



LA PRÉVENTION AU CŒUR D'UNE MEILLEURE SANTÉ  
BETTER HEALTH THROUGH PREVENTION

# 3<sup>rd</sup> Annual **PERFORM** Centre Research Conference

BIOIMAGING FOR PREVENTION  
AND HEALTH RESEARCH

## ABSTRACTS

May 19, 2016  
Concordia University  
Montreal, Canada





LA PRÉVENTION AU CŒUR D'UNE MEILLEURE SANTÉ  
BETTER HEALTH THROUGH PREVENTION

## Table of Contents

### Poster #

<b>Exergamers' preferences and intentions</b> <i>Erin O'Loughlin, Tanya Scarrapachia, Lisa Kakinami, Tracie Barnett, Catherine Sabiston.....</i>	1
<b>Smart treadmill for athletic training</b> <i>Abbas Meamarbashi; Merefat Siahkouhian.....</i>	2
<b>Expectations and non-invasive brain stimulation: Do they influence cognition?</b> <i>Sheida Rabipour; Allan D. Wu, Marco Iacoboni, Patrick S. R. Davidson.....</i>	3
<b>BDNF serum levels increased by motor and coordination exercises but not by combined strength-aerobic training intervention in older adults</b> <i>St-Onge, Florence, Berryman, Nicolas, Thien Tuong Minh Vu, Arbour Nathalie, Bherer, Louis.....</i>	4
<b>Altered brain perfusion patterns in idiopathic hypersomnia</b> <i>Soufiane Boucetta, Jacques Montplaisir, Francis Lachapelle, Paul Gravel, and Thien Thanh Dang-Vu.....</i>	5
<b>The impact of age-related hearing loss on cognition and posture in a dual-task paradigm</b> <i>Bruce, H.; Asare, G., Aponte, D., St-Onge, N., &amp; Li, K. Z. H.....</i>	6
<b>Cardiac pulsatility in the brain before and after exercise assessed using BOLD fMRI</b> <i>Athena Theyers, Benjamin Goldstein, Arron Metcalfe, Bradley MacIntosh.....</i>	7
<b>Dealing with interference control at the response level: Functional networks reveal higher efficiency in the bilingual brain</b> <i>Pierre Berroir, Ladan Ghazi-Saidi, Tanya Dash, Daniel Adrover-Roig, Habib Benali &amp; Ana Inés Ansaldo.....</i>	8
<b>The effects of physical activity on the depression-smoking relationship in asthmatic adults</b> <i>Jojich-White Una, Béland Mélanie, Briand Samantha, Lavoie Kim L, Bacon Simon L...</i>	9

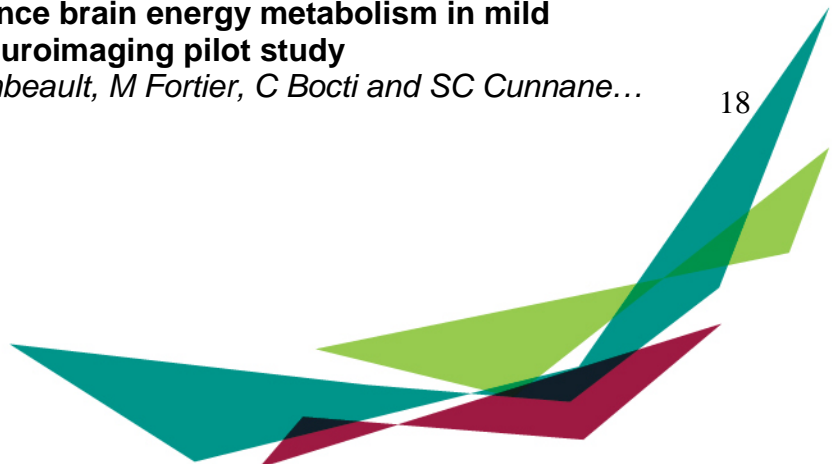




LA PRÉVENTION AU CŒUR D'UNE MEILLEURE SANTÉ  
BETTER HEALTH THROUGH PREVENTION

Poster #

<b>Factors associated with adipocyte size reduction after weight loss interventions for overweight and obesity: A meta-regression analysis</b> <i>Jessica Murphy; Grégory Moullec; Sylvia Santosa.....</i>	10
<b>Development of segmentation protocols using magnetic resonance imaging to study the morphology of the hypothalamic-pituitary-gonadal axis: Applications to project ice storm</b> <i>Jones, SL; Near, J; Maily, K; Newbold-Fox, H; Laplante, DP; King, S; Pruessner, J....</i>	11
<b>Modulation of helper T cells by <math>\beta</math>2-adrenergic receptor ligands</b> <i>Carvajal Gonczi, Catalina M; Tabatabaei Shafiei; Mahdieh2 ; Darlington, Peter J.....</i>	12
<b>Association between paraspinal muscle morphology, clinical symptoms and functional status in patients with degenerative cervical myelopathy</b> <i>Maryse Fortin; Octavian Dobrescu, Matthew Courtemanche; Carolyn J. Sparrey; Carlo Santaguida; Michael G. Fehlings; Michael H. Weber.....</i>	13
<b>Brain glucose and keytone metabolism in adults during moderate nutritional ketosis: A dua tracer quantitative PET-MRI study</b> <i>Courchesne-Loyer A, Croteau E, Castellano CA, St-Pierre V, Hennebelle M, Cunnane SC.....</i>	14
<b>Altered functional connectivity of the sensorimotor network post-stroke: A resting-state fMRI study</b> <i>Ilse Frias; Dorelle C. Hinton; Faryn Starrs; Alexander Thiel; and Caroline Paquette.....</i>	15
<b>Registration of pre- and post-resection ultrasound volumes with non-corresponding regions in neurosurgery</b> <i>Hang Zhou; Hassan Rivaz.....</i>	16
<b>The effect of immune cell activation on glycogen storage in the context of a nutrient rich microenvironment</b> <i>Tabatabaei Shafiei, Mahdieh, Carvajal Gonczi, Catalina M., Darlington, Peter J.....</i>	17
<b>Can a 3-month walking program enhance brain energy metabolism in mild Alzheimer’s disease? Results from neuroimaging pilot study</b> <i>CA Castellano; N Paquet, I Dionne, H Imbeault, M Fortier, C Bocti and SC Cunnane...</i>	18





LA PRÉVENTION AU CŒUR D'UNE MEILLEURE SANTÉ  
BETTER HEALTH THROUGH PREVENTION

**Poster #**

<b>School-aged children born with low and high birth weight: Investigation of obesogenic behaviors</b> <i>Dubé, Laurette; Dalle Molle, Roberta; Portella, André; Bischoff, Adriane; Silveira, Patricia</i> .....	19
<b>Remembering what but not where: Age-related deficits in autobiographical memory are specific to recall of spatial context</b> <i>Carina L. Fan; Sarah L. Peters, Signy Sheldon</i> .....	20
<b>Dynamic programming on a tree for ultrasound elastography</b> <i>Roozbeh Shams; Mathieu Boily; Paul A. Martineau; Hassan Rivaz</i> .....	21
<b>Influence of the alteration of flow topology on the abdominal aortic aneurysm local growth</b> <i>Florian Joly; Gilles Soulez; Claude Kauffmann</i> .....	22
<b>Physical fitness training and task-set cost in older adults</b> <i>Tudor Vrinceanu, Melanie Renaud, Louis Bherer</i> .....	23
<b>Comparison of skeletal muscle and fat measurements between single abdominal computed tomography scans and appendicular mass using dual energy x-ray absorptiometry in advanced cancer patients</b> <i>Noor Mady, Melanie Lessard, Elizabeth Nolin, Leonard Rosenthal MD, Jonathan Afilalo MD, Louis Antoine Mullie MD, Antonio Viganò MD, Robert D. Kilgour PhD</i> .....	24
<b>Investigating age-related differences in task-set inhibition from the dual mechanisms of control theory</b> <i>Steve Desbiens; Kiran Vadaga; Karen Li</i> .....	25
<b>Edge-preserving ultrasonic strain imaging with uniform precision</b> <i>Hossein Khodadadi, Amir G. Aghdam and Hassan Rivaz</i> .....	26
<b>Brain glucose and ketone metabolism in mild cognitive impairment and Alzheimer's disease: A cross-sectional study</b> <i>Etienne Croteau; Castellano CA; Bocti C; Fulop T; Paquet N; Cunnane S</i> .....	27
<b>Distinct brain activations during straight walking and steering of gait: An [18F]-FDG-PET study</b> <i>Faryn Starrs; Ilse Frias, Jean-Paul Soucy and Caroline Paquette</i> .....	28



**Poster #**

<b>Non-causal gauss markov based signal processing approaches for motion tracking in shear-wave elastography</b> <i>Mahmoud Derakhshan Horeh, Amir Asif, and Hassan Rivaz.....</i>	29
<b>The effect of training cessation on cognitive performances in older adults</b> <i>Lynden Rodrigues; Tudor Vricineau; Nicolas Berryman; Louis Bherer.....</i>	30
<b>Learning-induced plasticity in vascular properties in the human brain</b> <i>Avner Fitterman; Sophia Grahl; Uta Schneider; Christine Tardif; Chris Steele; Pierre-Louis Bazin; Claudine Gauthier.....</i>	31
<b>Associations between pulsatile hemodynamics in the middle cerebral arteries and cardiac-related fluctuations in functional magnetic resonance imaging</b> <i>Sarah Atwi, Ms; Andrew D. Robertson, PhD; Arron W.S. Metcalfe, PhD; Bradley J. MacIntosh, PhD.....</i>	32
<b>The Effect of combined activities on cognitive functions in older adults</b> <i>Louiza Kahina Harkouk, Laurence Lai, &amp; Karen Z. H. Li.....</i>	33
<b>Characterization of body composition, strength and performance in advanced lung cancer patients using dual energy x-ray absorptiometry: Subanalysis of an essential amino acid clinical trial</b> <i>Jonathan di Tomasso; Leonard Rosenthal MD; Robert Kilgour PhD; Antonio Viganò MD.....</i>	34
<b>Accuracy assessment of time-delay estimation in ultrasound elastography</b> <i>Mohamad Ghasemi Amidabadi; Dr. Omair Ahmad; Dr. Hassan Rivaz.....</i>	35
<b>Direct analytical estimation of strain elastography from ultrasound radio-frequency data</b> <i>Mona Omidyeganeh, M. Omair Ahmad, Hassan Rivaz.....</i>	36
<b>A low-cost camera-based transducer tracking system for freehand three-dimensional ultrasound imaging</b> <i>Mohammad M. Baba; Otmame Ait Mohamed; Falah Awwad; Mohammad I. Daoud.....</i>	37





