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CANADIAN ASSOCIATION FOR NEUROSCIENCE SATELLITE SYMPOSIUM

CAPnet-CPS Satellite

Perception and Action in Self and Other

Sunday May 13th, 2018

8:00 am to 5:00 pm

Sheraton Wall Centre, Vancouver, BC

Pavilion D

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Western
The Brain and Mind Institute

Perception and Action in Self and Other

Program committee: Craig Chapman (Alberta), Anthony Singhal (Alberta), Claudia Gonzalez (Lethbridge)

Scientific committee: Kyle Mathewson (Alberta), Peter Dixon (Alberta), Patrick Pilarski (Alberta), Chris Striemer (MacEwan), Deborah Giaschi (UBC), Alan Kingstone (UBC), Todd Handy (UBC), Miriam Spering (UBC), Jason Flindall (UBC), Rob Whitwell (UBC)

Student committee: Nathan Wispinski (Alberta), Scott Stone (Alberta), Ewen Lavoie (Alberta), Jeffrey Sawalha (Alberta), ShuaiNan Fang (Alberta), Jonathan Kuziek (Alberta)

8:45 - 9:00	**Welcome and Acknowledgements**
9:00 - 10:00	**CPS J.A.F. Stevenson Award Keynote Lecture: Miriam Spering (UBC)** Smooth pursuit eye movements as a model of visual prediction
10:00 - 10:15	**Morning Coffee Break**
10:15 - 11:15	**Talk Session 1: Neural Basis of Attention, Perception, and Action (Chair: Anthony Singhal)**
10:15 - 10:30	Cerebellar contributions to spatial and non-spatial visual attention *Christopher Striemer, Brandon Craig, Adam Morrill, Nadia Botha, Britt Anderson, & James Danckert*
10:30 - 10:45	Neural correlates of sensory and motor information retained in parietal area 5 for memory-guided obstacle avoidance in the walking cat *Carmen Wong & Steve Lomber*
10:45 - 11:00	Modulations in oscillations and auditory ERPs as a function of real-world environment *Kyle Mathewson, Eden Redman, Jonathan Kuziek, & Joanna Scanlon*
11:00 - 11:15	Continuous theta burst TMS of area MT impairs attentive motion tracking *Arijit Chakraborty, Tiffany Tran, Deborah Giaschi, & Benjamin Thompson*
11:15 - 12:15	**Talk Session 2: Perception (Chair: Deborah Giaschi)**
11:15 - 11:30	Fixation stability during global motion discrimination tasks *Kimberly Meier, Deborah Giaschi, & Miriam Spering*
11:30 - 11:45	To swing or not to swing? The role of eye movements and simple heuristics when making ultra-fast decisions in a go-no go manual interception task *Jolande Fooken & Miriam Spering*
11:45 - 12:00	An enactive approach to perception in reinforcement learning agents *Alex Kearney, Richard Sutton, & Patrick Pilarski*
12:00 - 12:15	Experience-dependent plasticity of somatosensory maps; evidence from hand perception studies *Lara Coelho, Jason Schacher, Cory Scammell, Jon Doan, & Claudia Gonzalez*

12:15 - 12:45	**Lunch**

12:45 - 1:45	**Poster Presentations**

1:45 - 2:45	**Talk Session 3: Action** **(Chair: Peter Dixon)**
1:45 - 2:00	Grasping verbs: Word-class modulates speech and manual action *Nicole van Rootselaar, Marisa Lelekach, Clarissa Beke, Fangfang Li, & Claudia Gonzalez*
2:00 - 2:15	Deciding while acting: An investigation of decision-making during ongoing action control *Julien Michalski, Andrea Green, & Paul Cisek*
2:15 - 2:30	Using Lab Streaming Layer to collect synchronized multimodal datasets *Scott Stone, Quinn Boser, T. Riley Dawson, Jacqueline Hebert, & Craig Chapman*
2:30 - 2:45	A flexible software platform for integrating eye tracking and motion capture data for measuring human movement behaviour in a reconstructed 3D environment *Quinn Boser, T. Riley Dawson, Aïda Valevicius, Albert Vette, Patrick Pilarski, Jacqueline Hebert, & Craig Chapman*

2:45 - 3:00	**Afternoon Coffee Break**

3:00 - 4:00	**Talk Session 4: Perception and Action in Self and Other** **(Chair: Claudia Gonzalez)**
3:00 - 3:15	Shared credit for shared success: Experiences of joint agency during interpersonal coordination *Janeen Loehr*
3:15 - 3:30	How many is too many at a cocktail party? Testing the limits of spatial resolution in complex auditory scenes *Vera Lee, Scott Stone, & Matthew Tata*
3:30 - 3:45	Critical properties of a “training set” for visual learning *Swapnaa Jayaraman & Linda Smith*
3:45 - 4:00	Moving as ongoing decision making *Nathan Wispinski & Craig Chapman*

4:00 - 5:00	**CAPnet Keynote: Jim Enns (UBC)** We read the body to reveal the mind

Note: The main poster session will be during lunch hours; however, posters should be up for the entire day. Poster boards will be numbered.

12:45 - 1:45 **Poster Presentations**

1. Pearls and perils of pupillometry using a webcam
   Mason Kadem & Rhodri Cusack

2. Effects of selective inactivation of the magnocellular visual pathway on visually-guided actions
   Megan McFadyen & Jenni Karl

3. EEG correlates of the perceived timing of events that trigger actions
   Yoshiko Yabe, Melvyn Goodale, & Damian Cruse

4. Early human prehension and the importance of the underlying surface
   Alexis Wilson, Marisa Bertoli, Chris Wilson, & Jenni M Karl

5. The influence of kinesthetic motor imagery on goal-dependent modulation of the long latency stretch response
   Christopher Forgaard, Ian Franks, Dana Maslovat, & Romeo Chua

6. The novel influence of co-action on a simple attention task: A shift back to the status quo
   Jill Dosso, Kevin Roberts, Alessandra DiGiacomo, & Alan Kingstone

7. The effect of stimulus area on global motion thresholds in children and adults
   Kevin Chang, Kimberly Meier, & Deborah Giaschi

8. Reading ability of children treated for amblyopia
   Laveniya Kugathasan, Marita Partanen, Violet Chu, Christopher Lyons, & Deborah Giaschi

9. Walking in outdoor environments: Using smartphones to assess the relationship between cognitive load and gait dynamics during outdoor walking
   Simon Ho, Amelia Mohtadi, Kash Daud, Ute Leonards, & Todd Handy

10. Sensory attenuation in interpersonal coordination
    Nicole Bolt & Janeen Loehr

11. Imagined hand-manipulations activate nodes in fronto-parietal network
    Christopher Donoff, Christopher Madan, Sarah Elke, & Anthony Singhal

12. Parallel planning of multiple responses is behaviourally observable and partially effector-independent
    Alice Atkin & Anthony Singhal

13. Impact of diverse allocentric cues on transsaccadic integration of multiple objects
    George Tomou, Xiaogang Yan, & J. Douglas Crawford

14. Motor imagery and inhibitory control
    Cathy Agyemang, Lydia Jiang, Scott Glover, & Peter Dixon

15. Dyad practice impacts self-directed practice behaviours and motor learning outcomes in a contextual interference paradigm
    April Karlinsky & Nicola Hodges

16. Multiple saccades in the brain: A proof-of-principle fMRI study
    Bianca Baltaretu, Xiaogang Yan, & J. Douglas Crawford

17. Audiovisual integration in timing and motion judgements is affected by performing a task jointly
Basil Wahn, Jill Dosso, Michelle Tomaszewski, & Alan Kingstone

18. Ethnicity and gender effects in the perception of age in faces
Seyed Morteza Mousavi, Mengqi Chen, & Ipek Oruc

19. Differential engagement of ventral and dorsal attentional regions for lexical versus sublexical reading
Chelsea Ekstrand, Josh Neudorf, & Ron Borowsky

20. Reinforcement contingencies affect pursuit target selection in healthy and Parkinson's disease participants
Gurkiran Mann, Jean-Bernard Damasse, Christina Jones, Martin McKeown, Anna Mottagning, & Miriam Spering

21. Cerebellar tDCS alters motion perception
Jean-François Nankoo, Omar Medina, Tyler Makepeace, Christopher Madan, & Christopher Striemer

22. Touchpoints reveal sensitivity to 2D object shape in an individual with visual agnosia and in another who is cortically blind
Robert Whitwell & James T. Enns

23. We eat first with our eyes; Detection biases for edibles
Mariel Rodriguez-Bellizia, Sofia Osimo, Sebastian Korb, & Claudia Gonzalez

24. The brain as a mirror for understanding actions
Kendra Underhill & Christine Tipper

25. The effect of visual hemifield on global motion perception: A developmental study
Yousef Shahin, Kimberly Meier, & Deborah Giaschi

26. Exploring the relationship between visuospatial and haptic processing
Daniela Aguilar, Jarrod Blinch, & Claudia Gonzalez

