Canadian Neuroscience Meeting Satellite Symposium

Montreal Hilton Bonaventure

Sunday May 25, 2014

9:00AM to 4:45PM

Centre for Applied Mathematics in Bioscience and Medicine

Canadian Physiological Society

CAPNET Canadian Action and Perception Network

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

Institute of Neurosciences, Mental Health and Addiction

Réseau de recherche en santé de la vision

Vision Health Research Network of Quebec

York Université University

Program Schedule

9:00 - 9:15 **Introductory Remarks and Acknowledgements (Erik Cook and Doug Crawford)**

9:15 - 10:30 **Session I (Doug Crawford, Chair)**

9:15 - 9:30 NOISE CORRELATIONS AND CODING DURING SPATIAL WORKING MEMORY
M. Leavitt and J. Martinez-Trujillo
McGill University

9:30 - 9:45 FUNCTIONAL ROLE OF CROSS FREQUENCY COUPLING IN PREFRONTAL AND ANTERIOR CINGULATE CORTICES DURING ATTENTIONAL SELECTION
B. Voloh and T. Womelsdorf
York University

9:45 - 10:00 PATIENT DF'S VISUAL BRAIN IN ACTION: THE ROLE OF TACTILE AND VISUAL FEEDBACK
R. Whitwell, A. Milner, C. Cavina-Pratesi, M. Barat, and M. Goodale
University of Western Ontario

10:00 - 10:15 INCREASES IN ALPHA AND BETA SYNCHRONIZATION FOUND IN PEOPLE WITH PARKINSON'S DISEASE FOLLOWING DANCE CLASS
G. Levkov, P. Di Noto, R. Bar and J. DeSouza
York University

10:15 - 10:30 MICRO-STIMULATION OF PREMOTOR AND MOTOR CORTEX AFFECTS CHOICE DURATION DURING DYNAMIC DECISION-MAKING
D. Thura and P. Cisek
Université de Montréal

10:30-11:00 **Coffee Break**

11:00-12:15 **Session II (Ravi Menon, Chair)**

11:00 - 11:15 LOCAL ADAPTATION OF FEEDBACK RESPONSES AND VOLUNTARY REACHING MOVEMENTS
T. Cluff and S. Scott
Queen's University

11:15 - 11:30 NEURAL LIMITS OF VISUAL MOTION-CORRELATION DETECTION
A. Golzar, P. Boyraz, B. Tripp and E. Cook
McGill University

11:30 - 11:45 CHANGES IN CONTRAST RESPONSES OF CELLS IN THE PRIMARY VISUAL CORTEX AFTER DEACTIVATION OF THE PULVINAR
J. Lai and C. Casanova
Université de Montréal

11:45 - 12:00 WEAK VISUOMOTOR ADAPTATION IN THE RAPID ONLINE CORRECTION MECHANISM FOR VISUALLY-GUIDED REACHING MOVEMENTS
S. Durocher, V. Gritsenko and J. Kalaska
Université de Montréal

12:00 - 12:15 THE ROLE OF THE SUPERIOR COLLICULUS IN THE COORDINATION OF THE PUPIL ORIENTING RESPONSE
C-A. Wang and D. Munoz
Queen's University

Program Schedule

12:15 - 1:15	**Lunch Break**
1:15 - 2:30	**Session III (Andrea Green, Chair)**
1:15 - 1:30	A BRAIN NETWORK FOR STRATEGIC DECISION-MAKING A. Parr, B. Coe, D. Munoz and M. Dorris Queen's University
1:30 - 1:45	VISUAL REMAPPING IS MORE IMPAIRED IN PATIENTS WITH UNILATERAL PARIETAL LESION THAN IN HEMIDECORTICATE PATIENTS AS REVEALED BY NOVEL VERSION OF THE DOUBLE STEP TASK K. Rath-Wilson and D. Guitton McGill University
1:45 - 2:00	GAMMA COHERENCE ACCOMPANIES RECEPTIVE FIELD REMAPPING IN MONKEY AREA V4 S. Neupane, D. Guitton and C. Pack McGill University
2:00 - 2:15	CORTICAL MECHANISMS UNDERLYING MOTOR PREDICTION R. Hermosillo and P. van Donkelaar University of British Columbia
2:15 - 2:30	ALLOCENTRIC VERSUS EGOCENTRIC REPRESENTATION OF REMEMBERED REACH TARGETS IN HUMAN CORTEX Y. Chen, S. Monaco, P. Byrne, X. Yan, D. Henriques and D. Crawford York University
2:30 - 3:00	**Coffee Break**
3:00 - 3:45	**Session IV (Erik Cook, Chair)**
3:00 - 3:15	NEURAL ENCODING OF LINEAR SELF-MOTION BY OTOLITH AFFERENTS M. Jamali, J. Carriot and K. Cullen McGill University
3:15 - 3:30	TOOL INCORPORATION IN THE BODY REPRESENTATION: DO TOOLS BECOME HANDS IN OUR BRAIN? L. Cardinali and J. Culham University of Western Ontario
3:30 - 3:45	EVIDENCE FOR A THREE-DIMENSIONAL TRANSFORMATION OF VESTIBULAR SIGNALS INTO BODY-CENTERED COORDINATES IN THE ROSTRAL FASTIGIAL NUCLEI C. Martin, J. Brooks and A. Green Université de Montréal
3:45 - 4:30	**Special Keynote Presentation:** WHAT SIMULTANEOUSLY RECORDED NEURONS CAN TELL US ABOUT HOW ATTENTION IMPROVES PERCEPTION Marlene Cohen University of Pittsburgh
4:30 -	**Discussion and Departures (evening social activities TBA)**

