed to attention. In sum, our results show that stimulus size can modulate pupil size even when the luminance is matched across the different stimuli.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #6**

Multisensory integration in human pupil orienting response

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The sudden appearance of a salient stimulus initiates a series of responses to orient the body for appropriate actions, including not only shifts of gaze and attention, but also transient pupil dilation. Recent studies have shown pupil dilation induced by presentation of visual and auditory stimuli, and the timing and size of the evoked responses are systematically modulated by stimulus salience. Moreover, microstimulation of the superior colliculus (SC), a midbrain structure involved in eye movements, attention, and multisensory integration, evokes similar transient pupil dilation, suggesting a coordinated role of the SC on the pupil orienting response. Although pupil dilation is evoked by presentation of single modality stimuli, stimuli in everyday life are often comprised of multisensory inputs. Here, we examined how human pupil dynamics are modulated by multisensory stimuli and hypothesized that sensory signals induced by salient stimuli presented from different modalities should be integrated in the SC to produce coordinated transient pupil responses. While requiring participants to maintain central fixation, we presented a visual, auditory, or combined audiovisual stimulus. Transient pupil dilation was elicited after presentation of visual or auditory stimuli. More importantly, presentation of audiovisual stimuli induced similar pupil responses with greater response magnitude. Together, the results demonstrated multisensory integration in pupil orienting responses, further arguing that the SC is the likely neural substrate coordinating these pupil orienting responses.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #7**

Cortical substrates for allocentric vs. egocentric representation of remembered saccade targets in the human

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The location of a remembered target can be defined in egocentric or allocentric reference frames, but the neural mechanisms for allocentric saccade coding in humans are essentially unknown. Here we employed an event-related fMRI design same as our recent reach study (Chen et al. J Neurosci., 2014) to investigate the brain areas supporting these two types of representation in twelve participants. The target and the landmark were always presented briefly, but at the beginning of each trial, participants were instructed to ignore the landmark and remember target location (Ego) or remember target location relative to the landmark (Allo). During the delay phase participants had to remember the target location in the appropriate reference frame. In a non-spatial Control participants remembered and reported the target color. We found that during the delay phase Ego and Allo elicited higher activation as compared to the Control in bilateral precuneus, midposterior intraparietal sulcus, dorsal premotor cortex and left extrastriate cortex. Inferior parietal lobes showed higher activation for Ego vs. Allo, whereas temporal and occipital cortex showed higher activation for Allo vs. Ego. Egocentric directional selectivity was observed in superior and inferior occipital cortex (IOG). Allocentric directional selectivity was observed in calcarine, IOG and precuneus. These results confirm different cortical mechanisms for egocentric vs. allocentric target memory, but comparing this to our previous study, the detailed mechanisms also depend on the motor effector (eye vs. hand).

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #8**

Plasticity within the vestibulo-ocular reflex circuitry: implications for use of vestibular prostheses

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Motor learning plays an essential role in fine-tuning the accuracy of complex movements as well as calibrating simple reflexes. In this context, the relative simplicity of the vestibulo-ocular reflex (VOR) circuitry and its precise behavioral readout (i.e., eye movements) make it an excellent model system for studying mechanisms of motor learning. Here we examined the neural correlates of VOR plasticity induced by applying temporally precise electrical stimulation to vestibular afferents in alert rhesus monkeys. Evoked eye movement and individual vestibular nuclei neurons responses were simultaneously recorded to link changes in neuronal activity across different sites within the VOR circuitry with changes in behavioral responses. We show for the first time that repeated stimulation markedly attenuated responses in neurons that receive direct vestibular nerve input, and in turn mediate the direct VOR pathway. In contrast, single vestibular afferents showed no change in their responses to the same stimulation, suggesting that stimulation induced plasticity at the vestibular afferent to central neuron synapse. Interestingly, we further found that while stimulation caused a coincident decrease in evoked eye movements, the overall attenuation lasted up to 6 hours but was significantly less than that of VOR interneurons response. Accordingly, we tested whether compensatory changes occurred in the indirect cerebellar and/or commissural VOR pathways. Surprisingly, responses of neither neuron group showed changes to comparable stimulation of the vestibular nerve. Together these findings suggest that rapid plasticity within indirect VOR pathways compensates for the reduced efficacy in the direct VOR pathway to ensure a robust behavioral output.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #9**