27. An eye for detail: Is spatial frequency processing a source for enhanced cortical functioning in people with autism spectrum disorder?
Todd Kamensek, Fakhri Shafai, Grace Iarocci, & Ipek Oruc

28. Exploring communication as actions in human-robot partnerships
Adam Parker & Patrick Pilarski

29. Reach influences gaze kinematics in head-unrestrained Rhesus monkeys during reaching at the visual target task
Harbandhan Arora, Vishal Bharmauria, Xiaogang Yan, Hongying Wang, Saihong Sun, & J. Douglas Crawford

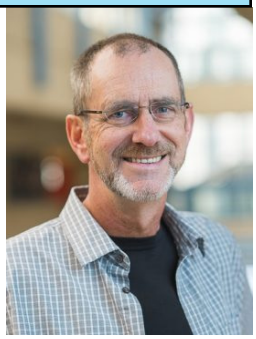
Abstracts

9:00 - 10:00 **CPS J.A.F. Stevenson Award Keynote Lecture: Miriam Spering (UBC)**
Smooth pursuit eye movements as a model of visual prediction

Real-world movements, ranging from intercepting prey to hitting a ball, require rapid prediction of an object's trajectory from a brief glance at its motion. The decision whether, when and where to intercept is based on the integration of current visual evidence, such as the perception of a ball's direction, spin and speed. However, perception and decision-making are also strongly influenced by past sensory experience. We use smooth pursuit eye movements as a model system to investigate how the brain integrates sensory evidence with past experience. This type of eye movement provides a continuous read-out of information processing while humans look at a moving object and make decisions about whether and how to interact with it. I will present results from two different series of studies: the first utilizes anticipatory pursuit as a means to understand the temporal dynamics of prediction, and probes the modulatory role of expectations based on past experience. The other reveals the benefit of smooth pursuit itself, in tasks that require the prediction of object trajectories for perceptual estimation and manual interception. I will conclude that pursuit is both an excellent model system for prediction, and an important contributor to successful prediction of object motion.

Dr. Miriam Spering is an Associate Professor in the Department of Ophthalmology and Visual Sciences at the University of British Columbia.

4:00 - 5:00 **CAPnet Keynote: Jim Enns (UBC)**
We read the body to reveal the mind



When cognitive and movement scientists take the social world seriously it changes the kinds of experiments they do. In my lab that means we study the perception of emotion in others, the perception of social interaction by others, the use of body language in collaborative cognition tasks, and the ability of humans to read others' intentions in the fine grained details of their actions. In each case, the signals reside in the fine-grained kinematics of actors as read by human observers. Studying the perception of body language in these everyday situations is a fun way to keep the fizz in psychophysics.

Dr. Jim Enns is a Distinguished University Scholar Professor in the Department of Psychology at the University of British Columbia.

10:15 - 11:15 **Talk Session 1: Neural Basis of Attention, Perception, and Action (Chair: Anthony Singhal)**

10:15 - 10:30 Cerebellar contributions to spatial and non-spatial visual attention
Christopher Striemer, Brandon Craig, Adam Morrill, Nadia Botha, Britt Anderson, & James Danckert

Over the past 20 years, evidence from functional neuroimaging and human lesion studies indicate that, in addition to its central role in motor control, the cerebellum is also involved in a variety of cognitive functions. Here I will present evidence from functional neuroimaging in healthy adults, as well as data from patients with cerebellar lesions, which demonstrate that the cerebellum is involved in both spatial and non-spatial visual attention. Specifically, functional neuroimaging data suggest that covert attention and eye movements share overlapping neural circuits in the cerebellum, and that these same circuits appear be more strongly engaged by reflexive compared to voluntary covert attention. These neuroimaging findings are further supported by data from two separate patient studies which indicate that damage to the lateral cerebellum slows the orienting of reflexive covert attention, as well as the onset of inhibition of return. However, cerebellar damage appears to have minimal effects on voluntary covert attention. Finally, I will also present data which indicate that cerebellar lesions disrupt the ability to detect targets presented within a series of rapidly presented visual stimuli (i.e., the “attentional blink”). Collectively, these data demonstrate that the cerebellum is involved in both spatial and non-spatial visual attention. Furthermore, these data suggest that damage to the cerebellum may induce a form of “attentional dysmetria,” such that performance may suffer under conditions in which the rapid deployment of attention (either spatial or non-spatial) is required.

10:30 - 10:45 Neural correlates of sensory and motor information retained in parietal area 5 for memory-guided obstacle avoidance in the walking cat
Carmen Wong & Steve Lomber

In complex environments, information about surrounding obstacles stored in working memory is used to coordinate the appropriate movements for avoidance. In quadrupeds, this memory system is particularly important for guiding hindleg stepping over an obstacle once it has passed under the body. In cats, deactivation of parietal area 5 incurs substantial memory deficits, precluding successful obstacle negotiation. To further examine the neural correlates of obstacle memory, floating microelectrode arrays were chronically implanted to record area 5 activity during obstructed and unobstructed locomotion in cats. These recordings revealed a heterogeneous population of units within area 5 with activity that could be modulated as an animal walks, as an animal walks towards or steps over an obstacle, or as an animal stands over an obstacle if obstacle negotiation is interrupted. Sustained activity throughout the delay when obstacle negotiation was paused may represent a neural correlate of working memory maintenance. In some units, this persistent delay activity was differentially modulated by which hindleg would lead obstacle clearance upon resuming locomotion. Such activity likely reflects the working memory maintenance of a specific motor plan to be implemented. In contrast, the activity of other units lacked this movement specificity, instead reflecting the retention of sensory characteristics of the obstacle. Altogether, area 5 appears to maintain both sensory and motor information in working memory to guide obstacle negotiation in the walking cat.

10:15 - 11:15 **Talk Session 1: Neural Basis of Attention, Perception, and Action (Chair: Anthony Singhal)**

10:45 - 11:00 Modulations in oscillations and auditory ERPs as a function of real-world environment
Kyle Mathewson, Eden Redman, Jonathan Kuziek, & Joanna Scanlon

Recent advances in technology have allowed for portable EEG recording in ecologically valid environments such as biking. We have recently recorded ERPs from an auditory oddball task while people rode bicycles outside on a shared-use path, finding decreased baseline alpha, increased N1, decreased P2 amplitude evoked by both targets and standards. In a pair of follow-up studies we have found decreases in P2 amplitude for targets during loud traffic sounds and busy videos recorded outside. Here we find further evidence for environmental effects on early ERP amplitude outside the lab, comparing auditory ERPs within-subject while riding bicycles outside on a shared-use path either beside a 50 km/hr road vs. riding beside a quiet park, with EEG equipment inside a backpack. We found increased N1 amplitude when riding in the quiet park compared to the roadside path. Further, baseline alpha power and P2 were diminished in both outdoor conditions compared to ERPs collected inside. We propose that these early ERP effects are associated with a filtering process required to minimize the influence of ongoing environmental noise.

11:00 - 11:15 Continuous theta burst TMS of area MT impairs attentive motion tracking
Arijit Chakraborty, Tiffany Tran, Deborah Giaschi, & Benjamin Thompson

Multiple object tracking (MOT) is impaired in amblyopia. This deficit has been associated with reduced middle-temporal (MT) cortex activity during MOT task, suggesting the involvement of MT in attentive tracking. To test this possibility, we assessed whether modulation of MT activity using inhibitory continuous theta burst stimulation (cTBS) would influence MOT performance in participants with normal vision.
The MOT stimulus consisted of 4 targets and 4 distractors and was presented at both hemifields. fMRI-guided cTBS was applied to left-MT. Participants (n=15, 27±3years) attended separate active/sham-cTBS sessions. Percent-correct for 40 trials was measured at baseline and 5min and 30min after cTBS. Baseline accuracy did not vary between the two hemifields. There was a significant interaction between cTBS type (active/sham) and measurement time (baseline/post-cTBS 5min/30min). For active-cTBS, there was a significant reduction in accuracy from baseline for the right-hemifield after 5min (10±2% reduction) and after 30min (15±3% reduction). The left-hemifield exhibited improved accuracy 30min after active-cTBS (6±1.5% improvement). For sham-cTBS, accuracy improved in both hemifields equally (right:9±2% and left:9±1.5% improvements). Our results demonstrate that cTBS of MT impaired MOT accuracy. The improvements in MOT accuracy in the control-hemifield and in the sham condition suggest a task learning effect. These results highlight the importance of lower-level motion processing for MOT and support previous findings indicating impaired MT function is responsible for MOT deficits in amblyopia.