LA PRÉVENTION AU CŒUR D'UNE MEILLEURE SANTÉ  
BETTER HEALTH THROUGH PREVENTION

**Poster #**

**No evidence of neurodegeneration in areas of decreased cerebral grey matter in chronic pain patients**

*FB Pomares; T Funck; N Feier; S Roy; A Daigle-Martel; M Ceko; S Narayanan,; D Araujo; A Thiel; N Stikov; MA Fitzcharles; P Schweinhardt.....*

38

**How do assessments of activities of daily living address executive functions: A scoping review**

*Frédérique Poncet, Bonnie Swaine, Elisabeth Dutil, Mathilde Chevignard.....*

39

**Effects of combined physical exercise and cognitive training on executive functions and dual-task performance in older adults**

*Laurence Desjardins-Crépeau, Maxime Lussier, Sarah Fraser, Karen Z. H. Li, Nicolas Berryman, Laurent Bosquet, David Predovan, Marie-Jeanne Kergoat, Thien T. M. Vu, Louis Bherer.....*

40

**Longitudinal impact of cardiovascular training on cerebral activity of older people measured by fNIRS during concurrent walk and working memory tasks**

*Thomas Vincent, Elisabeth Charlebois-Cloutier, Frédéric Lesage, Anil Nigam, Louis Bherer, Sarah A. Fraser.....*

41

**Changes in MEG scale free dynamics in patients with temporal lobe epilepsy**

*Aydin Ü.; Pellegrino G.; Hedrich T.; Kobayashi E.; Lina J.-M.; Grova C.....*

42



## Exergamers' preferences and intentions

Erin O'Loughlin<sup>1,2</sup>, Tanya Scarrapachia<sup>3</sup>, Lisa Kakinami<sup>4</sup>, Tracie Barnett<sup>5</sup>, Catherine Sabiston<sup>3</sup>

<sup>1</sup> Centre de recherche du CHUM (CRCHUM), Montreal, Quebec, Canada, erin\_oloughlin@hotmail.com

<sup>2</sup> Department of INDI program, Concordia University, Montreal, Quebec, Canada

<sup>3</sup> Faculty of Kinesiology and Physical Education, University of Toronto, Ontario, Canada

<sup>4</sup> Department of Department of Mathematics and Statistics, Concordia University, Montreal, Quebec, Canada

<sup>5</sup> Department of Exercise Science, Concordia University, Montreal, Quebec, Canada

**Introduction:** Research on exergaming is accumulating, but little is known about users' preferences or intentions of exergaming behaviours in a natural environment (non-intervention setting). Insight into these aspects is important for game developers in order to better tailor games to users' needs and expectations, as well as from a public health perspective. Specifically more evidence is needed on if and how exergames can increase physical activity participation. However, there are no reliable self-report measures of exergamer preferences or intentions.

**Method:** In this project, we examined the test retest reliability of the EXPAI-9 (a 9-item likert scale on preferences and intentions regarding exergaming (e.g. I prefer exergaming over participating in outdoor sports)) among past-year exergamers (n=40) age 19 years on average (64% female). Participants completed the EXPAI-9 through self-report in September 2015 and completed a retest one month later.

**Results:** Twenty-four percent of participants reported playing exergames 1-6 times per month in the last year using consoles and 34% used mobile devices. Individual items exhibited fair to good stability (intraclass correlation coefficient ranging from 0.338 to 0.760).

**Conclusion:** Overall the EXPAI-9 items were relatively stable over one month. Future research should test the reliability of the EXPAI-9 in larger more diverse samples, and examine exergaming behaviour in relation to the EXPAI-9 score over time.

## Smart treadmill for athletic training

Abbas Meamarbashi<sup>1</sup>; Marefat Siahkouhian<sup>2</sup>

<sup>1</sup>Associate Professor at the University of Mohaghegh Ardabili; Visiting Professor at McGill University; e-mail: abbas.meamarbashi@mcgill.ca

<sup>2</sup>Professor at the University of Mohaghegh Ardabili

Using treadmill and cycle ergometers are the best method of endurance training and choosing best training intensity is very crucial in endurance exercise training. According to one decade of our research experiences, it is possible to determine optimum personal training intensity based on estimation of person's anaerobic threshold. A hardware and software has been developed to monitor the heart rate and control the treadmill speed and slope. Software provided utilities to record the individual information (e.g. name, age, gender, weight and maximum and resting heart rate) and graphical curves of treadmill (speed, slope, work, power) and real-time heart rate. In this method, heart rate was used to draw the heart rate-time curve during an exhaustive graded maximal intensity exercise to find the best treadmill speed and slope in his/her anaerobic threshold. In this study, ten male athletes ( $19.3 \pm 1.7$  years;  $88.50 \pm 4.43$  kg;  $182.0 \pm 3.7$  cm) recruited. Validity and reliability of this method have been evaluated by gas analysis every 5 seconds to determine anaerobic threshold and compare it with the Heart Rate Deflection Point (HRDP) calculated by the software on a standard Treadmill protocol during two sessions with one week rest. Bland-Altman and Intraclass Correlation Coefficients (ICC) was used to find any agreement between the two methods and Test-Retest was used to prove the reliability of the method. There was a very high agreement between two methods ( $\pm 1.96$ ; 95% CI = -16.5 to +37.5 b/min) and calculate anaerobic threshold had a positive and significant correlation ( $r=0.932$ ;  $p<0.001$ ). Feasibility of design a hardware and software and validity and reliability of estimated individual anaerobic threshold ascertained. It is a reasonably low price hardware and software recommendable to implement in future treadmill manufacturing.

### References:

- [1] Siahkouhian M, Meamarbashi A. (2013). Advanced methodological approach in determination of the heart rate deflection point:  $S.D_{max}$  vs.  $L.D_{max}$  methods. *Journal of Sports Medicine and Physical Fitness*, 53(1), 27-33.
- [2] Mikulic P, Vucetic V, Sentija D. (2011). Strong relationship between heart rate deflection point and ventilatory threshold in trained rowers. *Journal of Strength & Conditioning Research*, 25(2), 360-6.
- [3] Siahkouhian M, Azizan S, Nakhostin Roohi B. (2012). A new approach for the determination of anaerobic threshold: Methodological survey on the modified  $D_{max}$  method. *Journal of Human Sport and Exercise*, 7(2), 599-607.



# Expectations and non-invasive brain stimulation: Do they influence cognition?

Sheida Rabipour<sup>1</sup>; Allan D. Wu<sup>2</sup>, Marco Iacoboni<sup>2</sup>, Patrick S. R. Davidson<sup>1</sup>

<sup>1</sup>*University of Ottawa, Canada; srabi091@uottawa.ca*

<sup>2</sup>*University of California, Los Angeles, USA*

Non-invasive forms of brain stimulation such as transcranial direct current stimulation (tDCS) appear to be safe and effective for improving executive functions, including attention and memory [1,2]. With low cost and relative ease of administration, tDCS has wide appeal for research, clinical, and individual use. Nevertheless, inadequate study designs have led to unsuccessful replications and obscured the mechanism(s) through which tDCS may influence cognition and behavior. Notably, studies of tDCS rarely account for psychological factors such as expectations of outcomes, which may influence response to tDCS through the placebo- or Hawthorne-like effects [3,4]. We assessed expectations of tDCS outcomes in healthy young adults on three occasions: i) at baseline; ii) after reading information implying either high or low effectiveness of stimulation; and iii) after a single session of sham-controlled anodal tDCS applied to the left dorsolateral prefrontal cortex, with online working memory training. Participants were randomly assigned to the information (high or low effectiveness) and stimulation (active or sham) conditions. Participants reported high expectations of the effectiveness of stimulation in improving cognitive function at baseline, and showed a significant change in these expectations after reading the information. Ratings nevertheless decreased significantly across all groups following the intervention. Similarly, despite trends towards a stronger influence of expectation over stimulation on cognitive performance, behavioral results suggested no significant effect of baseline expectations, information, stimulation, or individual characteristics on measures of working memory, executive function, and verbal fluency, regardless of whether these cognitive functions were evaluated individually or as a composite score.

## References:

1. Nitsche MA, Cohen LG, Wassermann EM, Priori A, Lang N, Antal A, et al. Transcranial direct current stimulation: State of the art 2008. *Brain stimulation*. 2008;1:206–23.
2. Sandrini M, Brambilla M, Manenti R, Rosini S, Cohen LG, Cotelli M. Noninvasive stimulation of prefrontal cortex strengthens existing episodic memories and reduces forgetting in the elderly. *Frontiers in Aging Neuroscience*. 2014;6:1–9.
3. McCambridge J, Witton J, Elbourne DR. Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *J Clin Epidemiol*. 2014;67:267–77.
4. Shiozawa P, Duailibi MS, da Silva ME, Cordeiro Q. Trigeminal nerve stimulation (TNS) protocol for treating major depression: An open-label proof-of-concept trial. *Epilepsy & behavior* : E&B. 2014;39:6–9.

## **BDNF serum levels increased by motor and coordination exercises but not by combined strength-aerobic training intervention in older adults.**

St-Onge, Florence.<sup>1,2</sup>, Berryman, Nicolas<sup>1,3</sup>., Thien Tuong Minh Vu<sup>1</sup>, Arbour Nathalie.<sup>2</sup> Bherer, Louis.<sup>1,4</sup>

<sup>1</sup> *Research Center of Geriatric Montreal Institute, Université de Montreal, Montreal, Canada*

<sup>2</sup> *Department of Neuroscience, Université de Montreal, CRCHUM, Montreal, Canada*

<sup>3</sup> *Department of Sports Studies, Bishop's University, Sherbrooke, Canada*

<sup>4</sup> *Department of Psychology, Faculty of Arts and Science, Concordia University, Montreal, Canada*

**Introduction:** Physical exercise has been reported as a promising approach to promote healthy aging[1]. Different exercise training programs have been associated with improvement of cognition and mood by enhancing molecular pathways. Brain-derived neurotrophic factor (BDNF) is a key neurotrophin allowing for neuroplasticity and is increased by different physical trainings[2]. However which type of physical training protocols trigger such increased BDNF levels, especially in participants over 60 years old, is unknown. Our goal is to compare the effects of two different protocols on serum BDNF levels in healthy older adults.