Accurate smooth pursuit leads to earlier and more accurate manual interception

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Tracking a moving object with smooth pursuit eye movements enhances our ability to predict the object's trajectory in space [Spering et al., J Neurophysiol 2011] and time [Bennett et al., Exp Brain Res 2010]. Catching or hitting a moving object critically relies on motion prediction. We assessed the functional significance of accurate smooth pursuit for manual interception. We developed a novel paradigm and asked observers to track a small moving dot, back-projected onto a translucent screen, and to intercept it fast and accurately. Observers (n=32) were instructed to hit the target with their index finger as soon as it entered a designated "hit zone". During training, the target's entire trajectory was shown; during the experiment, only the first part (100-300 ms) of the trajectory was shown and observers had to intercept the trajectory at its assumed current position in the hit zone. Task difficulty was increased by varying stimulus speed (25-35 deg/s) and trajectory shape (linear, curved). Eye movements were recorded using an Eyelink 1000 tower mount; hand movements were recorded with an Ascension TrakSTAR. In trials with better pursuit –low eye position and velocity errors, high eye-velocity gain, fewer catch-up saccades of smaller amplitude– observers intercepted earlier and more accurately. Smooth pursuit eye movements boost hand movement accuracy, indicating that accurate eye movements lead to a better velocity estimate. We implemented a Bayesian model to identify those eye movement parameters best predicting early and accurate interception.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #10**

Improving manual interception accuracy through eye-movement training

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Perceptual learning is highly specific to the trained task, stimulus and location. However, we recently showed that perceptual training during fixation transfers to smooth pursuit eye movements [Szpiro et al. JOV 2014]. Here we examined whether smooth pursuit training transfers to hand movements. In a track-intercept task, observers were instructed to track a moving target on a screen and to hit it with their index finger as soon as it entered a "hit zone". In each trial, only the first part (100-300 ms) of the trajectory was shown and observers had to extrapolate and intercept the target at its assumed position. Eye position was recorded using an Eyelink 1000 tower mount; hand position was recorded with an Ascension TrakSTAR. We compared interception performance (2D finger error) between pre- and post-test (day 1 and 5) in three groups (n=8 each): On days 2-4, group 1 trained on the track-intercept task (eye-hand training), group 2 trained on the task without intercepting (eye-training), group 3 received no training. All groups showed better interception on day 5: up to 56% improvement following eye-hand training, 18% following eye-training, 7% after no training. Critically, observers in the eye-training group showed systematic interception improvements across conditions (better with longer presentation duration and slower target speed) and improved pursuit, whereas the no-training group showed only unsystematic interception improvements and no significant pursuit improvement. These results indicate that improvements in smooth pursuit may mediate improvements in hand movement performance and that pursuit training can transfer to hand movement performance.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #11**

The impact of macula-sparing on single-word reading in hemianopia

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Previous work suggests a diagnostic criterion for the word-length effect of up to 160ms/letter for right hemianopic dyslexia, which helps distinguish this condition from pure alexia. However, central field vision is often preserved in right homonymous hemianopia, and the implications of central sparing on single-word reading are unknown. We had ten healthy subjects perform single-word reading under normal and simulated right hemianopic conditions with varying degrees of macula-sparing, using a gaze-contingent display generated by an eye-tracker, measuring both the mean reading time and the word-length effect as dependent variables. Our results replicated the magnitude of word-length effects reported in prior studies for both full-field viewing and for complete right hemianopia. Mean reading time correlated with the degree of macula sparing, but the word-length effect showed minimal if any decrease until sparing exceeded 5°. We conclude that the effects of macula-sparing on mean reading time and the word-length effect are distinct, with the latter effects more resembling the impact of macula-sparing previously reported for line bisection. Our results also provide diagnostic criterion for using the word-length effect to discriminate between hemianopic dyslexia and pure alexia for various types of central involvement by right hemifield loss.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #12**

The effect of pharmacological intervention on contrast sensitivity deficits in phenylketonuria