11:15 - 12:15	**Talk Session 2: Perception (Chair: Deborah Giaschi)**

11:15 - 11:30 Fixation stability during global motion discrimination tasks
Kimberly Meier, Deborah Giaschi, & Miriam Spering

Beyond the characteristic deficit in visual acuity in one eye, people with unilateral amblyopia show deficits on a range of visual functions including motion perception at slow speeds. These are usually attributed to the abnormal development of low-level visual motion processing mechanisms. However, unstable fixation has been reported in amblyopia, and may impact motion perception by degrading the input received by direction-selective neurons. Here we ask whether poor performance on slow motion tasks can be accounted for by poor fixation stability. We assessed fixation stability in adults with healthy vision and adults with amblyopia during a motion perception task. Participants performed a global motion direction discrimination task with stimuli moving at a slow or fast speed. Dot coherence was controlled with a staircase procedure to obtain coherence thresholds. In a control condition, participants viewed stationary dot patterns. Participants were asked to fixate a central cross throughout the task. Bivariate contour ellipse area and the number of microsaccades on each trial were calculated as indices of stability. Fixation was more stable for the motion discrimination task at either speed, compared to stationary viewing. Participants' overall stability did not predict their coherence thresholds on the motion discrimination task for either speed. Adults show no clear relationship between eye movement stability and global motion coherence thresholds. This suggests fixation instability may not solely account for the motion perception deficits observed in amblyopia.

11:30 - 11:45 To swing or not to swing? The role of eye movements and simple heuristics when making ultra-fast decisions in a go-no go manual interception task
Jolande Fooken & Miriam Spering

Hitting a baseball requires a two-stage decision: batters have to decide whether or not to swing, and when and where to hit the ball. These decisions have to be made ultra-fast, in less than 400 ms, and before the entire trajectory of the ball can be viewed. Here we investigate the role of eye movements in sensorimotor decision making and interception under uncertainty. We developed EyeStrike, a go/no-go manual interception task, in which observers (n=26 varsity baseball players, n=20 non-athletes) had to predict whether a ball would pass through (hit) or go by (miss) a designated strike box. In hit trials, observers were instructed to intercept the target with their index finger in the strike box as accurately as possible. In miss trials, observers had to withhold moving their hand. Only the initial launch (100-300 ms) of the ball was shown, and balls moved at either 36 or 40 deg/s. This task elicits a combination of smooth pursuit and saccadic eye movements. Manual hitting accuracy was best predicted by pursuit eye movement quality (eye position error, velocity gain). By contrast, the decision whether or not to intercept was best predicted by simple heuristics; observers who had a good internal model of hit and miss trial frequencies made more accurate decision. These findings indicate that observers make ultra-fast decisions based on simple heuristics rather than slower and possibly less reliable sensory inputs.

11:15 - 12:15	**Talk Session 2: Perception (Chair: Deborah Giaschi)**

11:45 - 12:00 An enactive approach to perception in reinforcement learning agents
Alex Kearney, Richard Sutton, & Patrick Pilarski

An artificial intelligence agent's ability to represent and perceive its environment is integral to its ability to achieve its goals. Within computational reinforcement learning (RL), there have been many proposals advocating the use of learned predictions about stimuli in the environment to help construct an agent's internal representation of its environment. Further work has proposed the use of abstract predictions to represent more complex, conceptual aspects of the environment. By treating prediction as perception, these methods are not just describing perception in terms of stimuli, but also in terms of the learned behaviours of the agent. This perspective is unique to RL; few other machine intelligence methods describe learning in terms of behaviour learned through experience. Learned predictions encode not just an expected stimulus from the environment, but also the expected stimuli response in terms of the whole agent situated in the environment. Similarly, the enactive approach describes perception not as observations, but as being constituted by sensorimotor knowledge. We do not apply sensorimotor knowledge to experience; instead, our perception is a skillful encounter. Perceptual experience is a skillful exploration of the world. In this work, we analyze the premises behind treating predictions as perception in machine intelligence and contextualize predictions within the enactive view of perception. We describe how taking an enactive view of perception impacts proposals for perception in RL—highlighting the strengths and weaknesses of current proposals—and how the enactive view can be used to propose further avenues of research in machine intelligence.

12:00 - 12:15 Experience-dependent plasticity of somatosensory maps; evidence from hand perception studies
Lara Coelho, Jason Schacher, Cory Scammell, Jon Doan, & Claudia Gonzalez

Tool-use has been found to change body representation. For example, participants who used a rake for 15 minutes, perceived their arms as being significantly longer immediately following its use (Sposito et al, 2012; Neuropsych). The present study investigates the long- and short-term effects of tool use and dexterity training on the implicit representation of the hands (as defined by Longo & Haggard, 2010; PNAS). To investigate this, participants placed their hands underneath a covered tabletop (no vision of their hands), and then they were asked to estimate where they thought ten different landmarks were on their hands by pointing on the tabletop. We tracked each landmark using a 3D motion capture system. In order to answer our research questions we tested 3 groups. The first group included elite baseball players (10 + years of competitive play). We chose to test this group to investigate the long-term effects of tool-use (baseball glove) on hand representation. Our second group was comprised of novice baseball players (no experience playing competitive baseball) from whom hand maps were recorded before and after 15 minutes of ball catching (with a baseball glove). Lastly, to investigate what effect dexterity training has on hand representation we tested a group of expert pianists (10+ years of playing). Our results show that the various experiences change hand maps differently. The results will be discussed in relation to theories of body ownership and brain plasticity.

1:45 - 2:45 **Talk Session 3: Action**
(Chair: Peter Dixon)

1:45 - 2:00 Grasping verbs: Word-class modulates speech and manual action
Nicole van Rootselaar, Marisa Lelekach, Clarissa Beke, Fangfang Li, & Claudia Gonzalez

Previous literature demonstrated an interaction between mouth movement and grasping. Speech is altered when produced during manual action, and vice versa but there is a lack of consistency regarding the interaction (i.e. interference or facilitation). This inconsistency may be partially attributed to the role of semantics, or the meaning of words. Evidence from behavioural and fMRI studies suggest that word class (i.e. verbs versus nouns) differentially affects speech and manual actions. For example, manual reaction time is faster when participants pick up an object and pronounce verbs versus nouns. fMRI studies indicate that verb production activates brain areas responsible for motor execution, a pattern not consistently observed during noun production. We hypothesized that both measures of speech and grasping would show significant differences according to the class of word pronounced. To test this, we did separate experiments in which we measured acoustic change in speech during homonym pronunciation of verb/noun pairs in different grasping conditions and changes in hand movement during speech production. The results demonstrated that while all measures changed significantly compared to control conditions, verb production altered both speech and grasping measures to a greater extent that noun production. These results suggest that the differential processing of verbs and nouns plays a role in mediating the interaction between speech and grasping. In future studies we will expand to include different word comparisons (such as graspable versus non-graspable nouns) to better understand the role semantics plays in the interaction of speech and manual action.

2:00 - 2:15 Deciding while acting: An investigation of decision-making during ongoing action control
Julien Michalski, Andrea Green, & Paul Cisek

Studies of decision-making have focused primarily on situations in which subjects must first make a choice and then report it with an action. However, we often make decisions while we are already acting (e.g., when playing almost any sport) that involve choosing between a current action and a new potential action. Here, we present an experimental paradigm for studying decision-making during ongoing action control. In the “continuous tracking” task, human subjects use a hand-held cursor to track a target that moves in the horizontal plane. At certain moments, a new target choice is presented on the screen. The subjects can either ignore it and continue tracking the current target, or they can choose to switch to the new target, which then starts to move and becomes the tracked target. The placement and timing of the new target is designed to present subjects with decision scenarios that are analogous to situations already well-studied in “decide-then-act” paradigms. We found a strong preference for closer and larger targets, as expected from prior studies, as well as a preference for targets aligned with the axis of hand movement. However, we found no preference for movements incurring lower biomechanical costs, contrary to previous observations in static paradigms. To further investigate this difference in results, we examine a version of the task in which the tracked target jumps discontinuously, as well as a version in which subjects are presented with identical choice scenarios but outside the tracking task context.

1:45 - 2:45	**Talk Session 3: Action** **(Chair: Peter Dixon)**

2:15 - 2:30 Using Lab Streaming Layer to collect synchronized multimodal datasets
Scott Stone, Quinn Boser, T. Riley Dawson, Jacqueline Hebert, & Craig Chapman

Synchronizing multiple data streams is a challenge. Typically, the different data streams are recorded and aligned offline. Alignment usually requires some common event occurring in all streams, which can be difficult if the modalities are vastly different from one another. Using Lab Streaming Layer, we have a created a system which simultaneously records and aligns data from three sources: OptiTrack motion capture, Pupil Labs eye-tracking, and Brain Products electroencephalography . Using this system, we are able to reliably record synchronized data in real-time. This system allows for the collection of automated synchronized datasets across an arbitrary number of sources, allowing for a multimodal look at behaviours typically recorded in one modality. Because all streams are synchronized, we can analyze brain activity or eye gaze (or both) at a particular point during a reach or vice versa. I will present preliminary data recorded from all three streams simultaneously. Using a simple reach-to-transport task, we are able to determine: brain activity for each portion of the reach, eye gaze during each phase of the reach and transport, as well as kinematic information about the body. Future work will improve the ease of data collection, as well as collection in virtual reality environments.