**Methods:** Thirty-four older adults were divided in two groups; combined strength and aerobic group (CSA, age: 70.5±5.3 yrs) and gross motor activities group (GMA, age: 74.6 ± 5.2 yrs). Both interventions were composed of three weekly 60-minute sessions for a period of 8 weeks. The intervention for the CSA group included maximal strength exercises and high intensity aerobic interval training. Locomotion activities, ball manipulation (hand-eye coordination), and stretching exercises were included for GMA group.

**Results:** One-way ANCOVAs were performed on variable absolute change, while controlling for age and baseline value. As expected, CSA group participants significantly increased their VO<sub>2</sub>max due to intervention. In contrast, BDNF levels were only significantly augmented in GMA group following intervention.

**Conclusion:** The present study indicates that BDNF levels may be modulated by gross motor development exercises. More research should be done on a larger sample and if confirmed, these results suggest that gross motor activities could potentially lead to improvements in cognition through BDNF pathway.

### **References:**

1. Bherer, L., K.I. Erickson, and T. Liu-Ambrose, *A review of the effects of physical activity and exercise on cognitive and brain functions in older adults*. *J Aging Res*, 2013. **2013**: p. 657508.
2. Szuhany, K.L., M. Bugatti, and M.W. Otto, *A meta-analytic review of the effects of exercise on brain-derived neurotrophic factor*. *J Psychiatr Res*, 2015. **60**: p. 56-64.

## Altered brain perfusion patterns in idiopathic hypersomnia

Soufiane Boucetta<sup>1,2,3</sup>, Jacques Montplaisir<sup>4,5</sup>, Francis Lachapelle<sup>1,2,3</sup>, Paul Gravel<sup>2,7</sup>, and Thien Thanh Dang-Vu<sup>1,2,3,6</sup>

<sup>1</sup> Center for Studies in Behavioral Neurobiology and Dpt of Exercise Science, Concordia University, Montreal, Quebec, Canada

<sup>2</sup> PERFORM Centre, Concordia University, Montreal, Quebec, Canada

<sup>3</sup> Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal, Montréal, Quebec, Canada

<sup>4</sup> Center for Advanced Research in Sleep Medicine, Hôpital du Sacré-Coeur de Montréal, Montreal, Quebec, Canada

<sup>5</sup> Dpt of Psychiatry, Université de Montréal, Montreal, Quebec, Canada

<sup>6</sup> Dpt of Neurosciences, Université de Montréal, Montreal, Quebec, Canada

<sup>7</sup> McConnell Brain Imaging Centre, Montreal Neurological Institute, McGill University, Montreal, QC, Canada

**Introduction:** Idiopathic hypersomnia (IH) is a sleep disorder characterized by excessive daytime sleepiness despite normal or long nocturnal sleep time. While some of its clinical characteristics overlap with other types of central hypersomnias such as narcolepsy, IH remains a poorly understood condition with unclear pathophysiological mechanisms. The present study aims at investigating the neural correlates of IH, using single photon emission computed tomography (SPECT).

**Methods:** Eleven patients with IH and eleven healthy controls (HC) were scanned during resting wakefulness in the morning using SPECT with Tc-99m ethyl cysteinate dimer (ECD). Distribution of regional cerebral blood flow (rCBF) between the two groups was compared. In addition, correlation analyses were made between rCBF and clinical characteristics to assess the functional correlates of specific brain perfusion patterns. Significance was set at  $p < 0.01$ .

**Results:** IH patients showed a significant rCBF decrease in regions belonging to the default mode network (DMN, e.g., medial prefrontal, anterior cingulate and precuneus) as well as in putamen and posterior cerebellum. In addition, they showed a significant increase in the amygdala and temporo-occipital cortices. Interestingly, lower rCBF in the DMN and putamen and higher rCBF in the amygdala were associated with larger levels of daytime sleepiness. Finally, higher rCBF in the amygdala and lower rCBF in the DMN were associated with larger depression symptoms.

**Conclusion:** This report constitutes the first neuroimaging investigation of IH. Our results suggest that identified abnormalities in the DMN and limbic system contribute to the excessive daytime sleepiness and mood disturbances in these patients.

# The impact of age-related hearing loss on cognition and posture in a dual-task paradigm

Bruce, H.<sup>1,2,3</sup>; Asare, G.<sup>1,2,3</sup>, Aponte, D.<sup>2,4</sup>, St-Onge, N.<sup>2,4,5</sup>, & Li, K. Z. H.<sup>1,2,3</sup>

<sup>1</sup>Concordia University, Department of Psychology; hbruc028@gmail.com

<sup>2</sup>PERFORM Centre

<sup>3</sup>Centre for Research in Human Development

<sup>4</sup>Concordia University, Department of Exercise Science

<sup>5</sup>Constance-Lethbridge Rehabilitation Center, Center for Interdisciplinary Research in Rehabilitation of Greater Montreal

Epidemiological research indicates a link between hearing loss and mobility [1]. A potential explanation is that cognitive compensation occurs in auditory and postural tasks in older adults. We investigated this hypothesis using a dual-task paradigm. Healthy young adults (YA:  $n = 29$ ), older adults (OA:  $n = 26$ ) and older adults with hearing loss (OAH:  $n = 32$ ) completed cognitive (modified n-back) and balance (recovery from anterior translation of the support surface) tasks singly and concurrently under noisy and quiet conditions with background noise (babble) used to simulate auditory aging. Analysis of background variables indicated that OA and OAH differed significantly on neuropsychological and mobility measures, even after controlling for age. Furthermore, a significant interaction of age group, auditory challenge and task difficulty indicated that OAH and OA made more cognitive errors than YA, particularly under noisy conditions despite correcting for auditory acuity. Furthermore, OAH also demonstrated an increase in errors from single to dual-task trials under noisy conditions. The kinematic data indicated that OA and OAH demonstrated greater passive plantarflexion of the ankle compared with YA. Conversely, YA showed greater extension in the hip and knee in response to the dual-tasking and noise suggesting that they may rely less on an ankle strategy and instead use a hip and knee strategy. Generally, hip strategy is used under more challenging perturbations [2] meaning YA may adapt their postural strategy to cope with the increasing task demands, while OA and OAH do not tune their postural strategy in the same way.

[1] Viljanen, A., Kaprio, J., Pyykko, I., Sorri, M., Pajala, S., Kauppinen, M., Koskenvu, M. & Rantanen, T. (2009). Hearing as a predictor of falls and postural balance in older female twins. *Journals of Gerontology: Medical Sciences*, 64, 312-317.

[2] Brown, L. A., Shumway-Cook, A., & Woollacott, M. H. (1999). Attentional Demands and Postural Recovery: The Effects of Aging. *Journal of Gerontology, MEDICAL SCIENCES*, 54A(4), 165-171.

# Cardiac pulsatility in the brain before and after exercise assessed using BOLD fMRI

Athena Theyers<sup>1,2,3</sup>; Benjamin Goldstein<sup>1,2</sup>, Arron Metcalfe<sup>1,2</sup>, Bradley MacIntosh<sup>1,2,3</sup>

<sup>1</sup>*Heart and Stroke Foundation Canadian Partnership for Stroke Recovery;*  
*atheyers@sri.utoronto.ca*

<sup>2</sup>*Sunnybrook Research Institute, University of Toronto, Toronto, Ontario, Canada*

<sup>3</sup>*Department of Medical Biophysics, University of Toronto, Toronto, Ontario, Canada*

Blood flow from our hearts is not at steady state; rather it comes in pulses with every beat. These pulses are dampened by our arteries which absorb excess energy before reaching delicate capillaries and tissue cells. It is theorized that failure to adequately dampen pulsatile pressure in the brain contributes to small vessel damage [1]. Furthermore, elevated pulsatility in the brain has been implicated in the progression of white matter hyperintensities, cognitive impairment and development of neurodegenerative diseases, such as dementia. [2,3]

Quantification of pulsatility in the brain is limited due to the skull which prevents direct measurement and hinders ultrasound imaging. We introduce an alternative approach, more amenable for clinical translation that involves analysis of functional magnetic resonance imaging of blood oxygenation level dependent (BOLD) data. BOLD is sensitive to cardiac fluctuations [4]. We propose a method of sorting BOLD temporal volumes based on when they occur in the cardiac cycle, allowing us to produce a pulse wave trace for each voxel. To test this method, BOLD imaging was performed with pulse trace monitoring in a cohort of adolescent participants (N=62) before and acutely following 20 minutes of aerobic exercise. Cardiac pulse wave analysis was performed voxel-wise, modeled by cosine waves and compared statistically against permuted data.

We identified several areas of robust cardiac pulsations, primarily surrounding major vessels. Pulsatility in the brain decreased following aerobic exercise, consistent with literature on blood flow. This method is effective at identifying expected markers of pulsatility not readily quantifiable with current methods.

## References:

- [1] O'Rourke, MF and Hashimoto, J. Mechanical Factors in Arterial Aging: A Clinical Perspective. *JACC*. 2007; 50(1): 1-13.
- [2] Makedonov, I et al. BOLD fMRI in the White Matter as a Marker of Aging and Small Vessel Disease. *PLOS One*. 2013; 8(7): 1-9.
- [3] Webb, AJ et al. Increased cerebral arterial pulsatility in patients with leukoaraiosis: arterial stiffness enhances transmission of aortic pulsatility. *Stroke*. 2012; 43(10): 2631-2636.
- [4] Dagli, MS et al. Localization of Cardiac-Induced Signal Change in fMRI. *NeuroImage*. 1999; 9: 407-415.

# Dealing with interference control at the response level: functional networks reveal higher efficiency in the bilingual brain

Pierre Berroir<sup>1,2</sup> Ladan Ghazi-Saidi<sup>1</sup> Tanya Dash<sup>1,3</sup> Daniel Adrover-Roig<sup>5</sup>

Habib Benali<sup>6</sup> & Ana Inés Ansaldo<sup>1,2,3,4</sup>

*pierre.berroir@polymtl.ca*

<sup>1</sup>Centre de recherche de l'Institut Universitaire de Gériatrie de Montréal, 4565 Queen-Mary Road, QC H3W1W5 Canada

<sup>2</sup>Université de Montréal and École Polytechnique, Institut de génie biomedical, Montreal, QC H3C3J7 Canada

<sup>3</sup>École d'orthophonie et d'audiologie, Faculté de médecine, Université de Montréal, Montreal, QC H3N1X7 Canada

<sup>4</sup>École d'orthophonie et d'audiologie, UDEM, Pavillon 7077, avenue du Parc, local 3001-1, Montreal, QC H3N1X7 Can.