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Patients with the autosomal recessive disorder phenylketonuria (PKU) have elevated phenylalanine levels, impeding production of tyrosine, a precursor to dopamine. Lowered dopamine levels lead to deficits including lowered visual contrast sensitivity (Diamond & Herzberg, 1996; Gramer et al, 2013; Stemerdink et al, 1999). We measured contrast sensitivity and blood phenylalanine and tyrosine levels on multiple visits in 10 PKU patients, 5 of whom began a course of sapropterin dihydrochloride (Kuvan®), which reduces phenylalanine levels (in some patients). The expectation was that in patients who responded well to sapropterin dihydrochloride, reduced phenylalanine levels would correspond to increased contrast sensitivity. Contrast thresholds for each PKU patient and age-matched controls were determined using a grating discrimination task (the Freiburg Visual Acuity Test, Bach, 1996; 2007) on multiple visits (1-4 per patient). On Visit 1, prior to treatment, contrast thresholds were an average of 67% higher in PKU patients than in age-matched controls, but no correlation between performance and phenylalanine or tyrosine levels was detectable. During treatment, however, phenylalanine levels dropped by half, and contrast sensitivity deficits disappeared. Practice played a role in improvement: threshold elevations were 10% lower on Visit 2 among those patients who had not begun treatment, similar to controls. Results during treatment suggest that sapropterin hydrochloride may be effective in reducing phenylalanine levels and corresponding perceptual deficits in PKU patients. The practice effect, however, raises the possibility that only some of the contrast sensitivity deficit in PKU patients is the result of dopamine-related impairments in the retina or visual cortex.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #13**

Asymmetrical medical geniculate body volume in people with one eye

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We have previously shown that people who have lost one eye early in life have enhanced sound localization (Hoover et al., 2011), lack visual dominance (Moro & Steeves, 2011) and integrate auditory and visual information optimally (Moro et al., 2013) compared to binocular and eye-patched viewing controls. Structurally, people with one eye have decreased lateral geniculate nuclei volume (LGN; thalamic visual relay station). However, this decrease is less severe in the LGN contralateral to the remaining eye, indicating altered structural development (Kelly, et al., 2013). The medial geniculate body (MGB; thalamic auditory relay station) plays a central role in auditory processing with both efferent and afferent tracts to primary auditory cortex (Schönwiesner et al., 2007). Given the existing audiovisual processing differences and LGN changes in people with one eye, we investigated whether structural MGB changes are also present. MGB volumes were measured in adults who had undergone early unilateral eye enucleation and were compared to binocularly intact controls using the current gold standard methodology for anatomical localization of the MGB (Devlin, 2006). Unlike controls, people with one eye had a significant asymmetry with a larger MGB volume in the left compared to the right hemisphere, independent of eye of enucleation. The volume asymmetry in the MGB in people with one eye may represent increased interaction between the left MGB and primary auditory cortex as compensation for the loss of one half of the visual inputs early in life.

Poster Session I – 12:30-1:15 PM, Sunday May 24, 2015 **Poster #14**

Development of a primate model of Alzheimer's Disease I. Characterization of molecular pathology

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Alzheimer's disease (AD) is a devastating neurodegenerative disorder, and therapeutics have proven difficult to translate from mouse models to human clinical trials. An intermediary primate model would greatly advance our understanding of mechanisms involved in AD pathogenesis and could be used to vet promising therapeutics. Here, we describe the molecular characterization of a non-human primate model of AD generated in macaque monkeys by icv injections of amyloid-β oligomers (AβOs). Soluble AβOs accumulate in the brains of AD patients and correlate with disease-associated cognitive dysfunction. In our first set of experiments molecular pathology was examined by immunohistochemistry on brains perfused several weeks after AβO injection. AβOs diffused into the brain and accumulated in several regions associated with memory and cognitive functions. Cardinal features of AD pathology, including synapse loss, tau hyperphosphorylation, astrocyte and microglial activation, were observed in regions of the macaque brain where AβOs were abundantly detected. Most importantly, AβO injections in macaques induced AD-type neurofibrillary tangle formation, unlike most rodent models. In ongoing experiments, Aβ, total tau and phosphor-tau in cerebrospinal fluid, as well as blood chemistry and endocrinology panels, are being examined before and several time points after icv injection of AβOs. Behavioural phenotype is now being characterized via activity tracking, and performance on learning and memory tasks using touchscreen CANTAB and saccadic eye movements (see Wither et al, this meeting).