2:30 - 2:45 A flexible software platform for integrating eye tracking and motion capture data for measuring human movement behaviour in a reconstructed 3D environment
Quinn Boser, T. Riley Dawson, Aïda Valevicius, Albert Vette, Patrick Pilarski, Jacqueline Hebert, & Craig Chapman

In recent years, there has been an increase in affordable commercial technology for measuring and analyzing human motion and behavior. An experimental design that leverages this technology by integrating multiple systems promises to provide a powerful tool for quantitative analysis of sensorimotor behaviour, and potentially overcome limitations of stand-alone technologies. For example, when coupled with 3D motion capture data, the accuracy of head mounted eye tracking can be substantially improved, and complex interactions between eye gaze behaviour and object interaction can be extracted with less manual overhead. However, the challenge of synthesizing multiple data streams and analyzing them in combination to compile meaningful metrics is non-trivial. This difficulty is compounded by the sheer amount of data generated by each system. In response we have developed Gaze and Movement Assessment (GaMA), a software platform for reconstructing and visualizing time-synchronous data streams and extracting meaningful measurements of performance. GaMA integrates eye tracking and motion capture data to examine the interactions between eye gaze, human kinematics, and environmental objects in 3D space. GaMA has successfully been used to quantify the differences in movement and eye gaze behaviour between able-bodied and upper limb prosthesis user populations. Through automation, the software platform drastically reduced the amount of time needed for manually processing the total data set. Since this initial proof of concept, we have added a pilot integration to support EEG analysis. Future platform iterations have the potential to dramatically increase our insight into human action, perception and decision making.

3:00 - 4:00	**Talk Session 4: Perception and Action in Self and Other (Chair: Claudia Gonzalez)**

3:00 - 3:15 Shared credit for shared success: Experiences of joint agency during interpersonal coordination
Janeen Loehr

When people perform actions alone, they experience a sense of self-agency, i.e., a sense of control over actions and their effects. Recent research has established that when people coordinate their actions with others, they experience a sense of joint agency, or shared control over actions and effects. Whereas much research has examined the cues that contribute to the sense of self-agency, little research has examined cues that contribute to the sense of joint agency. The current study examined how internal and external cues related to the success of interpersonal coordination influence joint agency. In three experiments, pairs of participants coordinated their actions to produce eight-tone sequences that matched a metronome pace. Across experiments, more successful joint performance (closer match to the required pace) was associated with stronger feelings of joint agency. This relationship was evident whether participants rated their experience of control over the timing of the sequence or their feelings of responsibility for the outcome of the task. Furthermore, the relationship was stronger when participants received external cues to joint success (i.e., veridical feedback about the pair's joint performance) compared to when participants could rely only on internal cues. Together, these findings indicate that a) people derive their sense of joint agency from success at the level of the dyad rather than from egocentric processes, and b) similar to self-agency, cues to joint agency may be weighted according to their salience in a given context.

3:15 - 3:30 How many is too many at a cocktail party? Testing the limits of spatial resolution in complex auditory scenes
Vera Lee, Scott Stone & Matthew Tata

The perceptual, neurobiological and computational mechanisms by which the brain resolves single voices among auditory distraction are not fully understood: this is known as the cocktail party problem. It is known that interaural time differences (ITD) and interaural level differences (ILD) between the ears are key cues used in spatial sound localization, but computational challenges arise. For a given true arrival angle, there are multiple possible locations that might yield the same binaural cues. Head movements may be critical in resolving these ambiguities. When the head rotates, egocentric changes in the ITD and ILD cues leave the sound source fixed in allocentric space, allowing us to resolve the true sound source. The goal of our study was to further explore the role of spatial separation in resolving complex auditory scenes. We developed a simple listening task in which participants counted the number of distinct voices that they heard in free-field. We reasoned that failure to resolve the scene would cause listeners to underestimate the number of voices. We restricted various set-sizes of voices to a single location and found that listeners were unable to resolve the scene. When we did not restrict voices to a singe location, we found that listeners made more errors in judging the number of talkers as set-size increased. This set-size effect was worse when head rotation was restricted, showing that listeners use head movements to resolve spatially complex scenes.

3:00 - 4:00 **Talk Session 4: Perception and Action in Self and Other (Chair: Claudia Gonzalez)**

3:30 - 3:45 Critical properties of a “training set” for visual learning
Swapnaa Jayaraman & Linda Smith

Humans are experts at processing complex visual images. As adults, we have had years of abundant experiences viewing, categorizing, and identifying countless visual stimuli, aiding us in the task of visual processing. However, by 3 months of age, infants show considerable competence – especially for faces – in recognition and discrimination. They do this depite the limitations of their nascent ocular and neural systems. What are the properties of faces in the visual experiences of infants that allow for the development of these skills, and do they change over time? In our present study, we use head camera images collected from 18 infants aged 1-3 months (9) and 7-9 months (9) as they went about their daily activities. The data consists of over 50,000 individually coded frames sampled at 0.2 Hz from 80 hours of infant-perspective scenes. The major finding from this study is that faces in view of very young infants have substantially different visual properties than those experienced by older infants. In early experiences, faces appear more frequently, are closer in view, tend to belong to fewer individuals and are temporally more persistent. This raises the question of whether the properties observed in the face experiences available to young infants are perhaps the ideal visual properties that support all varieties of visual learning. If true, developing such a “training set” for visual learning would have wide-ranging applications such as in machine learning.

3:45 - 4:00 Moving as ongoing decision making
Nathan Wispinski & Craig Chapman

Decision making is a foundational cognitive function, and is often conceptualized as a discrete stage of processing occurring after perception but before movement planning. In contrast with this view, recent studies have shown that decision making can continue past movement initiation to influence how we move in physical space. Here, we propose a computational model and argue that decision making is better conceptualized as an ongoing competition between parallel movement plans, gated by a decision about when to begin moving. This model is able to account for reaction times, choices, changes of mind, and individual reach trajectories in a simple value-based decision making task. Further, our model can generalize to account for information-rich movement trajectories in go-before-you-know and obstacle avoidance tasks. Our findings provide a simple formalization for the powerful idea that decisions are the result of ongoing, graded competition between multiple motor plans from stimuli onset to movement completion.

12:45 - 1:45 **Poster Presentations**

1. Pearls and perils of pupillometry using a webcam
   Mason Kadem & Rhodri Cusack

Current methods to measure infants' cognitive repertoire (i.e., collection of cognitive abilities) are limited. Previous testing paradigms required acquisition of non-age contextualized responses, and relied on measures that involved acquisition of other functions (e.g., language, motor). In addition to response limitations, cognitive functions may be difficult to observe in infants due to the difficulty in infant recruitment. Online testing has increased infant recruitment efforts and physiological responses have bypassed the motor, behavioural and linguistic limitations of infants. Recently, it has been shown that heart rate measures can be acquired through a webcam. Another feasible and reliable physiological measure is pupillometery, the measure of pupil diameter, whereby an increase in pupil diameter corresponds to an increase in cognitive load in response to meaningful stimuli in our environment. Through successive pilot studies over an online interface (i.e., Mturk), we optimized the participants imaging environment. We show that acquisition of pupil diameter is possible over Mturk using our in-house methods. Moreover, we validated our measurement methods as a reliable tool for measuring cognitive load in adults, and as a future means of characterizing cognitive activation in infants. To our knowledge, we are the first to acquire pupil diameter measures through an online interface. The methodologies developed herein can be used as a valid means for acquiring physiological responses in future studies investigating cognition, attention, and memory thereby overcoming current limitations in both acquisition of responses and participant recruitment of infants.

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2. Effects of selective inactivation of the magnocellular visual pathway on visually-guided actions
   Megan McFadyen & Jenni Karl

The action-perception theory proposes that a cortical dorsal stream enables vision-for-action, such as reaching out to grasp an object, while a cortical ventral stream enables vision-for-perception, such as recognizing that object as a cup. There is evidence that subcortical magnocellular (M) and parvocellular (P) visual pathways map on to the dorsal and ventral streams, respectively, but there is no behavioural evidence for this. We hypothesize that if the action-perception theory extends to the subcortical M and P pathways then selective inhibition of the M pathway should impair dorsal stream vision-for-action tasks, but not ventral stream vision-for-perception tasks. Participants will perform a grasping (vision-for-action) task by reaching out to grasp a circular target embedded within an ebbinghaus illusion. They will also perform an estimating (vision-for-perception) task by simply opening their index finger and thumb to match the perceived size of that same target. These tasks will be performed in a white light condition and a red light condition as diffuse red light is known to selectively inhibit the M pathway. Maximum opening of the index finger and thumb will be recorded during both tasks using electromagnetic sensors attached to the participants' fingers. If the action-perception theory extends to the M and P pathways, then it is expected that the accuracy of index-thumb opening will be impaired on the grasping, but not estimating task in the red light condition.