<sup>5</sup>University of the Balearic Islands, Departamento de Pedagogía Aplicada y Psicología de la Educación

<sup>6</sup>UPMC Univ Paris 6, UMR-S 678, LIF, Laboratoire d'Imagerie Fonctionnelle, Paris, France

The advantage of bilingualism in the context of aging was studied using fMRI during an interference management task. Precisely, the present study aimed at providing a more in depth perspective of the neural basis of performance in the Simon Task in elderly bilingual and monolingual speakers, by adopting a network perspective for the functional connectivity analysis.

The functional network was modeled from each subject with graph theory. A set of 160 regions of interest were segmented on the cerebral cortex images with freesurfer [1] to define the respective networks nodes. Then, inter-regional Pearson correlations were estimated between the average intrinsic BOLD signal of each ROI. The hypothesis that a given correlation coefficient was null has been tested to remove non-significant edges and emphasize the network topology. Lastly, the topology of these networks was analyzed through connectivity - ie the links between different regions. We observed differences between the functional networks, which indicates different cognitive strategies in the two groups.

Our results for the bilingual speakers showed a higher connectivity for the inferior temporal sulcus, which has a role in visuospatial processing [2][3]. On the other hand, in monolingual speakers, the areas with higher connectivity in the monolingual speakers, as well as the brain areas connected to them, are mostly involved in executive function and interference control. In other words, in comparison to the monolingual brain, the bilingual brain solves visuo-spatial interference in an economic manner, by allocating less and more specific-to-the task resources.

[1] Fischl, B. (2012). FreeSurfer. *Neuroimage*, 62(2), 774-781.

[2] Forstmann, B. U., van den Wildenberg, W. P., & Ridderinkhof, K. R. (2008). Neural mechanisms, temporal dynamics, and individual differences in interference control. *Cognitive Neuroscience, Journal of*, 20(10), 1854-1865.

[3] Liu, X., Banich, M. T., Jacobson, B. L., & Tanabe, J. L. (2004). Common and distinct neural substrates of attentional control in an integrated Simon and spatial Stroop task as assessed by event-related fMRI. *Neuroimage*, 22(3), 1097-1106.

# The effects of physical activity on the depression-smoking relationship in asthmatic adults

Jojich-White Una<sup>1,2</sup>, Béland Mélanie<sup>1,2</sup>, Briand Samantha<sup>1,2</sup>, Lavoie Kim L,<sup>1,3</sup> Bacon Simon L.<sup>1,2</sup>

<sup>1</sup> Montreal Behavioural Medicine Centre, Hôpital du Sacré-Coeur de Montréal

<sup>2</sup> Concordia University

<sup>3</sup> Université du Québec à Montréal

Correspondence: unajwhite@gmail.com

**Introduction:** High depressive symptoms are common in patients with asthma, are associated with worse asthma control, and have been associated with several unhealthy behaviours, such as smoking and low physical activity levels. However, to our knowledge, no studies have investigated the effects of physical activity on the association between depressive symptoms and smoking in adults with asthma.

**Methods:** A total of 643 adults ( $M$  (SD) age =49±14.1; 61% women) with confirmed asthma completed a series of questionnaires, including questions regarding their smoking habits (cumulative pack-yrs), leisure time physical activity (12-month physical activity recall: LTPA), and depressive symptoms (Beck Depression Inventory-II: BDI).

**Results:** GLM analyses revealed a main effect of LTPA ( $B=0.302$ ,  $p=.012$ ) but not BDI ( $B=0.037$ ,  $p=.534$ ) on pack-yrs. In addition, there was an interaction between LTPA and BDI ( $B=0.058$ ,  $p<.001$ ). All analyses included age, sex, and current smoking status as covariates. Post-hoc analyses revealed that in those with lower levels of LTPA there was no association between BDI and pack-yrs but that at higher levels of LTPA worse BDI was associated with increased cumulative smoking.

**Conclusion:** Given that other studies indicate that smoking is more important for asthma outcomes, compared to depressive symptoms and low LTPA, our data suggest that, in adults with asthma, targeting reductions in depressive symptoms in those that are active could potentially lead to reductions in smoking. Further longitudinal data is needed to explore this issue further.

## **Factors associated with adipocyte size reduction after weight loss interventions for overweight and obesity: a meta-regression analysis**

Jessica Murphy<sup>1,2,3</sup>; Grégory Moullec<sup>3,4</sup>; Sylvia Santosa<sup>1,2,3</sup>

<sup>1</sup>*Department of Exercise Science, Concordia University, Montreal, Quebec, Canada*

<sup>2</sup>*Nutrition, Obesity and Metabolism Laboratory, PERFORM Centre, Concordia University, Montreal, Quebec, Canada*

<sup>3</sup>*Centre de recherche - Axe maladies chroniques, Centre intégré universitaire de santé et de services sociaux du Nord-de-l'Ile-de-Montréal, Hôpital du Sacré-Coeur de Montréal, Montréal, Québec, Canada*

<sup>4</sup>*École de santé publique - Département de médecine sociale et préventive, Université de Montréal, Montréal, Québec, Canada*

**Introduction:** Enlarged adipocytes are a prime feature of adipose tissue dysfunction, and may be an appropriate target to decrease disease risk in obesity. We aimed to assess the change in adipocyte size in response to lifestyle and surgical weight loss interventions for overweight or obesity, and to explore whether certain participant and intervention characteristics influence this response.

**Methods:** We systematically searched MEDLINE, EMBASE, CINAHL and Cochrane electronic databases to identify weight loss studies that quantified adipocyte size before and after the intervention. Using meta-regression analysis, we assessed the independent effects of weight loss, age, sex, adipocyte region, and intervention type (surgical vs. lifestyle) on adipocyte size reduction. We repeated the model as a sensitivity analysis including only the lifestyle interventions.

**Results:** Thirty-five studies met our eligibility criteria. In our main model, every 1.0 % weight loss was associated with a 0.64 % reduction in adipocyte size ( $p = 0.003$ ); and adipocytes from the upper body decreased 5 % more in size than those in the lower body ( $p = 0.009$ ). These relationships were no longer significant when focusing only on lifestyle interventions.

Moreover, age, sex and intervention type did not independently affect adipocyte size reduction in either model.

**Conclusion:** Weight loss in obese individuals is consistently associated with a decrease in adipocyte size that is more pronounced in upper-body adipocytes. It remains to be clarified how biological differences and intervention characteristics influence this relationship, and whether it corresponds with reductions in other aspects of adipose tissue dysfunction and disease risk.



## Development of segmentation protocols using magnetic resonance imaging to study the morphology of the hypothalamic-pituitary-gonadal axis: Applications to project ice storm

Jones, SL<sup>1</sup>, Near, J<sup>2</sup>, Maily, K<sup>3</sup>, Newbold-Fox, H<sup>3</sup>, Laplante, DP<sup>4</sup>, King, S<sup>5</sup>, Pruessner, J<sup>6</sup>

<sup>1</sup> Sherri Lee Jones, Postdoctoral Fellow, Douglas Mental Health University Institute, Verdun, Qc, Canada; Department of Psychiatry, McGill University, Montreal, Qc, Canada. [sherri.jones@mail.mcgill.ca](mailto:sherri.jones@mail.mcgill.ca).

<sup>2</sup> Cerebral Imaging Center, Douglas Mental Health University Institute, Verdun, Qc, Canada; Departments of Psychiatry and Biomedical Engineering, McGill University, Montreal, Qc, Canada

<sup>3</sup> Cerebral Imaging Center, Douglas Mental Health University Institute, Verdun, Qc, Canada.

<sup>4</sup> Douglas Mental Health University Institute, Verdun, Qc, Canada.

<sup>5</sup> Douglas Mental Health University Institute, Verdun, Qc, Canada; Department of Psychiatry, McGill University, Montreal, Qc, Canada.

<sup>6</sup> Douglas Mental Health University Institute, Verdun, Qc, Canada; Department of Psychiatry, McGill University, Montreal, Qc, Canada; McGill Center for Studies in Aging, Department of Psychology, McGill University, Montreal, Qc, Canada.

Animal studies have shown that prenatal maternal stress disrupts the typical sex difference in hypothalamic volume and its associated sex-specific behaviors, and disrupts ovarian morphology and function by inducing polycystic ovaries. Whether these effects are paralleled in humans is not known, in part because of ethical limitations of stressing pregnant women. We have overcome this limitation in a unique longitudinal prospective study of women exposed to Quebec's 1998 ice storm, a sudden onset stressor, affecting pregnant women irrespective of their personal characteristics. Data collection began within six months of the storm and has continued approximately every two years, including brain scans collected with a 3T Siemens MRI at ages 12½ and 15½. For the 18½ year assessments, we continue to acquire T1-weighted brain images in the Ice Storm cohort and a 1997-born control cohort, and have refined an existing protocol designed to capture the hippocampus and amygdala, to also capture the hypothalamus in a single high resolution T2 scan (0.4 x 0.4 x 1mm, TR/TE 9630/85ms, flip angle 150°, 107Hz/Px). We are modifying existing whole hypothalamus segmentation protocols [1-4] by refining boundaries, and are developing novel segmentation protocols for hypothalamic nuclei, including those involved in the stress response, and reproductive behaviors and physiology. A high resolution T2 acquisition protocol of the ovaries (turbo spin echo, 0.6 x 0.6 x 3mm, TR/TE 4000/101ms, flip angle 150°, 200Hz/Px) has also been developed to image ovarian follicles. These protocols can also be broadly applied to the study of *in vivo* hypothalamic-pituitary-gonadal axis morphology.

### References

- [1] Makris, N, Swaab, DF, van der Kouwe, A, Abbs, B, Boriel, D, Handa, RJ, et al. Volumetric parcellation methodology of the human hypothalamus in neuroimaging: Normative data and sex differences. *NeuroImage*. 2013; 69: 1–10.
- [2] Bocchetta, M, Gordon, E, Manning, E, Barnes, J, Cash, DM, Espak, M, et al. Detailed volumetric analysis of the hypothalamus in behavioral variant frontotemporal dementia. *Journal of Neurology*. 2015; 262(12): 1–8.
- [3] Schindler, S, Schönknecht, P, Schmidt, L, Anwander, A, Strau, M, Trampel, R, et al. Development and evaluation of an algorithm for the computer-assisted segmentation of the human hypothalamus on 7-Tesla magnetic resonance images. *PLoS ONE*. 2013; 8(7): e66394.
- [4] Goldstein, JM, Seidman, LJ, Makris, N, Ahern, T, O'Brien, LM, Caviness, VS, Jr, et al. Hypothalamic Abnormalities in Schizophrenia: Sex Effects and Genetic Vulnerability. *Biological Psychiatry*. 2007; 61(8): 935–945.