9:15 AM, Sunday May 25, 2014

NOISE CORRELATIONS AND CODING DURING SPATIAL WORKING MEMORY

M. Leavitt and ***J. Martinez-Trujillo***
Department of Physiology, McGill University

Neurons in the primate dorsolateral prefrontal cortex (dlPFC) are known to exhibit selective activity during the delay period of spatial working memory (SWM) tasks. It has been hypothesized that functional interactions between these units may be involved in SWM maintenance, but whether and how these units interact with each other remains poorly understood. In order to investigate this issue, we recorded responses of multiple single units in dlPFC area 8r of two macaca fascicularis using microelectrode arrays. The task consisted of fixation on a central spot for 494-800ms, presentation of a circular sine wave grating at one of 16 randomly selected locations for 506ms, then offset of the grating followed by a delay period that could last between 494-1500ms, and ended with the offset of the central fixation point, cuing the animals to make a saccade to the remembered stimulus location. We recorded the activity of neurons in blocks of 32 channels and sorted spikes using Plexon software (Plexon Inc, TX). We isolated responses of 201 single units for a total of 1319 neuronal pairs. Neurons were classified as being selective for the spatial location of the stimulus during the delay period using a linear decoder (n = 133, or 66%). We then computed spike-rate correlations and found that interactions between neurons in the dlPFC vary based on task epoch and neurons' selectivity. Both positive and negative (anti) correlations increase during working memory maintenance. Positive correlations are larger between cells with similar tuning compared to cells with dissimilar tuning, while negative correlations increase between cells with dissimilar tuning.

9:30 AM, Sunday May 25, 2014

FUNCTIONAL ROLE OF CROSS FREQUENCY COUPLING IN PREFRONTAL AND ANTERIOR CINGULATE CORTICES DURING ATTENTIONAL SELECTION

B. Voloh [1] and ***T. Womelsdorf*** [1]
[1] Department of Biology, York University, Toronto, Canada

Selective visual attention is subserved by cortical oscillations in the gamma band (30---100 Hz)[1], while slower theta oscillations (4---10 Hz) have been implicated in long---range networks involved in stimulus expectancy and the preparation of attentional stimulus selection [2]. It remains an open question whether interactions between these oscillations – i.e. cross frequency coupling (CFC) – has a functional role in prefrontal and anterior cingulate cortices (PFC and ACC), structures responsible for implementing attentional election and updating top---down task representaitons in order to guide behavior [3].

We analyzed simultaneous local field potential recordings from the macaque PFC and ACC performing a selective attention task. Successful shifting of attention during task performance required the temporally coordinated integration of diverse neural assemblies encoding separate stimulus modalities and top---down information. We used the modulation index (MI) to test for CFC [4]. Across all recorded channel pairs, there was a significant increase in MI after attention cue onset between the phase of a 7 Hz band and the amplitude of a 40---45 Hz band. Channel pairs that showed a significant increase in theta---gamma coupling were widely spatially distributed, occurred both within and between areas, and were inhomogeneously represented across all area combinations.

These results suggest that coupling between theta and gamma frequencies could index efficient long---distance coordination of spatially segregated local circuitry involved in encoding internal expectancies and external salient sensory features in order to switch attention.

[1] Womelsdorf, T. et al (2006). Nature. 439:733---6.
[2] Phillips, J et al (2013). Cereb. Cortex (epub).
[3] Lisman & Jensen (2013) Neuron. 77(6):1002---16.
[4] Tort, A et al. (2010). J Neurophysiol. 104:1195---1210

9:45 AM, Sunday May 25, 2014

PATIENT DF'S VISUAL BRAIN IN ACTION: THE ROLE OF TACTILE AND VISUAL FEEDBACK

R. Whitwell [1,2,3], ***A. Milner*** [4], ***C. Cavina-Pratesi*** [4], ***M. Barat*** [3,5], and ***M. Goodale*** [2,3,5]
[1] The Graduate Program in Neuroscience, The University of Western Ontario, London, Canada
[2] The Department of Psychology, The University of Western Ontario, London, Canada
[3] The Brain and Mind Institute, The University of Western Ontario, London, Canada
[4] Department of Psychology, Durham University, Durham, UK.
[5] The Department of Physiology and Pharmacology, The University of Western Ontario, London, Canada