12:45 - 1:45 **Poster Presentations**

3. EEG correlates of the perceived timing of events that trigger actions
Yoshiko Yabe, Melvyn Goodale, & Damian Cruse

Recently, we showed that the perceived timing of a sensory event triggering an action is delayed, as if it were being pulled towards the action (Yabe and Goodale, 2015). To explore the underlying mechanism of this temporal distortion, we measured the perceived onset of the sensory events triggering actions while an electroencephalogram (EEG) was recorded. Participants were required to fixate a clock face with a second-hand rotating at 2560ms/cycle at the center of a computer screen ('Libet Clock' method). In the Action condition, participants were required to make a hand movement when they heard an auditory tone in which the pitch indicated a go trial. They were required to cancel their action when they heard a tone in which the pitch indicated a no-go trial. In the Control condition, they simply listened to the tones passively. The temporal delay associated with preparing an action was calculated by subtracting the reported time (vs. the real time) in the Control condition from the reported time (vs. the real time) in the Action condition. We found that an increase in the right centroparietal alpha-band power in Action condition (compared to the Control condition) was correlated with the delay in the perceived timing of the tone in Action condition compared to the Control condition. This result suggests that activity in the right parietal area, which has been termed the 'when' pathway (Battelli et al., 2007), plays a role in to the perceived onset of sensory events that trigger action planning.

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4. Early human prehension and the importance of the underlying surface
Alexis Wilson, Marisa Bertoli, Chris Wilson, & Jenni M Karl

Multiple Motor Channel Theory postulates that reaching and grasping are separate movements mediated by different neural circuits in the parietofrontal cortex. During early development reach and grasp movements are refined by tactile and proprioceptive control but eventually become integrated under visual control. What remains unknown is how the transition from tactile- to visually-controlled reaching and grasping occurs. Twelve-month-old infants reached to grasp for Cheerios located on either a flat table or a tall narrow pedestal while their arm, hand, and eye movements were filmed from three different angles and analyzed offline using frame-by-frame video analysis. Infants were more likely to contact the target with an appropriate grasping digit, defined as the tip of the index finger or thumb, if they first made contact with the underlying table surface. Measures of postural change, terminal reach velocity, and infant eye fixations revealed that infants did not relying on the underlying surface to terminate the reach movement near the target nor to stabilize their body weight, nor to direct their visual attention towards the target. Together, these results suggest that non-supportive physical contact with an underlying surface may assist 12-month-old infants in transitioning from tactile to visual control of their reach and grasp movements.

12:45 - 1:45 **Poster Presentations**

5. The influence of kinesthetic motor imagery on goal-dependent modulation of the long latency stretch response
Christopher Forgaard, Ian Franks, Dana Maslovat, & Romeo Chua

Upper-limb perturbations elicit short-latency (SLR; 25-50ms) and long-latency (LLR; 50-100ms) responses in stretched muscle. When compensating against the perturbation, the SLR is unaffected and the LLR increases. It remains debated whether LLR modulation results from gain modulation of the contributing neural circuits or is an artefact of a voluntary response superimposing onto the stretch response. It was suggested that a distinction between the reflexive and voluntary mechanisms responsible for goal-dependent LLR modulation may be difficult because both responses engage common supra-spinal circuitry. The LLR reflects the first volley of activity through the circuits that are later engaged by the voluntary response. The present study employed motor imagery to determine whether the overt execution of a voluntary response is a prerequisite for LLR modulation. Participants received a wrist extension perturbation and were instructed to “not-intervene with the perturbation, but imagine yourself compensating against the perturbation as fast as possible and the feeling that this produces”. Imagery trials were compared to “not-intervene” and “compensate” conditions. On ~35% of imagery trials, a partial voluntary response “leaked-out” into the wrist flexor EMG recording. On these trials, the LLR was increased compared to the not-intervene condition and the initial portion (50-75ms) of the LLR appeared similar to compensate trials. However, the LLR on “non-leaked” imagery trials was not different from the not-intervene condition. These findings suggest that the overt execution of a voluntary response is required for goal-dependent LLR modulation.

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6. The novel influence of co-action on a simple attention task: A shift back to the status quo
Jill Dosso, Kevin Roberts, Alessandra DiGiacomo, & Alan Kingstone

There is an increasing consensus among researchers that a complete description of human attention and action must include information about how these processes are informed by social context. For instance, it is important to identify precisely what is shared between co-actors in joint action situations. One group recently found that participants seem to withdraw their attention away from a partner and towards themselves when co-engaged in a line bisection judgment task (Szpak et al., 2016). This result runs counter to the typical finding that attention is drawn toward social (and non-social) items in the environment (Bonato et al., 2008; Toba et al., 2011). As such, the result suggests that joint action can lead to unique changes in the static topography of covert on-screen social attention that are detectable by a line bisection task. This task could therefore act as a simple and elegant measure of interpersonal effects on attention. For this reason, the present work attempted to replicate and extend the finding that attention is withdrawn away from nearby co-actors. Overall, however, our study found no evidence of social attentional modulation with the line bisection task. This suggests that the line bisection task may not be a sensitive or reliable task to measure interpersonal attention effects at the group level. There were suggestions in our data though that the task may be able to detect individual differences in the allocation of spatial attention.

12:45 - 1:45 **Poster Presentations**

7. The effect of stimulus area on global motion thresholds in children and adults
Kevin Chang, Kimberly Meier, & Deborah Giaschi

Coherence thresholds on a global motion task vary as a function of spatial and temporal stimulus parameters. This is of particular interest when studying visual development, because these parameters can have a larger impact on the performance of young children compared to adults. For example, children perform better when presented with a denser dot display whereas adult performance is unaffected. We previously found that coherence thresholds for global motion direction discrimination are immature in 4-6 year olds when smaller spatial displacements are used to create motion, but adult-like with larger values. The current study aims to investigate whether the apparent immaturity in motion perception for small displacements is due to immaturity in spatial integration mechanisms. To this end, we assessed the effect of stimulus area on coherence thresholds for small, medium, and large displacements.
Coherence thresholds were assessed in children (4-6 years old) and adults using a two-choice direction discrimination task with a staircase paradigm. Spatial displacement was 1, 5, or 30 arcmin; stimulus area was 9, 36, or 81 deg2. For each participant, we calculated the change in coherence threshold as a function of stimulus area (the “area effect”) at each spatial displacement.
There was a significant area effect at the largest displacement condition (30 arcmin), such that performance was better for larger stimulus areas. There was no age group effect and no age group by displacement interaction on area effect. Immaturities in global motion perception cannot be accounted for by limitations in stimulus area.

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8. Reading ability of children treated for amblyopia
Laveniya Kugathasan, Marita Partanen, Violet Chu, Christopher Lyons, & Deborah Giaschi

Previous studies have reported compromised reading ability in children with amblyopia, but standardized psychoeducational tests have not been used. Standardized tests are normed with a large sample size and are important for assessing the practical consequences of poor reading ability, such as eligibility for reading supports at school. It is also not clear how amblyopia treatment impacts reading ability. Thus, the goal of this study was to use standardized tests to compare binocular reading performance in children treated for amblyopia to that of a large normative sample, as well as to the types of control groups used in previous studies. Children treated for strabismic or anisometropic amblyopia (N=13) were compared to children treated for strabismus without amblyopia (N=9) and to control children with healthy vision (N=43). Visual acuity, intellectual functioning, single-word reading, and paragraph reading were assessed. The control group performed significantly better than the amblyopia and strabismus groups on both reading tasks, but mean performance for all groups was within the average range of the normative sample. While mean scores were in the average range, 7 children (4 with amblyopia; 3 with strabismus) performed below average (<16th percentile) on at least one reading task. Reading scores were not correlated with visual acuity or with intellectual functioning. The results suggest that both strabismus and amblyopia can disrupt reading ability, even following successful treatment, to an extent that might benefit from reading supports at school.

12:45 - 1:45 **Poster Presentations**

9. Walking in outdoor environments: Using smartphones to assess the relationship between cognitive load and gait dynamics during outdoor walking
Simon Ho, Amelia Mohtadi, Kash Daud, Ute Leonards, & Todd Handy

Many studies have shown a relationship between executive function and gait in elderly populations, however, less is known about the nature of that relationship in young adult samples. University-aged participants were asked to complete the verbal trail making test while walking down a hallway. Gait dynamics were recorded using smartphone-based accelerometry. Findings suggest that gait is negatively impacted when attentional resource competition is high, even in young adult populations.