Using eye movements to identify early biomarkers of disease progression in Parkinson's patients with and without LRRK2 gene mutations

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In some patients with Parkinson's disease (PD), variations of the Leucine-rich repeat kinase 2 (LRRK2) gene has been associated with the development of the disease. Patients with PD exhibit specific deficits when completing anti-saccades, an inhibitory process that requires looking in the opposite direction of a peripheral visual stimulus. These deficits include longer reaction times, more directional errors (erroneously looking at a stimulus), and hypometric saccades. We employed an interleaved pro- and anti-saccade task to age-matched controls, idiopathic PD patients, and LRRK2 mutation carriers either before (non-manifesting) or after they manifest PD (manifesting carriers). The pro-saccade task (look at the peripheral stimulus) assesses the basic sensory-motor processing of eye movements via automatic tendencies to look at salient visual stimuli, whereas the anti-saccade task assesses the inhibitory control of this automatic response and generation of a voluntary command to look in the opposite direction. We hypothesize that carriers of pathogenic LRRK2 genetic mutations, who have not yet developed parkinsonism, will have anti-saccade deficits similar to PD patients. Preliminary data has revealed that non-manifesting carriers resemble PD patients in terms of performance: they make more direction errors in the anti-saccade task, faster eye movements in the pro-saccade task, and hypometric saccades. Follow up of these results will be important to identify pre-symptomatic behavioural biomarkers of PD that accurately predict disease leading to an earlier detection of PD.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #16**

Conscious perception of sway influenced by postural threat

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BACKGROUND AND AIM: Threat-related postural changes [1,2] occur in conjunction with significant increases in vestibular and proprioceptive gain [3,4]. However, what is unclear is how conscious perception of sway during threatening conditions is affected. Therefore, the aim of this study was to examine how changes in threat influence conscious perceptions of postural sway. METHODS: 15 young healthy adults stood on a forceplate placed at two heights (0.8m and 3.2m). At each height, subjects stood quietly with eyes open (EO) and eyes closed (EC) for 60s while instructed to focus on postural sway and simultaneously track their perceived sway in the anteroposterior plane by rotating a hand-held potentiometer (PS). RESULTS: Threat significantly increased center of pressure (COP) total sway path (TSP) and mean power frequency (MPF), and decreased root mean square (RMS) independent of vision. Removing vision significantly increased COP-TSP and MPF independent of height. In the low condition, the change between EO and EC conditions in PS-TSP was uncorrelated to COP-TSP ($r=-0.046$, $p=0.872$); however, at high height, these changes were correlated ($r=0.573$, $p=0.026$). CONCLUSIONS: When sway amplitude is reduced, sway perception appears to remain unchanged. When threat is increased, sensory gain may be increased to compensate for postural strategies that reduce sway (i.e. stiffening strategy), thereby ensuring sufficient afferent information is available to maintain the conscious perception of postural sway.
REFERENCES: [1] Carpenter et al. (1999) J Vestib Res; [2] Davis et al. (2009) Gait Posture; [3] Horslen et al. (2008) J Neurophysiol; [4] Horslen et al. (2014) J Physiol.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #17**

Intersensory vestibular control of standing balance

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During standing balance, error signals delivered to the vestibular system through electrical vestibular stimulation elicit compensatory muscle responses in appendicular muscles involved in the control of upright stance. This response is present only in muscles that are active in balancing the whole-body, provided that afferent cues are congruent with efferent muscle signals of standing balance. Most notably, the response is suppressed when subjects balance a body-equivalent inverted pendulum through their ankles while being externally supported. Although somatosensory information during this condition mimics normal standing, vestibular information is incongruent with the balance task, suggesting that vestibular cues of self-motion are essential to engage the vestibular control of balance. Here, we tested the hypothesis that the vestibular control of balance can be engaged with varying combinations of non-vestibular cues of self-motion (i.e. somatosensory and visual). Ten healthy subjects maintained balance on a newly developed robotic balance simulator, with varying combinations of visual and somatosensory cues while vestibular cues of balance were minimized. To achieve this, subjects were held stable in space by the robotic balance simulator while receiving visual and/or lower-limb somatosensory information that was congruent with the motor control of standing. It was shown that even without vestibular cues of self-motion, a vestibular reflex response can be elicited, but only when visual and somatosensory information are simultaneously present. Our results suggest that the vestibular control of standing balance is not solely dependent on the vestibular cues of self-motion, and that control models ignoring cross-interactions of separate sensory pathways are insufficient to describe standing balance.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #18**