## Modulation of helper T cells by $\beta$ 2-adrenergic receptor ligands

Carvajal Gonczi, Catalina M<sup>1</sup>; Tabatabaei Shafiei, Mahdieh<sup>2</sup>, Darlington, Peter J.<sup>2</sup>

<sup>1</sup>*Department of Biology, Concordia University, the Centre for Structural and Functional Genomics, and the PERFORM Centre, Montréal, Québec, Canada;*  
[catalina.marysol.gonczi@gmail.com](mailto:catalina.marysol.gonczi@gmail.com)

<sup>2</sup>*Department of Biology, Department of Exercise Science, Concordia University, the Centre for Structural and Functional Genomics, and the PERFORM Centre, Montréal, Québec, Canada*

### Introduction:

T helper (Th) cells protect the body against infections, however, one type of Th cell called the "Th17 cell" can be a risk factor for autoimmune disease. The beta2-adrenergic receptor ( $\beta$ 2AR) pathway regulates metabolic reactions in response to catecholamine hormones such as epinephrine and norepinephrine. The aim of this study is to determine the effect that the signaling pathway has on Th17 cell proliferation and cytokine secretion.

### Methods:

Blood samples were taken from healthy subjects. The immune cells were isolated and treated with different pharmacological ligands in an *in vitro* setting. Proliferation was measured by flow cytometry and cytokines were measured by enzyme assay.

### Results:

The  $\beta$ 2AR-specific agonist terbutaline increased Th17 cell cytokines ( $p < 0.01$ ). Surprisingly, nearly one third of samples showed an opposite response ( $p < 0.05$ ). The effects could be blocked by a  $\beta$ 2AR-specific antagonist. Cell signaling pathways were targeted by adding an enzyme inhibitor for protein kinase A (H89) and a cAMP analog (dbcAMP). Th17 cytokines were inhibited in all subjects' samples when H89 was added, whereas dbcAMP effect was varied depending on the dose added. Proliferation was not altered by terbutaline.

### Conclusion:

Cell signaling through  $\beta$ 2AR alters the Th17 cytokines depending on the person tested. The diverse response to  $\beta$ 2AR agonists observed between people's samples may be explained by natural genetic variations in  $\beta$ 2AR genes, an idea that we are currently investigating. This work provides a better understanding of how genes and hormones interact with the immune system and influence predisposition for autoimmunity.

## Association between paraspinal muscle morphology, clinical symptoms and functional status in patients with degenerative cervical myelopathy

Maryse Fortin<sup>1,2</sup>; Octavian Dobrescu<sup>2</sup>, Matthew Courtemanche<sup>3</sup>; Carolyn J. Sparrey<sup>3</sup>; Carlo Santaguida<sup>4</sup>; Michael G. Fehlings<sup>5</sup>; Michael H. Weber<sup>2</sup>

<sup>1</sup>*PERFORM Centre, Concordia University; maryse.fortin@concordia.ca*

<sup>2</sup>*McGill University Health Centre, Department of Orthopedic Surgery*

<sup>3</sup>*Simon Fraser University, School of Mechatronic Systems Engineering*

<sup>4</sup>*McGill University Health Centre, Department of Neurology and Neurosurgery*

<sup>5</sup>*University of Toronto, Department of Neurosurgery and Spinal Program*

**Purpose:** To assess fatty infiltration and asymmetry of the multifidus (MF), semispinalis cervicis (SCer), semispinalis capitis (SCap) and splenius capitis (SPL) muscles in patients with degenerative cervical myelopathy (DCM) and evaluate their correlations with clinical symptoms and functional scores.

**Methods:** 38 patients diagnosed with DCM and spinal cord compression at C4-C5 or C5-C6 was included. Cervical muscle measurements of cross-sectional area (CSA) and ratio of functional CSA (fat free area, FCSA) to total CSA were obtained from T2-weighted axial MR images at the level above, same, and level below the most cranial level of compression. Muscle fatty infiltration and asymmetry was assessed at every level and their associations with respect to clinical signs, symptoms and functional scores were investigated.

**Results:** There was a significant increase in fatty infiltration of the MF ( $p=0.001$ ) and SPL ( $p<0.001$ ) muscles at the level below the compression. A significant increase in MF CSA asymmetry was also observed at the level below the compression. Lower MF FCSA/CSA ratio was associated longer 30-meter walking test time. Lower SCer FCSA/CSA was associated with corticospinal distribution motor deficits and atrophy of the hands. Greater asymmetry in SCap CSA was associated with higher Neck Disability Index (NDI) scores while lower asymmetry in MF CSA was associated with a positive Hoffman sign and weakness.

**Conclusion:** A significant increase in muscle fatty infiltration and CSA asymmetry at the level below the compression was observed in patients with DCM. Our results also suggest an association between cervical muscle morphology and DCM clinical symptoms and functional status.

## Brain glucose and ketone metabolism in adults during moderate nutritional ketosis: A dual tracer quantitative PET-MRI study

Courchesne-Loyer A<sup>1,2</sup>, Croteau E<sup>1</sup>, Castellano CA<sup>1</sup>, St-Pierre V<sup>1,2</sup>, Hennebelle M<sup>1</sup>, Cunnane SC<sup>1,2,3</sup>

<sup>1</sup>Research Center on Aging; [alexandre.courchesne-loyer@usherbrooke.ca](mailto:alexandre.courchesne-loyer@usherbrooke.ca)

<sup>2</sup>Departments of Pharmacology-Physiology, Université de Sherbrooke

<sup>3</sup>Departments of Medicine, Université de Sherbrooke

**Introduction:** Ketones ( $\beta$ -hydroxybutyrate and acetoacetate) are an important fuel for the human brain and have shown positive effects on cognitive performance in Alzheimer's disease. However, ketone utilisation in the adult brain remains poorly understood. Our hypothesis was that diet-induced ketosis would increase brain ketone uptake in direct proportion to the increase in plasma ketones. **Methods:** Ten healthy adults ( $28 \pm 3$  y) received a ketogenic diet (KD) (4.5:1; lipid:[protein+carbohydrates]) for four days. Brain uptake of ketones was quantified by PET/MRI before and after the KD using <sup>11</sup>C-acetoacetate (<sup>11</sup>C-AcAc) and <sup>18</sup>F-fluorodeoxyglucose (<sup>18</sup>FDG). **Results:** On the fourth day of the KD, plasma ketones increased 8 fold ( $0.60 \pm 0.61$  to  $4.84 \pm 0.91$  mM;  $p=0.005$ ) while plasma glucose decreased by 24% ( $5.1 \pm 0.4$  to  $3.9 \pm 0.3$  mM;  $p=0.005$ ). Whole brain <sup>11</sup>C-AcAc uptake increased 7 fold ( $0.67 \pm 0.57$  to  $4.83 \pm 2.36$   $\mu\text{mol}/100$  g/min;  $p=0.005$ ) whereas <sup>18</sup>F-FDG uptake decreased by 20% ( $31.6 \pm 3.0$  to  $24.5 \pm 5.4$   $\mu\text{mol}/100$  g/min;  $p=0.014$ ). Plasma ketones were positively correlated with whole brain <sup>11</sup>C-AcAc uptake ( $r=0.94$ ;  $p<0.0001$ ). Regional brain increases in <sup>11</sup>C-AcAc uptake during the KD varies between regions. **Conclusion:** These results confirm that brain <sup>11</sup>C-AcAc uptake in adult humans is directly proportional to plasma ketones. After a 4 day KD, ketones were supplying 18% of whole brain energy requirements in healthy adults from 1-2% pre-KD. Ketogenic supplements and diets have been shown to have therapeutic utility in cognitive impairment in Alzheimer's disease, Parkinson's disease and insulin-induced hypoglycemia. Increased brain ketone availability bypassing impaired brain glucose availability/utilisation could be a potential explanation for the positive effect of ketones in different cognitive disorders.

# Altered functional connectivity of the sensorimotor network post-stroke: a resting-state fMRI study

Ilse Frias<sup>1,2</sup>, Dorelle C. Hinton<sup>1,2</sup>, Faryn Starrs<sup>1,2</sup>, Alexander Thiel<sup>3,4</sup> and Caroline Paquette<sup>1,2</sup>

<sup>1</sup>Department of Kinesiology and Physical Education, McGill University, Montreal, Canada; ilse.frias@mail.mcgill.ca

<sup>2</sup>Centre for Interdisciplinary Research in Rehabilitation, Montreal, Canada

<sup>3</sup>Department of Neurology and Neurosurgery, McGill University, Montreal, Canada

<sup>4</sup>Lady Davis Institute for Medical Research at SMBO Jewish General Hospital, Montreal, Canada

**Introduction:** Damage from stroke lesions affect delimited regions, resulting in acute neurological deficits. However, stroke can also affect areas distant to the infarct, leading to reorganization of functional networks in the affected and unaffected hemisphere<sup>1</sup>. Advances in neuroimaging techniques, have contributed to a better understanding of neural reorganization after stroke. In this study, we examine changes of interhemispheric resting-state functional connectivity (FC) of the sensorimotor network after stroke aiming to identify a correlation between interhemispheric sensorimotor connectivity with the patients' impairment level.

**Methodology:** 6 chronic post-stroke and 8 age-matched controls participated in this study. Stroke-related neurological disability was evaluated using the NIHSS<sup>2</sup> scale. Seed-based resting-state analysis<sup>3</sup> was used to identify voxels temporally correlated in neural activity with Left and Right Primary-Sensorimotor Areas. The number of voxels connected within the seed was calculated. To examine the relationship between FC and impairment Pearson's correlation was completed.

**Results:** An assymetrical resting-state-FC of the affected sensorimotor network was observed. When the seed is placed over the affected hemisphere a higher number of voxels are connected only to the affected hemisphere, almost no connectivity in the unaffected side ( $p < 0.05$ ). When the seed was placed over the unaffected hemisphere a symmetrical and bilateral connectivity pattern was present. A significant positive correlation between interhemispheric FC and NIHSS scores was observed ( $p < 0.05$ ).

**Conclusion:** A control balance between hemispheres is crucial for optimal execution of sensorimotor function. Our findings could contribute to the development of therapies that modulate the connectivity between hemispheres to facilitate motor recovery after a stroke.