Patient DF, who developed visual form agnosia following ventral stream damage, configures her hand in flight to match the geometric properties of novel objects when picking them up, despite her inability to use these same properties to explicitly differentiate amongst these objects. We have proposed that her spared grasping is mediated by a feedforward visuomotor system housed within the posterior parietal cortex. Alternatively, DF might use haptic feedback from grasping the objects to calibrate egocentric visual cues to the object's surface, or she might use visual feedback during the grasp to appropriately scale her in-flight hand aperture to the target's size. To test these alternatives, we devised a grasping task that disrupted visual-haptic calibration by varying the visual size of the target from trial to trial while keeping its felt size constant. In a second condition, we removed visual feedback by suppressing her vision throughout her grasping movement. If the alternative accounts were true, DF's grasps should no longer reflect the visual size of the goal objects. Contrary to their predictions, however, DF continued to scale her grip aperture to the visual sizes of the targets. Furthermore, providing haptic feedback about perceptual judgments of visual size did not improve her chance performance. Together, these findings strengthen the proposal that DF's spared grasps are driven by visual feedforward processing. They also suggest that tactile contact with an object keeps DF's residual visuomotor system engaged, preventing the grasps from defaulting to pantomimes.

10:00 AM, Sunday May 25, 2014

INCREASES IN ALPHA AND BETA SYNCHRONIZATION FOUND IN PEOPLE WITH PARKINSON'S DISEASE FOLLOWING DANCE CLASS

G. Levkov [1,2], ***P. Di Noto*** [2,3,4], ***R. Montefusco-Siegmund*** [2,3], ***R. Bar*** [5] and ***J. DeSouza*** [1,2,3,4,6]
[1] Department of Biology, York University
[2] Centre for Vision Research, York University
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[4] Neuroscience Graduate Diploma Program, York University
[5] Canada's National Ballet School, Toronto, Canada
[6] Canadian Action and Perception Network (CAPnet), Canada

Parkinson's disease (PD) is a neurodegenerative disorder that causes motor and non-motor symptoms, some of which have been improved as a result of exercise. Although dance has been shown to alleviate motor symptoms more so than exercise, an understanding of the neural changes associated with these improvements remains elusive. In order to examine this, we have recorded two 180-second resting state EEG (rsEEG) sessions from participants of the Dancing with Parkinson's program offered at Canada's National Ballet School. rsEEG sessions were recorded before and after a single dance class, with an eyes open (EO) and eyes closed (EC) condition presented randomly. To date we have tested seven subjects: 6 with PD (3 females, mean age = 71.7 years) and one control (female, age = 67 years). Contrary to previous evidence that found no significant changes in alpha and low beta pre/post exercise in an elderly sample (Moraes et al. 2011), we found significant increases in alpha power (8 – 13 Hz) in the F7 and FC5 electrodes in the EO condition ($p < 0.05$), and increases in AF3 and F3 in the EC condition ($p < 0.05$) for people with PD after dance class. Increases in low beta power (13 – 20 Hz) were also observed in the F7 electrode in the EO condition ($p < 0.05$), suggesting increased brain activity due to dance. These preliminary results, which we are continually adding to each week, suggest that the effects of dance on oscillatory brain activity are stronger than exercise, and that dance has beneficial effects for people with PD.

10:15 AM, Sunday May 25, 2014

MICRO-STIMULATION OF PREMOTOR AND MOTOR CORTEX AFFECTS CHOICE DURATION DURING DYNAMIC DECISION-MAKING

D. Thura and ***P. Cisek***
Département de Neurosciences, Université de Montréal

Our previous work shows that in a task during which relevant sensory information for an action choice varies with time, many premotor (PMd) and primary motor (M1) cortex neurons reflect the evolution of the sensory information and reach a peak at decision time, suggesting that these structures are directly involved in deliberation and commitment to an action choice. To test this hypothesis further, we perturbed the activity of neurons in PMd and M1 using brief pulses of sub-threshold micro-stimulation.

One monkey performed a reaching decision task in which sensory evidence continuously evolves during the time course of a trial. In different blocks, the temporal properties of the task were varied to induce adjustments of monkey's speed-accuracy trade-off. On about 2/3 of trials, we stimulated sites in either PMd or M1 where we had recorded task-related neurons, to test the role of these regions in the deliberation and commitment process. Stimulation time was varied to either occur at the trial onset, 800 ms or 1400 ms later.

When applied very early in the trial, we found that micro-stimulation in PMd tends to shorten decisions, especially in conditions where the monkey favors decision speed over accuracy. This effect was not found when stimulating in M1. When applied later in a trial, stimulation in either PMd or M1 slowed down the decision process regardless of speed-accuracy trade-off conditions

These results provide evidence that PMd and M1 are directly involved in the process of deliberating about and committing to a choice between actions.