Do we know enough about motor memories? Savings, consolidation, and interference when adapting to altered visual input during precision walking

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From visually guided reaching to walking, the brain establishes an accurate relationship between perceived target locations and motor commands required to arrive at them (i.e., a visuomotor mapping). How these visuomotor mappings are stored and learned has long been a topic of research in reaching. Here, we expand these views by characterizing the mechanisms underlying consolidation and interference of visuomotor mappings during visually guided walking. Specifically, we asked subjects to walk and step onto two sequential targets while wearing prism goggles that shifted visual perception of the targets with respect to their actual location. We measured lateral end-point errors of foot placement from the targets. We first showed that subjects are able to recall a novel visuomotor mapping one-week apart, as evident from smaller errors and faster adaptation (i.e., savings) on day two. In addition, we used the ABA paradigm to examine if adapting to an opposing visuomotor mapping (B) interferes with the recall of the first visuomotor mapping (A). Subjects performed mapping B either five minutes or one week after the first mapping A, followed by mapping A one week later. In this case, errors were higher when mapping B was introduced five minutes after the first mapping A as compared to one week. Our results suggest that motor memories during walking are subject to interference and undergo a process of consolidation (i.e. become resistant to interference over time), characteristics that so far have only been demonstrated in reaching or sequence tasks.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #19**

The ability of persons with multiple sclerosis to adapt to altered visual input during visually guided walking

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Persons with multiple sclerosis (PwMS) exhibit deficits in mobility resulting from a range of symptoms. Spontaneous recovery of function and rehabilitation rely on the nervous system's ability to adapt, a form of short-term motor learning. Here, we sought to identify the capacity for adaptation in PwMS relative to healthy controls. 11 PwMS and 7 controls performed a precision walking task while adapting to altered visual input. The task required subjects to walk and step onto two targets without stopping. After a baseline phase of trials with normal vision, subjects adapted to prism glasses while walking (i.e., adaptation phase). The prism glasses laterally shifted the perception of target locations. A short post-adaptation phase of one normal-vision trial followed. To quantify performance, we determined foot placement error, defined as the medial-lateral distance between the middles of the target and foot. We quantified errors for the baseline phase (mean: last 10 trials), initial adaptation trial, early adaptation (mean: trials two to eight), late adaptation (mean: last 10 trials), and post-adaptation trial. Regardless of group, we found a reduction in error from initial to late adaptation trials, and large errors in the opposite direction (i.e., negative aftereffect) in the post-adaptation trial. In addition, we found that foot placement error was greater among PwMS when stepping to the second target, independent of phase. These preliminary results indicate that high-functioning PwMS maintain the ability to adapt despite evidence of greater error relative to controls.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #20**

Dissociation of parietal cortex contributions to obstacle memory in walking cats

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A working memory of environmental obstacles is essential for avoidance in walking mammals. In quadrupeds, vision is unavailable to guide hindleg stepping over an obstacle previously cleared by its forelegs. Instead, visual information about an obstacle and motor information about foreleg clearance are held in memory to modify hindleg movements. Previous studies suggest that this memory system relies on parietal areas associated with sensorimotor integration. To examine parietal contributions to obstacle memory, cortical cooling was used to reversibly deactivate areas 5 or 7 in cats trained to step over an obstacle with their forelegs and pause for a variable delay period before resuming locomotion. Hindleg step height and trajectory over the obstacle were measured to assess memory. While hindleg stepping was unaffected when area 7 was bilaterally cooled, bilateral cooling of area 5 resulted in significantly lower steps and altered trajectories, demonstrating a disregard for the obstacle. When bilateral cooling was restricted to the delay phase during which obstacle memory must be maintained, similar stepping deficits were observed. Additionally, cooling of area 5 in one hemisphere produced stepping deficits in the contralateral hindleg only. Finally, when area 5 cooling was stopped immediately after the memory acquisition phase (approach and foreleg clearance), high hindleg steps were restored, suggesting reactivation of obstacle memory. These results suggest that area 5 is critical for maintaining the memory of an obstacle encountered in the contralateral hemispace.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #21**