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10. Sensory attenuation in interpersonal coordination
Nicole Bolt & Janeen Loehr

Sounds that follow self-initiated actions are perceived as less loud and show a reduced neural response compared to sounds produced by an external source. This effect, termed sensory attenuation, is thought to result from sensory prediction. Recent work suggests that a similar predictive process exists when observing others' actions; however, little research has investigated sensory attenuation during interpersonal coordination. The current study tested whether people show attenuation for predictable sounds produced by an interaction partner (social sensorimotor equivalence) or not (social sensorimotor differentiation). Pairs of participants produced four-tone sequences that matched the pace set by a metronome. Participants produced sequences alone, with their partner (alternating actions: ABAB), and listened to a computer produce sequences. Auditory N1 event-related potentials that followed partner tones were not attenuated relative to computer tones. This finding is consistent with social sensorimotor differentiation: When people coordinate their actions with a partner, they distinguish the sensory consequences of their own actions from those produced by their partner.

12:45 - 1:45 **Poster Presentations**

11. Imagined hand-manipulations activate nodes in fronto-parietal network
Christopher Donoff, Christopher Madan, Sarah Elke, & Anthony Singhal

An objective, multiple-choice style test was used to study imagined hand manipulations for both right- and left-handed participants. EEG data was simultaneously recorded to measure how the power of cortical oscillations associated with mental imagery might differ as a function of electrode site, mental imagery accuracy, handedness of stimuli, and participant handedness. Each trial consisted of five written finger-movement instructions that were sequentially presented, followed by a separate display of four line-drawings of hands in different conformations. Only one of the line-drawings was the correct final hand conformation, resulting in an objective way to measure mental imagery accuracy. EEG data was recorded using a 256-channel array, allowing spatial distinctions to be made between alpha- (8 – 12 Hz), beta- (18 – 25 Hz) and theta-band (4 – 8 Hz) power, revealing which imagery processes are recruited. Using the Better OSCillation (BOSC) detection method, the results depicted significantly more alpha-band power over posterior-parietal sites (Pz), compared to central sites for correct versus incorrect trials. A significant increase in frontal-midline theta (Fz) was also detected for correct versus incorrect trials, indicating that working-memory functions were elicited by performing the present hand-manipulation task. From these results, imagining sequences of single-digit hand manipulations activates nodes in the fronto-parietal network, as opposed to the predicted motor-cortex regions with movement imagery tasks. The current task appears to evoke spatial imagery, required for evaluating and manipulating spatial information using mentally generated images.

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12. Parallel planning of multiple responses is behaviourally observable and partially effector-independent
Alice Atkin & Anthony Singhal

Theories about how action decisions occur fall into two categories: serial and parallel. Serial theories claim that decisions are made before the precise movements required to complete the action are specified; thus, only one action is ever planned at once. Alternatively, parallel theories claim that movements can be specified prior to decisions, resulting in multiple potential actions being planned simultaneously. Most experiments designed to test these theories involve cued actions rather than voluntary actions. Cued actions are unusual outside of lab conditions, however, and past evidence suggests that cued and voluntary actions differ behaviourally and neurologically. We therefore performed a series of three behavioural experiments in which participants were presented with reach targets on a touchscreen and allowed to choose their response hand. Experiment 1 presented a target in one of several possible screen locations, with participants producing longer RT for targets presented centrally, where hand use was roughly equivalent, versus laterally where the ipsilateral hand was highly preferred. Experiment 2 introduced a fixation cross prior to target onset to control and vary the visual field that targets appeared in, with participants producing longer RT for targets when saccade direction and reach direction differed. Finally, Experiment 3 introduced a cued response condition to explicitly contrast cued and voluntary actions, with cued responses showing the opposite pattern to that found in Experiment 1 while also being more accurate. Overall, the results of these experiments indicate that people prepare multiple responses simultaneously, and that voluntary and cued actions are behaviourally distinguishable.

12:45 - 1:45 **Poster Presentations**

13. Impact of diverse allocentric cues on transsaccadic integration of multiple objects
George Tomou, Xiaogang Yan, & J. Douglas Crawford

Transsaccadic integration is the ability to synthesize visual information between different stable fixations. In order to do this, the brain must be able to retain and update object locations and features despite relative changes in retinal location produced by saccades. We compared performance in a transsaccadic integration task (e.g., Prime et al. Exp. Brain Res. 2007) with or without the presence of allocentric landmarks. 1-7 Gabor patches with pseudorandom orientations were presented while participants fixated a randomized fixation cross. Following a visual mask, participants were required to saccade to a new location and were asked to identify whether a new Gabor patch presented at one of the same locations was rotated clockwise or counterclockwise from the original orientation. In 50% of the trials, an allocentric landmark was presented throughout the trial. The landmark was: Experiment 1 – a cross positioned pseudorandomly within the stimulus array and extending across the screen; Experiment 2 – circular rings that occupied the spatial location of the stimuli following initial presentation. Results confirmed the expected result that in the absence of the landmark, performance decreased significantly (from a baseline of ~90% correct) as the set size increased ($p < .001$). More importantly, the presence of the landmark ameliorated this decrease, providing significantly better performance for set sizes of 3 and higher ($p = .029$) in the cross condition, but not in the circular ring condition. These preliminary results suggest that egocentric and allocentric mechanisms may combine to provide optimal performance in transsaccadic integration of multiple objects.

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14. Motor imagery and inhibitory control
Cathy Agyemang, Lydia Jiang, Scott Glover, & Peter Dixon

The temporal properties of imagined movements often show comparable effects to overt movements. In this research, we investigated the effects of inhibitory control: When an imagined action is inappropriate, does it need to be inhibited in the same way as an overt action? Here, subjects were asked to move, or imagine moving, either toward or away from the location of a target. Movements away from the target were slower because the natural tendency to move to the target must be inhibited. Critically, the same result was obtained if subjects merely imagined the movement. As well, both imagined and overt movements were slower with more distant targets. These results have implications for the processes common to imagined and overt actions.

12:45 - 1:45 **Poster Presentations**

15. Dyad practice impacts self-directed practice behaviours and motor learning outcomes in a contextual interference paradigm
April Karlinsky & Nicola Hodges

Allowing learners to practice in pairs and choose how to schedule practice (i.e., when to switch tasks) are manipulations shown to benefit motor learning. Here we studied dyad practice to determine whether and how turn-taking with a partner impacts self-directed practice scheduling and learning outcomes. The task was to practice three, 5-keystroke patterns, each with a different timing goal. Participants were assigned to be either Partner 1 (P1) or 2 (P2). P1s followed a blocked (low-switching), random (high-switching), or self-directed practice schedule, while all P2s self-directed practice (~15 pairs/group). Day 1 comprised a pretest, paired practice session where partners alternated turns every 9 trials, and posttest. Day 2 comprised two retention tests (with and without feedback). Participants improved with practice, and based on switching schedules, the self-directed P2s showed both partner-dependent and their own error-dependent practice. P2s switched patterns more often with a random than a blocked or self-directed partner ($p < .001$). P2s were also influenced by the content of their partner's practice (matching the P1's patterns more often with a random than blocked partner). For both partners, random practice resulted in better timing accuracy than blocked practice in the posttest and feedback retention test ($ps < .05$). These data give evidence that self-directed practice behaviours and to a lesser degree learning outcomes are modulated by vicarious practice experiences related to the partner's practice schedule.

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16. Multiple saccades in the brain: A proof-of-principle fMRI study
Bianca Baltaretu, Xiaogang Yan, & J. Douglas Crawford

Neural correlates associated with the production of multiple fast eye movements, or saccades, have been discovered in eye movement areas, such as the frontal eye fields (FEF; Gaymard et al. 1998) and parietal eye fields (PEF; Muri et al. 1996; Medendorp et al. 2001; Sereno et al. 2001). To date, functional imaging studies have uncovered the aforementioned cortical regions as being important for the production and processing of saccades. However, functional studies have employed the use of not only has the single-step, or single saccade, task, but also double- and -triple step tasks (Heide et al. 2001). BOLD signals have never been analyzed in order to dissociate the signal relative to the type of saccade being produced. Here, our aim was to use the principle of previously developed software (Keith & Crawford, 2008) that is able to distinguish neuronal activity (vision, motor, etc.) using BOLD activity. We used a multiple-saccade paradigm. In a typical trial, participants (n=3) made a saccade to an unpredictable location, followed by fixation. In order to determine the cortical regions that are responsive to the production of saccades, we used a Saccade > Fixation contrast. Preliminary results show that each of the participants showed activation in both FEF and PEF. These findings show that these areas not just involved in the production of single saccades, but also of multiple saccades. The next steps are to create a program that can analyze the BOLD activity in these areas and determine the saccade vector produced.