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11:00 AM, Sunday May 25, 2014

LOCAL ADAPTATION OF FEEDBACK RESPONSES AND VOLUNTARY REACHING MOVEMENTS

T. Cluff [1] and ***S. Scott*** [1,2]
[1] Centre for Neuroscience Studies, Queen's University
[2] Department of Biomedical and Molecular Sciences, Queen's University

A hallmark of voluntary motor control is the ability to adapt our motor patterns to physical loads applied to the limb. This adaptation generalizes to movements that differ in amplitude, direction, and speed, with the amount of learning decaying rapidly with the distance from the training conditions. In parallel, recent studies have highlighted feedback responses that mirror the adaptation of voluntary behaviour, leading to the hypothesis that feedback responses should exhibit the same learning patterns expressed during voluntary actions. Here we investigate whether feedback responses compensate for novel interaction loads, and then measure how these adapted responses transfer across conditions requiring identical or different joint motion patterns. Participants reached to two targets while adapting to loads that altered the relationship between elbow and shoulder motion. On random trials, we applied elbow perturbations while subjects reached to a probe target that required only shoulder motion. We found that, as subjects adapted their reaching patterns, shoulder muscle responses compensated for the novel interaction loads. Importantly, these adapted feedback responses generalized when subjects reached from different workspace locations to targets requiring identical joint motion patterns, but this transfer was non-existent when joint motion patterns differed from the training task. We propose that a common learning mechanism governs the adaptation of feedback control and voluntary action, and produces learning that is localized and sensitive to the training conditions.

11:15 AM, Sunday May 25, 2014

NEURAL LIMITS OF VISUAL MOTION-CORRELATION DETECTION

A. Golzar [1], ***P. Boyraz*** [2], ***B. Tripp*** [3] and ***E. Cook*** [1]
[1] Department of Physiology, McGill University
[2] Department of Engineering, University of Leicester
[3] Systems Design Engineering, University of Waterloo

The visual system effortlessly computes spatio-temproal relationships between various local features of the visual scene. It has been widely shown that increased temporal correlations between elements of a visual object enhances psychophysical performance in figure-ground segregation and edge detection. The goal of our study was to understand the neural mechanisms that underlie the computation of visual motion-correlations.

We trained three macaque monkeys to detect temporal correlation between two non-overlapping random dot patches (RDP). The RDPs moved in either the preferred or null direction of the neuron under study, and a trial began with no temporal correlation between the two RDPs. When the two RDPs started moving in a correlated fashion the animals had to release the lever. During the task we recorded from 91 pairs of MT neurons using two electrodes separated 1-4 mm on the cortex. We optimized the speed and the direction of each motion stimulus to the preferred speed and direction of each neuron.

We found that the ability of the animals quickly to detect the correlated motion quickly decreased for temporal frequencies above 10Hz. We also found that the link between neural responses as a function of temporal frequency showed the same critical frequency at 10Hz. However, we found that the entire range of stimulus temporal frequency is encoded with an equal power in area MT that goes beyond 10 Hz. Taken together, these findings suggest that the temporal correlations are computed downstream to area MT.