Prediction of future sensory states requires self-generated motor commands

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Predicting the sensory consequences of limb movement has been thought to influence current decisions, however it is unclear whether these predictions are based on knowledge of upcoming movements or based directly on motor planning signals. The present experiment examines how forward modeling can influence limb localization. It has been previously shown that crossing the arms induces a subjective reversal of spatially-defined cutaneous temporal order judgments. By applying brief vibrations to the hands during the planning stages of an arm-crossing movement, we observed how forward modelling systematically influences temporal order judgements. We tested this by having subjects either actively moving their arms into a crossed posture or having a robot passively move their arms into a crossed posture. In the active condition, error rates increased as the planning process evolved, mirroring the errors that were observed when the limbs were physically crossed. However, in the passive condition, error rates remained constant across the planning period. This data suggest that the brain uses motor planning signals to predict sensations from impending movements, and not necessarily the context of future limb postures.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #22**

Cumulative activation effect predicts faster reaction times compared to startle only related activity

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In a simple reaction time (RT) paradigm, a response is known in advance thus allowing for response selection and preparation processes to occur prior to the imperative "go" signal (IS). These processes can be described using a neural activation model, in which neural activity increases until an "ignition" threshold is reached. This model can be probed using a startling acoustic stimulus (SAS), which is known to elicit pre-programmed responses at a shorter latency. The mechanisms of this phenomenon are currently debated; however, a recent study suggested that a cumulative effect of both voluntary and startle-related initiation processes following the IS may be responsible. The purpose of this experiment was to further probe this cumulative effect by presenting a SAS at specific time points following the IS. It is hypothesized that a SAS presented at a short latency following the IS will result in faster RTs than a SAS presented concurrent with the IS, which can only make use of startle-related initiation processes. Participants performed 5 blocks of 20 trials involving a ballistic wrist extension movement. In 20% of trials, a white noise SAS (120 dB) was randomly presented at 0, 12, 24, 36 or 48 ms following the IS (82 dB). Preliminary results have indicated that premotor RTs for control trials were 187 ms, and premotor RTs for SAS trials were 92, 89, 93, 111 and 126 ms respectively. The faster RTs seen at 12 ms compared to at 0 ms lend further support to the cumulative model and demonstrate that the additional activation provided by the SAS increases the rate of activation.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #23**

A secondary motor task modulates action prediction for motor- but not perceptual-trained observers: evidence for motor simulation

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The perceptual skills of visual-motor experts, previously presumed to be based on the acquisition of a large repertoire of visual experiences, are now thought to be driven by motor experience. Action-prediction is thought to involve a covert simulation of the internal motor commands associated with an observed action. Across three groups (n=10/gp), we tested the role of the motor-system in action-prediction, using effector and non-effector specific secondary tasks to potentially interfere with prediction accuracy. In the "motor" group, right-handed novices completed the dart-landing prediction task (temporally occluded videos) before and after practice throwing darts at 3 targets. A "perceptual" group was trained to associate dart throwing actions with landing outcomes and a "control" group did not practice. Only the trained groups significantly improved their prediction accuracy after visual-motor (Mpost-pre = 25.81%, SD = 7.82) and perceptual training (Mpost-pre = 12.59%, SD = 14.41). However, only the motor group showed a significant decrease in prediction accuracy when performing the secondary motor task with their right hand only (~ 21% decrease). This interference effect indicates evidence of motor-simulation during action-prediction, but only among observers with motor experience. This suggests that action-prediction can involve two different processes – one based on action-recognition (perceptual group), and one motor-driven. The interference was effector-specific, underscoring the specificity of motor system involvement in action-prediction.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #24**

Recruitment of lateral occipitotemporal cortex (LOTC) during observation and visualization of dance and movement of the foot in expert and novice dancers