## References:

- [1] Chollet, F., DiPiero, V., Wise, R. J., Brooks, D. J., Dolan, R. J., & Frackowiak, R. S. (1991). The functional anatomy of motor recovery after stroke in humans: a study with positron emission tomography. *Ann Neurology*, 29(1), 63-71.
- [2] Adams, H. P., Jr., Davis, P. H., Leira, E. C., Chang, K. C., Bendixen, B. H., Clarke, W. R Hansen, M. D. (1999). Baseline NIH Stroke Scale score strongly predicts outcome after stroke: A report of the Trial of Org 10172 in Acute Stroke Treatment (TOAST). *Neurology*, 126-131.
- [3] Cole, D. M., Smith, S. M., & Beckmann, C. F. (2010). Advances and pitfalls in the analysis and interpretation of resting-state fMRI data. *Front Syst Neurosci*, 4, 8.

# Registration of pre- and post-resection ultrasound volumes with non-corresponding regions in neurosurgery

Hang Zhou<sup>1</sup>; Hassan Rivaz<sup>2</sup>

<sup>1</sup> Hang Zhou is with the Department of Electrical and Computer Engineering and PERFORM Centre, Concordia University, Montreal, Quebec, Canada  
e-mail:z\_hang@encs.concordia.ca

<sup>2</sup> Hassan Rivaz is with the Department of Electrical and Computer Engineering and PERFORM Centre, Concordia University, Montreal, Quebec, Canada  
e-mail:hrivaz@ece.concordia.ca

Brain tissue deforms significantly after opening the dura and during tumor resection, invalidating pre-operative imaging data. Ultrasound is a popular imaging modality for providing the neurosurgeon with real-time updated images of brain tissue. Interpretation of post-resection ultrasound images is difficult due to large brain shift and tissue resection. Furthermore, several factors degrade the quality of post-resection ultrasound images such as the strong reflection of waves at the interface of saline water and brain tissue in resection cavities, air bubbles and the application of blood-clotting agents around the edges of resection. Image registration allows the comparison of post-resection ultrasound images with higher quality pre-resection images, assists in interpretation of post-resection images and may help identify residual tumor, and as such, is of significant clinical importance. In this work [1] [2], we propose a nonrigid symmetric registration (NSR) framework for accurate alignment of pre- and post-resection volumetric ultrasound images in near real-time. We first formulate registration as minimization of a regularized cost function, and analytically derive its derivative to efficiently optimize the cost function. An outlier detection algorithm is proposed and utilized in this framework to identify non-corresponding regions (outliers) and therefore improve the robustness and accuracy of registration. We use an Efficient Second-order Minimization (ESM) method for fast and robust optimization. Furthermore, we exploit a symmetric and inverse-consistent method to generate realistic deformation fields. The results show that NSR significantly improves the quality of the alignment between pre- and post-resection ultrasound images.

## References:

- [1] Zhou, H., & Rivaz, H. (2015, August). Robust Deformable Registration of Pre- and Post-resection Ultrasound Volumes for Visualization of Residual Tumor in Neurosurgery. IEEE EMBC Conference, Milan, Italy (peer reviewed, indexed in PubMed). **Selected for submission of full paper to IEEE JBHI. Only 10 selections out of 2948 papers in IEEE EMBC.**
- [2] Zhou, H., & Rivaz, H. Registration of Pre- and Post-resection Ultrasound Volumes with Non-corresponding Regions in Neurosurgery. IEEE JBHI. Revision under review.

## **The effect of immune cell activation on glycogen storage in the context of a nutrient rich microenvironment**

Tabatabaei Shafiei, Mahdiah <sup>1</sup>, Carvajal Gonczi, Catalina M <sup>2</sup>, Darlington, Peter J. <sup>3</sup>

<sup>1</sup>*Department of Biology, Concordia University, the Centre for Structural and Functional Genomics, and the PERFORM Centre, Montréal, Québec, Canada.*

*Email: [mtaba70@yahoo.com](mailto:mtaba70@yahoo.com)*

<sup>2</sup>*Department of Biology, Concordia University, the Centre for Structural and Functional Genomics, and the PERFORM Centre, Montréal, Québec, Canada.*

<sup>3</sup>*Department of Biology, Department of Exercise Science, Concordia University, the Centre for Structural and Functional Genomics, and the PERFORM Centre, Montréal, Québec, Canada.*

Lymphocytes of the immune system become activated in order to fight pathogens. Activated lymphocytes absorb more glucose due to their high-energy demand. Glycogen is a branched polymer of glucose units that is formed in times of nutrient sufficiency and it is utilized in times of need. In the presence of high glucose, lymphocytes build up glycogen stores, but the fate of this content is not very well understood. The objective of this work was to demonstrate the influence of peripheral blood mononuclear cells (PBMC) activation on glycogen storage and to investigate the impact of low nutrient levels on the glycogen content of these cells. This was achieved by isolation of PBMCs from human blood, followed by in-vitro activation of the cells by a general activator and a T cell specific activator. Glycogen concentrations were measured through periodic acid Schiff's staining (PAS) and enzymatic detection methods, in time points including 30 minutes, 1-3 days post activation treatment. Upon stimulation of lymphocytes with the activators, there was an increase in glycogen expression in the activated lymphocytes as compared to the non-activated group ( $p < 0.05$ ). Additionally, when the amount of nutrients was lowered, less glycogen was stored in PBMCs. We were also able to demonstrate that glycogen has an effect on proliferation of activated PBMCs. This was confirmed through the use of glycogen phosphorylase inhibitor (GPI). Upon addition of GPI to the cultures, the cells proliferation was lowered ( $p < 0.05$ ). The knowledge that was created in this study translates into better understanding of the efficiency of immune system while it is protecting us against infectious agents.

## Can a 3-month walking program enhance brain energy metabolism in mild Alzheimer's disease? Results from neuroimaging pilot study.

CA Castellano<sup>1</sup>; N Paquet, I Dionne, H Imbeault, M Fortier, C Bocti and SC Cunnane<sup>1,2</sup>

<sup>1</sup>Research assistant at the Research Centre on Aging – CIUSSS de l'Estrie - CHUS;

Alexandre.Castellano@USherbrooke.ca

<sup>2</sup>Université de Sherbrooke – CIUSSS de l'Estrie - CHUS

**INTRODUCTION:** Decreased brain glucose but not ketone metabolism is observed in Alzheimer's disease (AD) [1]. Exercise induces mild ketosis and improves cognitive outcomes in AD [2]. The aim of this study is to evaluate the impact of a 3-month supervised walking program on brain glucose and ketone uptake in mild AD. **METHODS:** Cerebral glucose (CMRglu) and ketone metabolism (CMRket) were quantified before and after PET/MRI exams with 18F-FDG and 11C-AcAc ( $\mu\text{mol}/100 \text{ g}/\text{min}$ ). The Walking group trained on a treadmill during 15-40 minutes at moderate intensity, 3 times/week for 12 weeks. The Sedentary group received no active treatment. **RESULTS:** Ten participants ( $75 \pm 5$  years old) have completed the study. After 3-month of physical exercise, plasma ketone concentration was increased by 17% ( $0.4 \pm 0.1 \text{ mM}$ ) whereas glucose concentration remained stable ( $5.1 \pm 0.3 \text{ mM}$ ). Compared to the Sedentary group ( $n=3$ ), the Walking group ( $n=7$ ) tended to maintain their global CMRglu over the 3-month period (+3% vs. -16%;  $p=0.09$ ), an effect localized mostly to the frontal and subcortical regions ( $p=0.06$  and  $p=0.09$ ). The Walking group also had a trend towards higher CMRket in the cingulate (+89%;  $p=0.08$ ). **CONCLUSIONS:** These preliminary results show that walking could potentially increase brain ketone metabolism while maintaining glucose metabolism in AD. If confirmed at the end of the study, these results would help explain why aerobic exercise has a beneficial effect on cognition in mild AD. **ACKNOWLEDGEMENTS:** Supported by the FRQS, CIHR, CFI, CRC, Université de Sherbrooke, FQRNT and INAF.

### References:

- [1] Castellano et al. (2015). Lower brain 18F-fluorodeoxyglucose uptake but normal 11C-acetoacetate metabolism in mild Alzheimer's disease dementia. *J Alzheimers Dis.* 43(4): 1343-1353.
- [2] Cunnane et al. (2016). Can ketones compensate for deteriorating brain glucose uptake during aging? Implications for the risk and treatment of Alzheimer's disease. *Ann N Y Acad Sci.*



# School-aged children born with low and high birth weight: Investigation of obesogenic behaviors

Dubé, Laurette<sup>1</sup>; Dalle Molle, Roberta<sup>2</sup>; Portella, André<sup>3</sup>; Bischoff, Adriane<sup>4</sup>; Silveira, Patricia<sup>4,5</sup>

<sup>1</sup> Professor, Marketing; McGill Centre for the Convergence for Health and Economics, McGill University; laurette.dube@mcgill.ca

<sup>2</sup> McGill University

<sup>3</sup> Universidade Federal de Ciências da Saúde de Porto Alegre

<sup>4</sup> Hospital de Clínicas Porto Alegre

<sup>5</sup> Universidade Federal do Rio Grande do Sul

**Introduction:** Environmental adversities during fetal development increase the risk of chronic diseases in adulthood [1], and insufficient fetal growth influences feeding preferences throughout life [2]. However, little is known about the influence of fetal adversity on other specific behaviors. We aimed at evaluating differences in obesogenic behaviors among school-aged children born with low and high birth weight. **Methods:** Families from Montreal answered questionnaires about household demographic information, sedentary time, physical activity level, and the Child Eating Behavior Questionnaire (CEBQ) and the Children's Sleep Habits Questionnaire (CSHQ). Birth weight ratio (BWR) was calculated and the sample was classified in: Small for Gestational Age (SGA): BWR<0.85; Adequate (AGA): BWR 0.85-1.2; and Large (LGA): BWR>1.2. **Results:** There were 282 boys (40 SGA, 37 LGA) and 281 girls (36 SGA, 29 LGA). Baseline characteristics were similar between groups. SGA and LGA boys spent more minutes per week in screens than AGA boys. Differences in physical activity were not observed, but SGA boys have less sleep problems than the other groups. Results of the CEBQ showed lower scores of restrictive eating for LGA boys compared to AGA boys, there were no differences in emotional and external eating. **Conclusion:** SGA and LGA children have differences in obesogenic behaviors when compared to AGA children, although the behavioral pattern varies according to birth weight and sex. Therefore, fetal adversity seems to program a cluster of behavioral aspects generating different patterns of "thrifty behavior", which may contribute differently to the increased risk of chronic diseases.