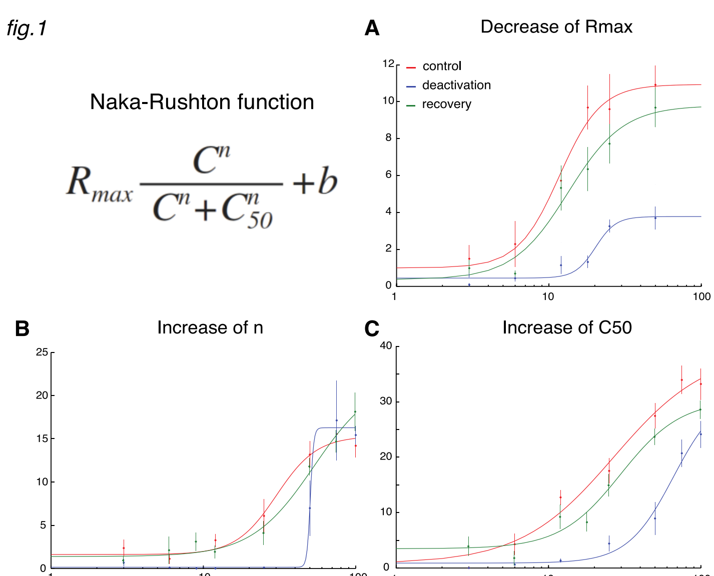
11:30 AM, Sunday May 25, 2014

CHANGES IN CONTRAST RESPONSES OF CELLS IN THE PRIMARY VISUAL CORTEX AFTER DEACTIVATION OF THE PULVINAR

J. Lai and ***C. Casanova***
École d'optométrie, Université de Montréal

The pulvinar establishes reciprocal connections with nearly all visual cortical areas and is thus in a strategic position to influence their stimulus decoding processes. Projections from the pulvinar to the primary visual cortex (V1) are considered to be modulatory, altering the response of neurons without changing their basic receptive field properties. Results from our laboratory, based on optical imaging, had lent support to this assumption (*Soc. Neurosci. Abst.* 2011. Vanni et al.). Here, we investigate further this issue by studying V1 single unit responses during the reversible deactivation of the lateral posterior (LP) - pulvinar complex in the cat through microinjections of gamma-aminobutyric acid. Recording and injection electrodes were positioned to obtain overlapping thalamic and cortical receptive fields. Results are as follows: no change in the preferred orientation or direction selectivity of V1 neurons was observed during pulvinar deactivation. However, for 67% of the cells tested (n=39/58), the response amplitude to the optimal stimulus was reduced by a mean of 65%. The contrast response function of neurons was modeled with the Naka-Rushton function and analysis of the effects of pulvinar deactivation revealed at least three types of modulation based on the function parameter predominantly affected: 24% of cells had a decrease in R_{max}, 13% had an increase in the exponential factor and 11% had a C^{50} increase. Our results suggest that the pulvinar modulates activity of V1 neurons in a contrast-dependent manner.

Supported by CIHR grant #MOP231122 to CC.



V1 responses to contrast were fitted using the Naka-Rushton function. $R_{max}C^n/(C^n + C_{50}^n) + b$, where R_{max} is the peak response, C is the contrast of the grating, b is the baseline response, n is the exponent of the power function and C_{50} is the contrast value at 1/2 R_{max}. (A-C) Graphs illustrating results for the most predominant changes in the parameters of the function after pulvinar deactivation.

11:45 AM, Sunday May 25, 2014

WEAK VISUOMOTOR ADAPTATION IN THE RAPID ONLINE CORRECTION MECHANISM FOR VISUALLY-GUIDED REACHING MOVEMENTS

S. Durocher, ***V. Gritsenko*** and ***J. Kalaska***
GRSNC, Département de Neurosciences, Université de Montréal

It is widely presumed that the motor system (MS) uses circuits that represent the visuomotor mapping between arm and target location to plan and initiate the proper reaching movement to the target.

The MS also has many feedback circuits such as the “rapid online correction mechanism” (ROCM) that is recruited if the target unexpectedly changes position after the onset of a reach. The ROCM must also know the visuomotor mapping between sensory input and motor output, but it is still not clear if the mapping circuits for planning and online correction are shared or independent.

We used two different visuomotor dissociations (mirror and complete inversion) to compel subjects to adapt the mapping circuits involved in the planning/initiation of reaching movements. We also presented rare “probe” trials, in which the target jumped 10° CW or CCW to assess whether the mapping of the ROCM also adapted at the same time.

Our results suggest that after extensive practice of a visuomotor dissociation, subjects readily adapted their planning of the initial reach direction, but failed to adapt their ROCM, which would have been expected if the same mapping circuit was used for the initial planning and online correction. Instead, subjects seemed to suppress or diminish the gain of the normal ROCM response in the direction of the visual target displacement, while applying a late appropriate mirror or inverse correction. Our findings are consistent with at least partially independent visuomotor mapping circuits for reach planning and online correction.

12:00 PM, Sunday May 25, 2014

THE ROLE OF THE SUPERIOR COLLICULUS IN THE COORDINATION OF THE PUPIL ORIENTING RESPONSE

C-A. Wang and ***D. Munoz***
Centre for Neuroscience Studies, Queen's University

Pupil size, as a component of orienting, changes rapidly in response to local salient events in the environment in addition to an illumination-dependent modulation. A growing body of evidence suggests that the superior colliculus (SC) encodes stimuli based upon saliency to coordinate the orienting response. Although the SC is involved causally in the initiation of saccadic eye movements and attention, its role in coordinating other components of orienting is less understood. Here, we examined how pupil dynamics are modulated by the SC and stimulus saliency. While requiring subjects to maintain central fixation, we either presented a salient visual, auditory, multisensory stimulus or delivered weak electrical microstimulation to the intermediate SC layers (saccades were not evoked). Transient pupil dilation was elicited after presentation of salient stimuli, and this dilation was qualitatively similar to that evoked by SC microstimulation. Moreover, the timing and magnitude of evoked pupil responses scaled with the level of stimulus saliency, with significantly faster and larger pupil responses observed for more salient stimuli. The same modulation of stimulus saliency was demonstrated in human subjects. Importantly, the pupil response onset latencies for salient stimuli were comparable to those produced by the pupillary light reflex and much faster than the pupillary darkness reflex, suggesting that the initial component of pupil dilation is more likely mediated by inhibition of the parasympathetic pathway. Together, the results suggest that the transient pupil orienting response is modulated by stimulus saliency, and the SC is a likely neural substrate coordinating these pupil orienting responses.