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The lateral occipitotemporal cortex (LOTC) is responsible for higher order visual processing, with sub-regions selectively activated by images of human bodies (extrastriate body area, EBA), objects (lateral occipital complex, LO) and motion (MT+). However, the involvement of these areas during motor imagery and movement, as well as the influences of learning and expertise on modulating LOTC activation, remain unclear. The aim of the present study was to examine and compare LOTC activity in expert and novice dancers during three visuomotor processes: viewing, visualization, and execution of visually cued movement. Professional ballet dancers (n=18) were scanned up to four times over 34 weeks of rehearsal and performance with functional magnetic resonance imaging along with 8 novices during four tasks: viewing (n=21) and visualizing a newly learned ballet dance (n=25), visualizing a dance that is not being learned (n=10), and movement of the right foot (n=27). We show that all LOTC sub-regions were bilaterally activated most while viewing a dance sequence compared to visualization and movement. Left LO activation increased significantly over time while visualizing the unlearned dance only, and all sub-regions showed bilateral activation during the viewing task after 34 weeks of rehearsal and performance, indicative of LOTC modulation over time. We also provide novel evidence for expertise effects, with less recruitment of EBA among expert dancers during movement execution. Together, these results provide a composite of LOTC activation using complex and naturalistic stimuli. We confirm that these higher-order visual processing areas are primarily responsible for mediating action observation of whole-body movement, with new evidence for modulation by expertise in dance.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #25**

Changes in functional brain connectivity following concussion

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Adolescents with concussion often have impairments in information processing, reaction time, movement, speed, memory, and executive function. Traumatic axonal injury is the proposed clinical pathology responsible for poor motor and cognitive outcomes due to disruptions in white matter tracts. Previous fMRI findings from our lab have shown increased connectivity in the right frontal pole in the executive function network and increased connectivity in the left frontal operculum cortex associated with the ventral attention network following sports-related concussion in adolescents. In addition, structural changes are evident in the integrity of white matter tracts in the same group. The goal of this study is to test whether diffusion MRI-based Graph Theory Analysis (GTA) would show an increase in global integration in structural networks in regions related to executive function, attention, and movement related symptoms. We assessed global and local changes in Fractional anisotropy, mean diffusivity, radial diffusivity, and axial diffusivity between healthy controls (n=9) and age-matched concussed (n=12) athletes specifically in the corpus callosum and tracts within the corona radiata bilaterally. Brain networks of both groups showed small-world topology with no statistically significant differences in the global metrics; however, significant differences were found in the local metrics suggesting that these neuropathological changes may be the substrate for impaired cognitive, attention and motor related symptoms.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #26**

Prolonged cognitive-motor impairments in children with a history of concussion

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We have previously shown impaired cognitive-motor integration (CMI) in asymptomatic adult athletes following concussion. Here we investigate whether the same is seen for still-developing children. Asymptomatic children with concussion history (n=23, 0.25-40 months post, mean 10; mean age 13.17 yr) and age-matched no-history controls (n=23, mean age 12.30 yr) performed two tasks using a dual-touchscreen laptop in which they had to slide a cursor from a central to a peripheral target using their finger. There was one direct-interaction task where target location and motor action were aligned, and a CMI task where targets were in a different plane from hand motion, and visual feedback was reversed. We observed a significant impairment in both movement timing and trajectory formation with concussion history, and an interaction effect with CMI. Importantly, we observed a significant regression whereby those with a history of concussion did not perform the CMI task at the non-concussed baseline level until 18 months following their concussion. We previously observed similar timing but not trajectory deficits in varsity athletes with concussion history. We suggest that these performance deficits are due to concussion-induced disruptions in the fronto-parietal networks responsible for rule-based movement guidance, networks that are likely vulnerable in the developing brain. The observed prolonged deficits in CMI suggest that current return to sport/school/work assessments that do not test this ability, crucial in sport, are not fully capturing functional abilities post-concussion.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #27**

Frontal brain activity during a visual working memory task: an fNIRS study

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Executive function and working memory (WM) are commonly used in studies evaluating cognitive brain function. Visual working memory involves activation within distributed neural regions including posterior areas in visual cortex as well as anterior areas in prefrontal cortex. A new emerging imaging modality, functional near-infrared spectroscopy (fNIRS), has provided the opportunity to measure cortical activation under less constrained conditions at a fraction of the cost. The purpose of this pilot study was to measure frontal activation changes during a WM task with two levels of difficulty. We recorded brain signals in nine healthy young adults with an 8-channel NIRS cap placed on the forehead while they completed a modified Sternberg Item Recognition Test. PFC activation was measured, and load related oxy- and deoxy hemoglobin was studied. Our results show that with an increased workload, there was a corresponding increase in oxygenated hemoglobin. In addition, there was an increase in the time to return to baseline. These preliminary results suggest that fNIRS has the sensitivity to capture the change in cerebral activation even with the minimal increase in WM load.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #28**