## References:

- [1] Hales, C.N.; Barker, D. The thrifty phenotype hypothesis. *Br Med Bull.* 2001; 60: 5-20.
- [2] Dalle Molle, R.; Bischoff, A.R.; Portella, A.K.; Silveira, P.P. The fetal programming of food preferences: current clinical and experimental evidence. *J Dev Orig Health Dis.* 2015; 28: 1-9.

## Remembering what but not where: Age-related deficits in autobiographical memory are specific to recall of spatial context

Carina L. Fan<sup>\*</sup>; Sarah L. Peters, Signy Sheldon

*Department of Psychology, McGill University; \*carina.fan@mail.mcgill.ca*

Healthy aging is characterized by deficits in autobiographical memory retrieval [1], particularly in the use of episodic memory processes to recall details from past events. This impairment has been attributed to age-related changes to the medial temporal lobes, and specifically to the hippocampus [2]. Recent evidence suggests that different hippocampal networks support distinct forms of autobiographical memory retrieval [3]: memories recalled via a specific context are dependent on one network, whereas memories accessed via thematic information, such as event activities, are dependent on a different network. The aim of the present study was to examine whether aging selectively impairs autobiographical memories retrieved by either contextual (i.e., location) or thematic (i.e., activity) routes. Older and younger adult participants described autobiographical memories that were cued by either a location (e.g., malls) or an activity (e.g., celebrating). The resulting memory narratives were scored for the number of episodic (internal) and semantic (external) details present with a validated scoring technique. Overall, older adults generated more external detail than did younger adults, suggesting that they relied more on non-episodic processes when remembering past events. Moreover, we found a specific age-related deficit in the number of internal details provided in memories cued by location. This suggests that age-related episodic memory deficits are most apparent when retrieval is guided by contextual cues as compared to broader thematic cues. These findings are discussed in terms of planned neuroimaging work that will investigate age-related changes in the recruitment of hippocampal networks during autobiographical memory retrieval.

### References:

- [1] Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: dissociating episodic from semantic retrieval. *Psychology and aging, 17*(4), 677-689.
- [2] Maguire, E. A., & Frith, C. D. (2003). Aging affects the engagement of the hippocampus during autobiographical memory retrieval. *Brain: A Journal of Neurology, 126*(7), 1511-1523.
- [3] Sheldon, S., Farb, N., Palombo, D. J., & Levine, B. (2016). Intrinsic medial temporal lobe connectivity relates to individual differences in episodic autobiographical remembering. *Cortex, 74*, 206-216.

# Dynamic programming on a tree for ultrasound elastography

Roozbeh Shams<sup>1</sup>; Mathieu Boily<sup>2</sup>; Paul A. Martineau<sup>2</sup>; Hassan Rivaz<sup>1,3</sup>

ro\_shams@encs.concordia.ca

<sup>1</sup>Concordia University, Montreal, Canada;

<sup>2</sup>McGill University Health Centre (MUHC), Montreal, Canada;

<sup>3</sup>PERFORM Centre, Montreal, Canada;

Ultrasound Elastography is an emerging imaging technique that allows estimation of the mechanical characteristics of tissue [1]. Two issues that need to be addressed before widespread use of elastography in clinical environments are real time constraints and deteriorating effects of signal decorrelation between pre- and post-compression images. Previous work has used Dynamic Programming (DP) to estimate tissue deformation [2]. However, in case of large signal decorrelation, DP can fail. In this paper we, have proposed a novel solution to this problem by solving DP on a tree instead of a single Radio-Frequency line. Formulation of DP on a tree allows exploiting significantly more information, and as such, is more robust and accurate. Our results on phantom and in-vivo human data show that DP on tree significantly outperforms traditional DP in ultrasound Elastography. This work was recently presented in SPIE Medical Imaging Conference in San Diego, CA [3].

## References:

- [1] Ophir, J., Alam, S. K., Garra, B., Kallel, F., Konofagou, E., Krouskop, T., & Varghese, T. (1999). Elastography: ultrasonic estimation and imaging of the elastic properties of tissues. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, 213(3), 203-233.
- [2] Rivaz, H., Boctor, E. M., Choti, M. A., & Hager, G. D. (2011). Real-time regularized ultrasound elastography. *Medical Imaging, IEEE Transactions on*, 30(4), 928-945.
- [3] Shams, R., Boily, M., Martineau, P. A., Rivaz, H. (2016). Dynamic programming on a tree for ultrasound Elastography. In *SPIE Medical Imaging* (pp. 9790-9790). International Society for Optics and Photonics. **Selected as a finalist for a Robert F. Wagner All Conference Best Student Paper Award. Only 16 finalists out of more than 1000 presentations in SPIE.**

# Influence of the alteration of flow topology on the abdominal aortic aneurysm local growth

Florian Joly<sup>1</sup>; Gilles Soulez<sup>2, 3</sup>; Claude Kauffmann<sup>2</sup>

<sup>1</sup>CRCHUM, University of Montreal, QC, Canada; [florian.joly@umontreal.ca](mailto:florian.joly@umontreal.ca)

<sup>2</sup>CRCHUM, University of Montreal, QC, Canada

<sup>3</sup>CHUM, Department of Radiology, Montreal, QC, Canada

**Introduction:** The maximal diameter measurement is currently the reference for the follow-up and repair planning of abdominal aortic aneurysms (AAA). However, growth prediction and associated risk assessment remains at stake. Our goal is the quantification of the blood flow stagnation in the AAA lumen which promotes thrombus deposition and thus premature aortic wall degradation [1].

**Methods:** (i) Segmentation of AAA lumen and thrombus on a patient with 9 pre-repair CT-As (2006 to 2013). (ii) Numerical simulation of the blood flow in the lumen, validated towards 4D MRI. (iii) Extraction of the dynamically isolated zones from the Lagrangian coherent structures (CLS) of the flow [2].

**Results:** In each of the 9 simulations, 2 stagnation zones were discernible along with a 3<sup>rd</sup> zone, connecting the inlet to the outlet. Their volume grew of 127% and 293% while the 3<sup>rd</sup> zone volumes stay constant. The relative occupancy of the stagnation in the lumen went from 25% to 50% in 7 years. Both stagnation zones grew quasi linearly (respectively  $r^2=0.98$  and  $0.84$ ).

**Discussion:** Stagnation zones are known for promoting the advection of shear-stress activated platelets to the wall leading to the apparition of thrombus. Here we propose a robust and practical workflow to quantify their volume in a highly transient flow. Observing and quantifying the phenomena leading the AAA growth is believed to provide an overall better understanding of the disease as well as a more patient-specific follow-up.

## References:

[1] Wilson, J. S., Virag, L., Di Achille, P., Karsaj, I., & Humphrey, J. D. (2013). Biochemomechanics of Intraluminal Thrombus in Abdominal Aortic Aneurysms. *Journal of Biomechanical Engineering*, 135(2), 021011 (4 pp.)

[2] Shadden, S. C., & Arzani, A. (2014). Lagrangian Postprocessing of Computational Hemodynamics. *Annals of Biomedical Engineering*, 1–18.

## Physical fitness training and task-set cost in older adults

Tudor Vrinceanu<sup>1,2</sup>, Melanie Renaud<sup>2</sup>, Louis Bherer<sup>1,2</sup>

<sup>1</sup>Concordia University; [vrinceanu.tudor@gmail.com](mailto:vrinceanu.tudor@gmail.com)

<sup>2</sup>Institut universitaire de gériatrie de Montréal

The effect of physical fitness training on attentional control has already been shown to be affected by age and initial fitness level (Renaud et al., 2010). To further investigate this, 49 older adults from two age categories (57-69 vs. 70-80) participated in a cardiorespiratory exercise-training program or were assigned to a control group (waiting list). The training comprised of stretching, fast walking and aerobic dancing for three months. Before and after the training program all participants completed a computerized cognitive dual-task (with audio/visual stimuli) and the Rockport one-mile test.

Participants in the training group improved their walking speed while the control group did not. No significant interaction was found between training and age category or initial fitness level. However, amongst the 57-69 group, a regression analysis showed that the improvement in the speed of walking predicted the task set cost improvement, standardized  $b = -.58$ ,  $R^2 = .34$ ,  $F(1, 13) = 6.22$ ,  $p = .028$ , such that higher speed improvement predicts better cost reduction.

Those findings suggest that physical fitness improvement can help improve task-set cost, one specific parameter of dual-task performance and that this effect could be stronger in relatively younger older adults. This means that the improvement in the ability to prepare and maintain multiple task sets is related to the fitness improvement.

### References:

- [1] Renaud, M., Maquestiaux, F., Joncas, S., Kergoat, M-J., & Bherer, L. (2010). The effect of three months of aerobic training on response preparation in older adults. *Frontiers in Aging Neuroscience*, 2(148), 1-9.

# Comparison of abdominal computed tomography (CT) scan skeletal muscle and fat cross sectional area versus dual energy x-ray absorptiometry (DXA) appendicular lean (skeletal muscle mass) and fat masses using novel imaging software in advanced cancer patients

Noor Mady<sup>1,2</sup>, Melanie Lessard<sup>1,2</sup>, Elizabeth Nolin<sup>1,2</sup>, Leonard Rosenthal MD<sup>3</sup>, Jonathan Afilalo MD<sup>4</sup>, Louis Antoine Mullie MD<sup>5</sup>, Antonio Vigano MD<sup>2,6</sup>, Robert D. Kilgour PhD<sup>2,6,7</sup>

<sup>1</sup>Department of Psychology and Science College, Concordia University; [nmady66@gmail.com](mailto:nmady66@gmail.com)

<sup>2</sup>McGill Nutrition and Performance Laboratory, McGill University Health Centre, Montreal;

<sup>3</sup> Department of Radiology, McGill University, Montreal;

<sup>4</sup> Divisions of Cardiology and Clinical Epidemiology, Jewish General Hospital, Montreal;

<sup>5</sup> Internal Medicine, McGill University Health Centre, Montreal;

<sup>6</sup> Department of Exercise Science and Science College, Concordia University, Montreal; <sup>7</sup> PERFORM Centre, Concordia University, Montreal

**Introduction:** Although dual energy x-ray absorptiometry (DXA) has been the reference standard for measuring body composition, the use of computer tomography (CT) scans has been gaining popularity as a surrogate and opportunistic measure of overall body composition, especially in clinical populations<sup>1,2</sup>. It remains to be determined if the cross-sectional areas of skeletal muscle and fat found in single abdominal CT scans are related to appendicular skeletal muscle and fat masses measured by DXA in advanced cancer patients. **Methods:** In 19 patients with advanced or metastatic cancer, cross sectional areas of skeletal muscle mass (psoas, paraspinal and abdominal wall) and fat (visceral, subcutaneous, and intramuscular) were measured from CT scans using novel imaging software (CoreSlicer). Appendicular skeletal muscle and fat masses were obtained in the same patients using DXA. **Results:** Spearman rank correlations between skeletal muscle cross sectional areas (cm<sup>2</sup>) and appendicular skeletal muscle mass (g) were moderately to highly related (psoas vs. appendicular; rho=0.72), (paraspinal vs. appendicular; rho=0.77) and (abdominal wall vs. appendicular; rho=0.84). Similar strong relationships existed between subcutaneous and appendicular fat (rho = 0.94) but not with visceral vs. appendicular (rho=0.38) or intramuscular vs. appendicular (rho=0.02) fat. **Conclusions:** Based upon these preliminary results, selected skeletal muscle and fat cross sectional area measurements from single abdominal CT scan may serve as an opportunistic surrogate for appendicular DXA measures. Larger cohort studies are needed to determine if CT scans truly reflect trends in appendicular tissue masses in order to assess sarcopenia and cachexia in clinical populations.