1:15 PM, Sunday May 25, 2014

A BRAIN NETWORK FOR STRATEGIC DECISION-MAKING

A. Parr, ***B. Coe***, ***D. Munoz*** and ***M. Dorris***
Centre for Neuroscience Studies, Queen's University

During competitive interactions, one's actions and their outcomes change dynamically based on the actions of other agents. A mixed-strategy is often used, choosing among actions unpredictably and stochastically, to avoid exploitation from opponents. We have previously shown that mixed-strategy decision-making (DM) recruits a distributed brain network in humans; however, the role of motor structures remains unknown. The current study used fMRI to dissociate key regions of a strategic network from those involved in controlling specific motor effectors; the eye and hand.

A colour-based version of Matching Pennies was played against a dynamic computer opponent that exploited biases in player's responses. Players chose one of two different coloured visual targets, and were rewarded if their choice matched the opponent's. Using a block design, we contrasted brain activation underlying choices made using a saccade with choices made using a button-press; differences in brain patterns should highlight effector-specific processes.

Strategic DM, *regardless of the effector*, was associated with activation of the caudate nucleus (head), dorsolateral prefrontal, anterior cingulate, parietal, insular and orbitofrontal cortices, comprising the core elements of a strategic network. Conversely, we observed *effector-specific* activation of the frontal eye fields during saccade blocks, and the supplementary motor area (SMA) and pre-SMA during button press blocks. Results suggest that strategic DM activates a common brain network, distinct from regions involved in controlling specific effectors.

1:30 PM, Sunday May 25, 2014

VISUAL REMAPPING IS MORE IMPAIRED IN PATIENTS WITH UNILATERAL PARIETAL LESION THAN IN HEMIDECORTICATE PATIENTS AS REVEALED BY NOVEL VERSION OF THE DOUBLE STEP TASK

K. Rath-Wilson and ***D. Guitton***
Department of Neurology and Neurosurgery, McGill University

Studies of remapping abilities in human patients with distinct cortical lesions are inconclusive. Patients with parietal lobe lesions, primarily of the right side, tested on the classical double-step task have a particular deficit in generating an ipsilesional saccade if it follows a contralesional saccade (Duhamel et al, 1992 & Heide et al, 1995). This deficit has been explained as an inability to generate/ interpret corollary discharge for saccades elicited by the lesioned hemisphere. Recent studies, however, have called this finding into question. A review has re-interpreted the data from these earlier publications, suggesting that these results are actually evidence of right-hemisphere dominance in human visual remapping (Pisella et al, 2011). Several studies of patients with right parietal lesions have determined that ipsilesional but not contralesional eye movements can result in a deficiency in remembering spatial information from previous fixations (Vuilleumier et al, 2007 & Russel et al, 2010). We tested hemidecorticate subjects on a novel version of the double-step task, adapted because our patients are hemianopic. We found that they do not have any impairment in remapping in either direction. We have tested a right parietal patient with this novel double-step task and found that he is unable to generate a contralesional saccade when it follows an ipsilesional saccade, in opposition to the findings of Duhamel et al, 1992. We are in the process of testing more patients with our novel paradigm to provide further insight into the saccadic remapping system in humans.

1:45 PM, Sunday May 25, 2014

GAMMA COHERENCE ACCOMPANIES RECEPTIVE FIELD REMAPPING IN MONKEY AREA V4

S. Neupane, ***D. Guitton*** and ***C. Pack***
Department of Neurology and Neurosurgery, McGill University

Predictive remapping of visual receptive fields (RFs) prior to execution of a visually guided saccade has been observed in multiple visual areas. During remapping, neurons transiently respond to stimuli flashed, prior to the eye movement, in their future RF location parallel to the impending saccade vector. Other findings suggest that RFs converge towards the saccade target (Tolias et. al., 2001, Zirnsak et. al., 2014) irrespective of the saccade vector. The mechanisms underlying remapping are unknown.

One mechanism that could theoretically support remapping is a change in the coherence of gamma oscillations between distant sites on a retinotopic map. Gamma coherence has previously been shown to facilitate communication between brain areas, and we reasoned that it might similarly permit a transfer of stimulus information within a single region, as occurs during remapping. We tested this hypothesis by recording from multi-electrode arrays while monkeys performed a saccade task.

We mapped visual receptive fields by flashing visual probes at random locations and times relative to the execution of saccades in different directions. We found that peri-saccadic RFs mapped with both spikes and LFPs showed receptive field shifts parallel to the saccade vector, consistent with standard accounts of remapping. In LFPs, such shifts were, in addition, accompanied by a subsequent shift towards the saccade target. Peri-saccadic (spike) RFs of a minority of neurons showed a shift towards the saccade target (similar to Tolias et. al. 2001 and Zirnsak et. al. 2014), while another minority showed a mixture of the two types.

Cells that showed a clear tendency to remap had spiking outputs that were more strongly locked to the gamma oscillations (40-60Hz) found in the LFPs. This suggested a potential role for gamma synchrony in visual remapping. Consistent with this hypothesis we found that gamma coherence increased around the time of saccades for electrodes whose RFs were separated by a distance equal to that of the saccade vector. Thus there was enhanced gamma coherence between neuronal pairs encoding the RF and future RF; we also found a similar increase in coherence between electrodes encoding the RF and those encoding the saccade target.