Differential effects of dopamine and selective dopamine agonists on spatial working memory, attention, learning and reaction time in healthy controls

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Dopamine (DA) plays a critical role in working memory and cognitive control. However, DA has been shown to both improve and/or impair cognitive performance across different subjects, tasks, and studies. This complex relationship may be due to the differential effects of dopamine at D1 and D2 receptors in basal ganglia cognitive loop nuclei (striatum and the dorsolateral prefrontal cortex). In order to address this question, we have investigated the effects of DA manipulation on cognitive performance in healthy monkeys using a touch screen running the CAmbridge Neuropsychological Test Automated Battery (CANTAB). One of three DA drugs or placebo were administered prior to each daily CANTAB session: Sinemet (Levadopa/Carbidopa), Dihydrexidine hydrochloride (selective D1 like receptor agonist) or Sumanirole maleate (selective D2 agonist). Three CANTAB tasks were tested at each session: (1) 'visually guided reaching task', which tests reaction time and reaching accuracy, (2) 'reversal learning task', which tests association learning, cognitive flexibility and attention, and (3) 'spatial ordered sequential search task' which tests spatial working memory. Metrics from these tasks were compared between control and each DA drug condition. Results demonstrated that in healthy monkeys, DA administration had minimal effects on learning, reaction time, and spatial working memory. These results provide insight into the relationships between DA and cognition and provide baseline behavioral data for future physiological recordings in the basal ganglia.

Poster Session II – 1:15-2:00 PM, Sunday May 24, 2015 **Poster #29**

Neural correlates of dynamic emotional facial expressions in infants

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Infants' ability to discriminate between different facial expressions is necessary for emotional development. Simulation theories assert that in order to recognize the emotions of others, observers recruit the neural circuitry involved in creating their own emotional facial expressions. The mirror neuron system has been shown to be involved during both action observation and action performance. The electroencephalography (EEG) mu rhythm is considered to be an index of mirror neuron activation during action observation. Recently, it was suggested that observing emotional faces may also elicit mu rhythm desynchronization. However, to date, the EEG mu response to viewing different facial expressions in infants has not been studied. In this study, we recorded EEG responses in 8-10 month old infants (n=14) and in adults (n=10) while they observed dynamic facial expressions of sad, pain and happiness. Mean mu desynchronization was calculated for each expression in the central brain regions. Observations of all emotional expressions resulted in significant mu desynchronization. Importantly, infants showed the highest magnitude of mu desynchronization in response to observing pain, ($p=0.014$). In contrast, adults showed the largest desynchronization response to the expression of happiness and lowest to the expression of pain. Our preliminary results suggest that infants between 8 to 10 months respond differentially to dynamic facial expressions and that the perception of painful expressions may evoke a stronger response. These results may provide insights into the developmental processes associated with empathy.

The positive affective consequences of acting over merely attending

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How we attend to visual images influences their subsequent affective evaluation, such that images we ignore are evaluated more negatively than those we actively attend (distractor devaluation; Raymond & Fenske, 2006). Here we ask whether this also applies to real objects, specifically those we must avoid (obstacles) and those we aim to act on (targets), when moving in three-dimensional space. To answer this question, we combined the attend-ignore factor of previous attention research with the obstacle-target factor that is relevant when reaching in personal space.

Participants were cued to reach and grasp one of two objects (iPods) displaying abstract art on a tabletop. The art presented on each trial could be classified as belonging to the grasp target, a neutral distractor, or a grasp obstacle (an object that impeded limb movement toward the target). Following each successful grasp of the target object, participants made an affective evaluation of either the art presented on the target, distractor, or obstacle object on that trial, or novel art (art that had not been seen before on that trial).

Art presented on grasp targets was rated more positively than art presented on distractor or obstacle objects, or novel art, suggesting strong positive emotional tags associated with attending and acting on an object. This is in contrast to previous findings of negative emotional attributions to objects that are ignored in a covert attention task. Our finding implies that acting on an object contributes to its positive emotional evaluation.