12:45 - 1:45 **Poster Presentations**

17. Audiovisual integration in timing and motion judgements is affected by performing a task jointly
Basil Wahn, Jill Dosso, Michelle Tomaszewski, & Alan Kingstone

Humans constantly receive sensory input from several sensory modalities. Via the process of multisensory integration, this input is often combined into a unitary percept. Recent research suggests that audiovisual integration is affected by social factors (i.e., when a task is performed jointly rather than alone) in a congruency task (Wahn, Keshava, Sinnett, Kingstone, & König, 2017). However, these findings were concerned with reaction time data and thus it cannot be excluded that social factors affected the preparation or execution of the motor response rather than the audiovisual integration process itself. To address this point, we investigated whether social factors affect perceptual judgements in two tasks (i.e., a motion discrimination task and a temporal order judgement task) that previous research has shown to yield reliable audiovisual integration effects which alter perceptual judgements (Soto-Faraco, Lyons, Gazzaniga, Spence, & Kingstone, 2002; Morein-Zamir, Soto-Faraco, & Kingstone, 2003). In both tasks, pairs of participants received auditory and visual stimuli and each co-actor was required to make perceptual judgements for one of the sensory modalities in a joint and an individual condition. We find that audiovisual integration effects are reduced when participants perform the tasks jointly compared to individually. In an additional experiment, this effect did not occur when participants perform the tasks alone while being "watched" by a camera (i.e., an implied social presence). Overall, our results suggest that social factors influence audiovisual integration, and that this effect is specific to live partners and not sources of implied social presence.

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18. Ethnicity and gender effects in the perception of age in faces
Seyed Morteza Mousavi, Mengqi Chen, & Ipek Oruc

Observers recognize own-race faces more easily than other-race faces. This is attributed, in part, to differential experience with faces of unfamiliar ethnicities. Furthermore, differential experience can have an impact on other face perception aspects such as gender categorization. One study found evidence for other-race effects in age perception in African observers, though it was not present in Caucasian subjects (Dehon & Brédart, 2001). We investigated age perception in East Asian and Caucasian observers who viewed 288 faces that ranged from 18 to 89 years old. Average age estimates increased monotonically with the true age of the face stimuli. Age estimation accuracy was maximal for the middle age range, while age was overestimated for younger, and underestimated for older faces. Overall, Caucasian and male faces were perceived to be older than East Asian and female faces, respectively. Females overestimated male faces' age by one year, though males perceived these faces veridically. However, female faces were slightly underestimated by both females and males. Age perception in other-race faces showed a bi-phasic pattern that switched between over- and under-estimation around 42-47 years for both observer groups. East Asian observers rated Caucasian faces older and East Asian faces younger than did Caucasian observers before this range. The pattern reversed after this range. These results reflect physiognomic features in Caucasian and East Asian, as well as female and male, faces that influence age perception. Additionally, they represent evidence of other-gender and other-race effects in age perception.

12:45 - 1:45 **Poster Presentations**

19. Differential engagement of ventral and dorsal attentional regions for lexical versus sublexical reading
Chelsea Ekstrand, Josh Neudorf, & Ron Borowsky

Spatial attention and reading have long been investigated in isolation, however we have recently investigated their behavioural interactive effects (Ekstrand et al., 2016). Neuroanatomically, both reading and attention dissociate along dorsal and ventral streams- lexical reading engaging a left ventral occipito-temporal circuit and sublexical reading engaging a left dorsal temporo-parietal circuit. Similarly, voluntary attention engages a dorsal attentional system, whereas reflexive attention engages a ventral attentional system. However, their neuroanatomical interactive relationship has yet to be explored. We sought to investigate the interactive neural mechanisms of spatial attention and reading using fMRI. Participants performed two hybrid attentional orienting tasks (reflexive and voluntary) where, following the attentional cue, exception word (EXC; lexical reading) or pseudohomophone (PH; sublexical reading) targets were presented. We hypothesized that lexical reading should rely more strongly on reflexive attention, thus showing activation in these areas even in the voluntary task. In contrast, sublexical reading should rely more strongly on voluntary attention, thus activating voluntary attentional areas even in the reflexive orienting task. FMRI results found significantly greater activation in the right temporoparietal junction for EXCs than PHs in the voluntary attention task, suggesting that EXCs engage reflexive attention even under voluntary cuing. Further, PHs showed significantly greater activation than EXCs in the right superior parietal lobule, left visual word form area, and left Broca's in the reflexive orienting task, suggesting that they rely on voluntary attention. These results show that spatial attention and reading interact in different ways depending on the reading strategy employed.

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20. Reinforcement contingencies affect pursuit target selection in healthy and Parkinson's disease participants
Gurkiran Mann, Jean-Bernard Damasse, Christina Jones, Martin McKeown, Anna Mottagning, & Miriam Spering

Voluntary eye movements are sensitive to reward contingencies and allow a continuous read-out of reward processing. Here we investigate eye movement responses to visual targets associated with different probabilities of monetary gain or loss. In a novel task, inspired by the Iowa Gambling Task (IGT, Bechara et al., 1994), observers had to fixate in the screen center while two targets moved towards fixation from different directions. Once the targets reached fixation, observers had to track one of them with their eyes. Importantly, in the main experiment, each target's direction was associated with a different stochastic reinforcement rule, either advantageous, yielding an overall gain across trials, or disadvantageous, yielding an overall loss. In a control experiment, the target was explicitly instructed (e.g. "follow black") with no association between target selection and reward. Participants were patients diagnosed with Parkinson's disease (PD) and tested both ON and OFF medication, and age-matched and young healthy controls. For all groups, choice latency (the delay after which the oculomotor target selection becomes evident) was shortened in the IGT-task compared to the control-task. Moreover, eye movements deviated toward the selected target direction in the anticipatory phase. However, early visually-guided eye movements underwent a significantly stronger bias toward the selected direction in young controls than in PD patients the age-matched controls. The analysis of target selection strategy with respect to the reinforcement rule revealed a consistent impairment in decision-making for PD patients.

12:45 - 1:45 **Poster Presentations**

21. Cerebellar tDCS alters motion perception
Jean-François Nankoo, Omar Medina, Tyler Makepeace, Christopher Madan, & Christopher Striemer

Converging evidence from lesion, brain stimulation and single unit recording studies indicate that the cerebellum plays an important role in motion perception. In particular, research suggests that the cerebellum processes optic flow. Optic flow provides information about body and eye movement that is critical for controlling balance and gait, and for determining direction of heading. However, the specific mechanism by which the cerebellum contributes to optic flow perception remains unclear. In this study, we examined role of the cerebellum in processing optic flow signals by altering the activity of neurons within the cerebellum using transcranial direct current stimulation (tDCS). Specifically, tDCS is thought to increase (using anodal (+) stimulation) or decrease (using cathodal (-) stimulation) the activity of neurons in and around the stimulated area. Performance for up/down and right/left large-field motion displays were measured prior to, during, and post stimulation using random-dot stimuli. Each participant completed three stimulation conditions: sham, anodal, and cathodal. We found that anodal stimulation resulted in a significant increase in performance during and post stimulation for right/left motion. No effect of anodal stimulation was found for up/down motion. In addition, we did not find any effect of cathodal stimulation for either up/down, or right/left motion. These results demonstrate that cerebellar activity can be modulated with tDCS to enhance motion perception, but the direction of motion appears to be a critical factor. The results will be discussed in relation to cerebellar organization and connections with cortical motion areas.

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22. Touchpoints reveal sensitivity to 2D object shape in an individual with visual agnosia and in another who is cortically blind
Robert Whitwell & James T. Enns

Object shape processing is crucial for object recognition and object-directed actions like reaching and grasping. Classic work has shown that information about 3D shape is expressed in the grasp kinematics of individuals with compromised shape perception that followed damage to ventral-stream (Goodale et al. 1991). Recent work with normally-sighted populations has shown that the freely chosen end points from point-to-touch movements directed at simple 2D shapes reveal the shape's medial axis (Firestone & Scholl, 2014). We tested whether or not this phenomenon extends to dorsal-stream representations of shape, by testing DF, who has visual form agnosia resulting from lesions that encompass the shape-sensitive ventrolateral cortical area (LOC) bilaterally, and MC, who is cortically-blind following lesions that also encompass area LOC bilaterally. Each patient touched pebble-like shapes shown on a touchscreen in random positions and orientations. DF and MC could not reliably discriminate amongst the shapes in same/different, oddball, and 1-back tasks, confirming their deficits in visual shape perception. Nevertheless, both DF and MC manually localized the shapes relatively effortlessly. Moreover, DF's and MC's touchpoints each fell significantly closer to the centre-of-mass and the medial axis of each of the shapes, when compared to sampling distributions for squared- and absolute-mean-deviation metrics derived from samples of random points. These findings indicate that, in addition to the centre-of-mass, other shape metrics such as the medial axis inform dorsal-stream mediated visually-guided movements.