We conclude that the sub-threshold neuronal activity reflected in LFP gamma coherence provides a mechanism for transiently updating representations of visual space around the time of each saccade.

2:00 PM, Sunday May 25, 2014

CORTICAL MECHANISMS UNDERLYING MOTOR PREDICTION

R. Hermosillo and ***P. van Donkelaar***
School of Health and Exercise Sciences, University of British Columbia

Limb movement prediction has been previously hypothesized to allow differentiation between self-induced sensory information arising from limb from external somatic information. This process of forward modeling has been used to explain many sensory cancellation processes in the body, the cortical regions responsible for this process in limb movements are still unclear. In our current experiment, we applied repetitive transcranial magnetic stimulation (rTMS) to 3 different cortical locations (posterior parietal cortex (PPC), dorsal premotor cortex (dPMC), and visual area V4) while subjects performed a vibrotactile temporal order judgement task (TOJ) under moving or stationary conditions. Under moving conditions, participants were instructed to cross their arms as soon as they heard a tone. Previous work has shown that under stationary conditions, error rates increase when participants have their arms crossed or are about to cross his or her arms. Under stationary conditions, we observed an increase in TOJ error after rTMS was applied to the PPC, but not when it was applied to the dPMC compared to pretesting or to control. However under moving conditions, after rTMS to the dPMC, error rates were decreased relative to pre-testing. This trend was not observed after area V4 was stimulated, and TOJs increased slightly after PPC stimulation. This pattern of results suggests that the brain generates predictions about spatial state of the limb using dorsal premotor cortex in concert with spatial information from the parietal cortex.

2:15 PM, Sunday May 25, 2014

ALLOCENTRIC VERSUS EGOCENTRIC REPRESENTATION OF REMEMBERED REACH TARGETS IN HUMAN CORTEX

Y. Chen [1], ***S. Monaco*** [2], ***P. Byrne*** [2], ***X. Yan*** [2], ***D. Henriques*** [2] and ***D. Crawford*** [3]
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The location of a remembered reach target can be encoded in egocentric and/or allocentric reference frames, but the cortical mechanisms for allocentric representations are essentially unknown. Here, we utilized an event-related fMRI design to distinguish the brain areas involved in these two types of representation. Twelve participants reached toward a remembered target location with their right hand. Reach targets and additional landmarks were presented for 2s, but at the beginning of each trial, participants were instructed to ignore the landmark and remember target location (*Egocentric reach*) or remember target location relative to the landmark (*Allocentric reach*). During the following *Delay phase* (12s) participants had to remember the target location in the appropriate reference frame, or remember (and later report) the color of the target (*Color*). At the end of the delay the landmark re-appeared at its original or a novel location. Subsequently, an audio instructed participants to perform a pro- or anti-reach (*Egocentric*), or an allocentric reach (*Allocentric*) during the *Response phase*. We found that during the *Delay phase Egocentric* and *Allocentric* tasks elicited overlapping regions as compared to the *Color* control, but with higher activation in parieto-frontal cortex for *Egocentric* task and higher activation in early visual cortex for *Allocentric* task. Egocentric directional selectivity (target relative to gaze) was observed in superior and inferior occipital gyrus, whereas allocentric directional selectivity (target relative to landmark) was observed in inferior temporal and inferior occipital gyrus. During the *Response phase* the parieto-frontal network resumed egocentric directional selectivity, showing higher activation for contralateral than ipsilateral reaches.

3:00 PM, Sunday May 25, 2014

NEURAL ENCODING OF LINEAR SELF-MOTION BY OTOLITH AFFERENTS

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Understanding how sensory neurons transmit information about relevant stimuli is a major challenge in neuroscience. Accordingly, we took advantage of the otolith system which is well-defined anatomically and physiologically and benefits from easily characterized sensory stimuli (i.e., head acceleration). Moreover, otolith afferents have a broad diversity in their spontaneous discharge regularity. Here, we employed multiple measures (i.e., gain, information theoretic, and spike timing precision) to probe the impact of background discharge regularity on the encoding of linear acceleration by otolith afferents. Specifically, we investigated how sensory information is processed in macaques' otolith afferents during translations with broad band (0-15 Hz) noise linear accelerations.

We found an increase in gain for both regular and irregular afferents as a function of the stimulus frequency; however, the gain enhancement was more prominent for irregular units. Irregular units conveyed more information at higher frequencies (e.g., >7Hz), whereas regular afferents transmitted slightly greater information at low acceleration frequencies (≤2Hz). Finally, our preliminary analysis shows that irregular units display more spike time precision in response to the same stimuli suggesting a role for spike timing in the encoding of linear motion. Taken together our results suggest that while highly sensitive irregular afferents are more advantageous for transient and dynamic stimuli, the regular units can provide accurate information when the stimulus is less dynamic (e.g. static tilt).

3:15 PM, Sunday May 25, 2014

TOOL INCORPORATION IN THE BODY REPRESENTATION: DO TOOLS BECOME HANDS IN OUR BRAIN?

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Almost 15 years ago, Botvinik and Cohen discovered that when subjects watched their own hand being brushed synchronously with a fake hand, they felt like the fake hand was their real hand. This illusion, called the Rubber Hand Illusion (RHI), has been proposed to rely on multisensory integration in premotor and intraparietal areas.

Among the key aspects necessary to induce the RHI there is the visual resemblance between the real and the fake hand. Indeed, the RHI arises only in presence of a fake hand and not other objects, as for example wooden blocks (even when they are shaped as a human hand). Here we tested whether functional similarity (instead of anatomical similarity) is sufficient for the illusion of ownership to extend to non-hand-shaped tools. In particular, we wanted to test whether it is possible to induce the illusion by stroking a grabber that shares the same functionality of a human hand (to grasp), despite its different visual appearance. We hypothesized that motor experience with the tool would be necessary to induce the illusion.

We tested subjects in a modified version of the classical RHI paradigm. Subjects were asked to observe a grabber being stroked synchronously (test) or asynchronously (control) with their own (hidden) right hand, before and after a short period of tool-use consisting in grasping and lifting objects with the grabber. We used three different measures: proprioceptive drift, questionnaire and GSR (Galvanic Skin Response) to threat. Crucially, subjects had no previous experience with the tool prior to the experiment.

Results from this study showed that it is possible to experience an illusory sense of ownership over a tool. Moreover, we found that the presence of the illusion is modulated by the amount of experience with the tool itself.

3:30 PM, Sunday May 25, 2014

EVIDENCE FOR A THREE-DIMENSIONAL TRANSFORMATION OF VESTIBULAR SIGNALS INTO BODY-CENTERED COORDINATES IN THE ROSTRAL FASTIGIAL NUCLEI

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The vestibular sensors provide self-motion information in a head-centered reference frame. Thus, to contribute to tasks such as reaching, vestibular signals must first be transformed from a head- to a body-centered reference frame. Previous studies provided evidence for such a transformation by demonstrating shifts in the spatial tuning properties of rostral fastigial nuclei (rFN) neurons when the head was statically repositioned relative to the body in the horizontal plane. Importantly, however, if rFN cells reflect a true three-dimensional (3D) transformation of vestibular signals, then they should also exhibit head-orientation-dependent tuning when the head is statically reoriented in the vertical plane. We tested this hypothesis by characterizing the 3D tuning properties of rFN neurons in two rhesus monkeys during sinusoidal translational motion (0.5 Hz, +/-9 cm, +/-0.09G) with the head upright, after head reorientation relative to the body in the vertical plane (i.e., in pitch/roll) and, whenever possible, after reorientation in the horizontal plane. Consistent with the hypothesis of a 3D transformation, we observed tuning shifts toward body-centered coordinates after both vertical- and horizontal-plane head reorientations. Notably, however, most cells showed evidence for only a partial transformation and there was no consistent relationship in the extent of transformation observed after vertical versus horizontal plane reorientations. Thus, while these results show for the first time that rFN neurons carry the necessary signals for a 3D vestibular signal transformation, they suggest that a true 3D representation of body heading direction is not encoded in individual cell activities but may exist only at the population level.

3:45 PM, Sunday May 25, 2014

SPECIAL KEYNOTE: WHAT SIMULTANEOUSLY RECORDED NEURONS CAN TELL US ABOUT HOW ATTENTION IMPROVES PERCEPTION

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Visual attention improves perception of an attended location or feature. Attention has also been associated with changes in the responses of neurons in visual cortex, typically increasing the responses of neurons that encode the attended location or feature. However, the mechanisms by which changes in visual cortex could account for the perceptual improvements remains largely unknown.

In recent years, correlations between the trial-to-trial fluctuations in the spiking of pairs of neurons (spike count correlations) have been used to study the neuronal mechanisms underlying sensory, motor, or cognitive processes, including attention. Several studies have now shown that attention decreases spike count correlations.

However, all of the previous studies measured correlations between pairs of neurons within the same cortical area that provide evidence in favor of the same decision in a behavioral task. The previous results are therefore consistent with either of two hypotheses. Attention-related changes in rate and correlation might be linked (perhaps through a common mechanism), so that attention decreases correlations every time it increases rates. Alternately, attention might either increase or decrease spike count correlations, possibly depending on the role the neurons play in the behavioral task or whether the neurons are in the same cortical area.

We recorded simultaneously from dozens of neurons in either areas V1 and MT or in area V4 while monkeys performed visually guided tasks that required them to modulate their spatial attention. We found strong evidence in favor of the second hypothesis, showing that attention increases correlations between neurons that contribute to different perceptual decisions or are from different cortical areas. These results place constraints on models of the neuronal mechanisms underlying cognitive factors and suggest that in addition to affecting the way sensory stimuli are encoded within a cortical area, attention may affect the transmission of sensory information between neurons that play different roles in a cortical circuit.

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