12:45 - 1:45 **Poster Presentations**

23. We eat first with our eyes; Detection biases for edibles
Mariel Rodriguez-Bellizia, Sofia Osimo, Sebastian Korb, & Claudia Gonzalez

Every awake moment lots of stimuli impact our retina, and our attention processing system is tasked to ensure we attend to what is relevant. This visual attention is biased for objects that could threat survival such as knifes or snakes. Despite the high-survival value of edible objects, the existence of a visual detection bias for food is still controversial. The present study investigates if human participants have faster visual detection for edible objects versus non-edible objects in two visual attentional tasks. Seventy-eight university students (18 males), gave consent to participate in the study. In Experiment 1, 34 participants were presented with pictures of 80 edible and 80 non-edible objects on a computer screen with a blank background. Stimuli were further subdivided into man-made or natural (e.g. pizza versus broccoli or ball versus pinecone). To increase the difficulty of detection, in Experiment 2 (44 participants) stimuli were embedded in a high colorful mask background. Within each Experiment half of the participants responded to the location of the object (left or right of a central fixation cross; Covert condition) whereas the other half of the participants responded if the object was edible or non-edible (Overt condition). Reaction times were faster for edible objects versus non-edible objects regardless of experiment or condition. Interestingly, a trend for an interaction between 'edibility' and the category (man-made and nature) was observed. Participants responded faster for man-made food stimuli than for natural, whereas no such difference was found for non-edibles.

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24. The brain as a mirror for understanding actions
Kendra Underhill & Christine Tipper

This fMRI study investigated brain processes underlying action understanding as a step toward elucidating the brain basis of social and cognitive deficits associated with developmental disorders such as autism spectrum disorder (ASD). We tested whether a hypothesized system of sensorimotor neurons that fire both when actions are seen and performed, known as the "mirror neuron system" and thought to support action understanding, plays a direct role in the neural coding of the physical means and/or the outcome of an action. We recorded fMRI while participants performed a virtual reality task in which complex action sequences were either observed or executed. fMRI repetition suppression (RS) analysis identified neuronal populations that responded identically regardless of whether the means or outcomes of and action were seen or performed (i.e., their activity was agent-independent). Using constrained principal component analysis on brain regions showing RS across instances of action observation and execution, we identified distinct functional networks that exhibited agent-independent RS ($p < 0.05$) for coding action means and outcomes. This suggests that social understanding is achieved in part by the brain "mirroring" observed actions in sensorimotor systems that would be engaged as one performs that same action oneself.
The results provide evidence that means and outcomes - two distinct aspects of action representation contributing to social understanding - are decoded by distinct neuronal populations that exhibit mirror neuron-like responses.

12:45 - 1:45 **Poster Presentations**

25. The effect of visual hemifield on global motion perception: A developmental study
Yousef Shahin, Kimberly Meier, & Deborah Giaschi

The traditional view of visual processing is that form perception is mediated by the ventral pathway and motion perception is mediated by the dorsal pathway, but this view is probably too simplistic (e.g., the ventral pathway is implicated in the processing of slow motion). Recently, a lateral motion pathway that is distinct from the dorsal and ventral pathways has been proposed. This distinction is partly based on the different visual field representations in the dorsal (lower field), ventral (upper field), and lateral (full-field) pathways. As a preliminary test of the lateral pathway hypothesis, we assessed global motion perception in children and adults with stimuli presented to the central, upper or lower visual fields. For centrally-presented stimuli, motion perception in 7 to 9-year-olds is adult-like for fast speeds but immature at slow speeds. The current study determined if visual field location affects this developmental pattern for up/down and left/right motion direction discrimination. If the immaturity at slow speeds reflects the protracted development of the dorsal pathway, we would expect it to occur in the lower and central, but not the upper visual field. Instead, children performed worse than adults in all conditions. These results are not consistent with exclusive processing of global motion by either dorsal or ventral pathways. This work advances our understanding of normal mechanisms of human motion perception, and has implications for understanding the disruption of global motion perception in developmental disorders that is often attributed to dorsal pathway vulnerability.

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26. Exploring the relationship between visuospatial and haptic processing
Daniela Aguilar, Jarrod Blinch, & Claudia Gonzalez

Right hemisphere dominance for visuospatial and haptic functions is well known. But no research has been done to investigate if there is a relationship between the two. In other words, do people with better visuospatial abilities display enhanced haptic processing and vice-versa? Right-handed participants were divided into four age groups: 5-8 years old (n=28), 9-12 years old (n=25),13-17 years old (n=24) and 18-25 years old (n=97). To assess visuospatial abilities, we employed the Shepard and Metzler mental rotation test, a visual search task, and a novel Lego-based test combining mental rotation and visual search. To assess haptic processing an object-recognition task was employed, which involved the use of left and right hands. Significant correlations were found between the two domains in all age groups. Additionally, the 5-8 age group executed the haptic task significantly faster with the left hand than with the right hand. Although, the left hand was faster than the right hand in the 9-12 and the 13-17 age groups this difference was not significant. In the 18-25 age group both hands were virtually identical. We suggest that shared mechanisms support visuospatial and haptic processes. Their relationship was exhibited in children, adolescent and young adult stages. Moreover, our results suggest a strong right hemisphere dominance for haptic processing in younger children, which lessens as age increases.

12:45 - 1:45 **Poster Presentations**

27. An eye for detail: Is spatial frequency processing a source for enhanced cortical functioning in people with autism spectrum disorder?
Todd Kamensek, Fakhri Shafai, Grace Iarocci, & Ipek Oruc

Autism Spectrum Disorder (ASD) is a developmental disorder characterized by deficits in social-communication and interaction in addition to resitricted and repetitive behaviour and interests (APA, 2013). Despite these deficits, studies have shown superior performance in various visual tasks, such as visual search (O'Riordan et at. 2001) and embedded figures (Shah and Frith 1983). It has been suggested that these atypicalities can be attributed to enhanced functioning of low-level perceptual processes (Mottron et al, 2006). In the present study we examined visual processing of spatial frequency (SF) as a potential source for enhanced perceptual functioning (EPF). We employed three experiments to asses three aspects of SF perception: sensitivity, precision, and accuracy. In Experiment 1, using a 2-interval forced choice (2-IFC) detection paradigm, contrast sensitivity was measured at eight SFs (1-24 cpd). In Experiment 2, we assessed precision as a function of spatial frequency via a 2-IFC discrimination paradigm. In Experiment 3, accuracy of SF perception was assessed via a method-of-adjustment paradigm. Finally, in Experiment 4 we implemented a search experiment that has reliably demonstrated superior performance in ASD. No evidence for EPF was found in any of our three experiments examining SF perception in ASD (N=20) compared to age-, gender-, IQ-matched controls (N=20). Also, results from the search experiment failed to replicate previous findings of superior performance in ASD. These findings suggest that enhanced low-level visual processing is not a source of EPF in ASD.

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28. Exploring communication as actions in human-robot partnerships
Adam Parker & Patrick Pilarski

Agents regularly interact via movement and action in order to accomplish shared objectives. More generally, humans use their actions throughout ongoing interactions to convey information to each other, as do other animals. Seeing eye dogs are one such
example where a human and animal agent need to interact in a regular and non-verbal way, communicating via movement and body language to achieve a shared task. In this work, we consider a related, emerging area of dyadic agent interaction: a human interacting with a learning machine, in particular, an assistive machine like an upper-limb robotic prosthesis intended to learn and adapt to better support the human in their daily life. In this setting the robot agent often has no means of taking certain actions directly, even if its observations would allow it to improve the ability of the human-machine partnership; it must rely on communication with the human to improve performance in real-world tasks. In this way, communication on the part of the machine can be seen as actions with potentially causal effects. This work therefore examines how a machine-learning agent in an assistive robot might use communication as actions to work with a human user to accomplish the partnership's goals. As a primary contribution, we outline a new experimental domain and preliminary results demonstrating the value of this communication to the human user, along with an interesting experimental framework to examine how the learning agent might learn how to communicate rather than simply what.

12:45 - 1:45 **Poster Presentations**

29. Reach influences gaze kinematics in head-unrestrained Rhesus monkeys during reaching at the visual target task
Harbandhan Arora, Vishal Bharmauria, Xiaogang Yan, Hongying Wang, Saihong Sun, & J. Douglas Crawford

Non-human primates have been used extensively as animal models for human eye-head coordination and eye-hand coordination within a 2-D plane, but the more natural condition of eye-head-hand coordination during a 3-D reach has not been studied. Our goal here was to determine if reaching influences eye-head coordination, and vice versa. Eye, head, and hand motion were recorded in two rhesus monkeys using search coil and touch screen technology, respectively. Animals were seated in a customized ‘chair’ which allowed the head to move freely and the hand to reach in both depth and direction. In the reach condition, monkeys were trained to initially touch a central LED at the waist level and maintain gaze for 400-800 ms on a central fixation point. When the fixation light was extinguished, animals were required to reach toward a target appearing at one of 15 locations in a 40° horizontal x 20° vertical (visual angle) array. In other conditions, initial hand and gaze position were varied in the horizontal plane. Animals were rewarded for touching the target. Similar task was also performed for making only gaze shift towards the target. Saccade reaction times reduced from means of 185/131ms in the gaze control to 152/109 ms in the reach condition in animals’ A/B respectively, and the head moved more in the reach condition significantly $p<0.001$. This data show as if eye-head coordination was disinhibited and/or driven more by reaching.