1. Prado, C.M.M., and Heymsfield, S.B. 2014. Lean tissue imaging: A new era for nutritional assessment and intervention. JPEN J. Parenter. Enteral Nutr. 38: 940–953.
2. Shen, W., Punyanitya, M., Wang, Z., Gallagher, D., St-Onge, M., Albu, J., et al. 2004. Total body skeletal muscle and adipose tissue volumes: Estimation from a single abdominal cross-sectional image. J. Appl. Physiol. 97: 2333–2338

## Investigating age-related differences in task-set inhibition from the dual mechanisms of control theory

Steve Desbiens<sup>1,2</sup>; Kiran Vadaga<sup>1,2</sup>; Karen Li<sup>1,2</sup>

<sup>1</sup> Centre for Research in Human Development and; [sdesbiens77@gmail.com](mailto:sdesbiens77@gmail.com)

<sup>2</sup> Department of Psychology, Concordia University, Montréal, Québec, Canada.

We examined the utility of the Dual Mechanisms of Control (DMC; Braver, Gray, & Burgess, 2007) theory in predicting age-related differences in task set inhibition. The DMC theory postulates two control mechanisms that achieve conflict resolution by early (proactive) and late (reactive) correction mechanisms either by the use of predictive information (e.g., valid task cues; proactive) or by stimulus characteristics (reactive). With a task-switching methodology, we examined age-related differences in task set inhibition in four conditions that varied in proactive and reactive demands: exclusively proactive control (EPC), exclusively reactive control (ERC), proactive plus reactive (P+R) control, and reliance of reactive over proactive (ROP) control. Healthy young (age: 18-35) and older adults (age: 60-75) completed a computerized simple math task consisting of single digit addition, subtraction and multiplication. In EPC and P+R trials, a cue (e.g., plus, minus, multiply) preceded the stimulus. In EPC, the stimulus did *not* indicate the operation (e.g.,  $2 \_ 6 = 8$ ). In ROP and ERC trials, cues were *misleading* and *missing* respectively, therefore participants had to rely on the stimulus. The task-set inhibition was computed by contrasting RTs on A in ABA and CBA sequences. The longer RTs in A in ABA trials indicated persistent inhibition of previous task sets. Results indicate task-set inhibition in reactive control (ERC) and moderate age effects (Cohen's  $d = .60$ ) favoring older adults in reactive over proactive control (ROP). These findings suggest that age-related differences in task-set inhibition may vary as a function of proactive and reactive control.

### References:

- [1] Braver, T.S., Gray, J.R., & Burgess, G.C. (2007). Explaining the many varieties of working memory variation: Dual mechanisms of cognitive control. In Conway, A. R., Jarrold, C. E., Kane, M. J., Miyake, A., & Towse, J. N. (2007). *Variation in working memory* (pp. 76-106). Oxford, United Kingdom: Oxford University Press.

## Edge-preserving ultrasonic strain imaging with uniform precision

Hossein Khodadadi<sup>1</sup>, Amir G. Aghdam<sup>1</sup> and Hassan Rivaz<sup>1,2</sup>

*h\_khodad@encs.concordia.ca*

<sup>1</sup>*Concordia University, Montreal, Canada;*

<sup>2</sup>*PERFORM Centre, Montreal, Canada;*

Ultrasound Elastography involves measuring the mechanical properties of tissue, and has many applications in diagnostics and intervention. A common step in different Elastography methods is imaging the tissue while it undergoes deformation and estimating the displacement field from the images. A popular next step is to estimate tissue strain, which gives clues into the underlying tissue elasticity modulus. To estimate the strain, one should compute the gradient of the displacement image, which amplifies the noise. The noise is commonly minimized by least square estimation of the gradient from multiple displacement measurements, which reduces the noise by sacrificing image resolution. In this work, we adaptively adjust the level and orientation of the smoothing using two different mechanisms. First, the precision of the displacement field decreases significantly in the regions with high signal decorrelation, which requires increasing the smoothness. Second, smoothing the strain field at the boundaries between different tissue types blurs the edges, which can render small targets invisible. To minimize blurring and noise, we perform anisotropic smoothing and perform smoothing parallel to the direction of edges. The first mechanism ensures that textures/variations in the strain image reflect underlying tissue properties and are not caused by errors in the displacement estimation. The second mechanism keeps the edges between different tissue structures sharp while minimizing the noise. We validate the proposed method using phantom and in-vivo clinical data.



## **Brain glucose and ketone metabolism in mild cognitive impairment and Alzheimer's disease: A cross-sectional study**

Etienne Croteau<sup>1</sup>; Castellano CA<sup>2</sup>; Bocti C<sup>3</sup>; Fulop T<sup>4</sup>; Paquet N<sup>5</sup>; Cunnane S<sup>6</sup>

<sup>1</sup>*Research Centre on Aging, Department of Medicine, Department of Pharmacology-Physiology Université de Sherbrooke; Etienne.croteau@usherbrooke.ca*

<sup>2</sup>*Research Centre on Aging, Université de Sherbrooke;*

<sup>3</sup>*Department of Medicine, Université de Sherbrooke;*

<sup>4</sup>*Research Centre on Aging, Department of Medicine, Université de Sherbrooke;*

<sup>5</sup>*Department of Nuclear Medicine, Université de Sherbrooke;*

<sup>6</sup>*Research Centre on Aging, Department of Medicine, Université de Sherbrooke;*

**Introduction:** Deteriorating brain glucose hypometabolism precedes and appears contribute to the etiology of Alzheimer disease (AD). Ketone bodies, mainly  $\beta$ -hydroxybutyrate and acetoacetate, are the primarily alternative brain fuel to glucose. Little is known about whether brain ketone metabolism also changes as AD develops.

**Objective:** To evaluate brain energy metabolism (glucose and acetoacetate) in cognitively healthy older adult controls (CTL), mild cognitive impairment (MCI) and patients with mild AD.

**Methods:** 22 CTL, 15 MCI and 15 AD of similar age underwent our dual tracer PET/MRI protocol. The rate constants and cerebral metabolic rate of glucose ( $CMR_g$ ) and acetoacetate ( $CMR_a$ ) were evaluated with PET [<sup>18</sup>F]-FDG, a glucose analogue, and [<sup>11</sup>C]-acetoacetate, respectively.

**Results:** In AD vs. CTL,  $CMR_g$  was significantly lower in frontal, parietal, temporal and cingulate gyrus regions ( $\sim -10\%$ ,  $p < 0.05$ ). Compared to CTL, the rate constant for [<sup>18</sup>F]-FDG uptake was also lower in the frontal (AD  $\sim -20\%$ ) and cingulate gyrus (AD  $\sim -20\%$ , MCI  $\sim -10\%$ ),  $p < 0.05$ . Regional-based  $CMR_a$  analysis did not reach significance between CTL and MCI or AD.

**Discussion:** Kinetic, quantitative PET imaging of glucose and acetoacetate metabolism demonstrates that deteriorating energy substrate utilisation by the brain in MCI and AD is specific to glucose. These results need to be confirmed in a longitudinal study. However, they suggest that ketogenic supplements may be able to bypass the brain energy deficit in MCI and AD.

**Financial support:** Université de Sherbrooke, FRQS, CIHR, CFI, CRC, Alzheimer Association USA, Sojecci 2.

# Distinct brain activations during straight walking and steering of gait: an [<sup>18</sup>F]-FDG-PET study

Faryn Starrs<sup>1,2</sup>; Ilse Frias<sup>1,2</sup>, Jean-Paul Soucy<sup>3</sup> and Caroline Paquette<sup>1,2</sup>

<sup>1</sup>Department of Kinesiology and Physical Education, McGill University, Montreal, Canada; [faryn.starrs@mail.mcgill.ca](mailto:faryn.starrs@mail.mcgill.ca)

<sup>2</sup>Centre of Interdisciplinary Research in Rehabilitation, Montreal Canada.

<sup>3</sup>PET Unit, McConnell Brain Imaging Centre, Montreal Neurological Institute, McGill University, Montreal, Canada

**Introduction:** Turning while walking is an essential component of locomotion as it allows one to steer around obstacles, or redirect themselves<sup>1</sup>. Functional magnetic resonance imaging (fMRI) studies found that volitional goals originate from higher regions of the frontal cortex, which then alter lower, more automatic structures<sup>2,3</sup>. However, participants imagine walking while lying in the scanner, thus, there is no sensory feedback. This study aims to determine brain regions controlling straight walking and steering of gait using [<sup>18</sup>F]-fluorodesoxy-glucose (FDG) Positron Emission Tomography (PET). We hypothesize that parietal and sensorimotor regions will be activated during steering of gait and occipital areas will be activated during straight walking.

**Methods:** [<sup>18</sup>F]-FDG-PET was used to quantify regional cerebral glucose metabolism (CMGlc) in 7 healthy subjects ( $M_{age}=25$ ). Subjects were injected with 150MBq of [<sup>18</sup>F]-FDG and began the 40min task. All subjects performed 3 motor tasks for 40mins after injection: 1) steering of gait (SG), 2) straight walking (SW) and 3) upright standing (US) (all subjects performed each task once). Resting PET images were subtracted from the intervention images (eg. SG-SW). Regions showing significant increases and decreases in CMGlc were thresholded at  $p < .05$ , and corrected for multiple comparisons<sup>4</sup>.

**Results:** Young subjects showed consistent activations during SG in the intraparietal sulcus, sensorimotor cortex and cerebellar vermis. As with SW, visual areas in the occipital lobe, sensorimotor cortex and cerebellar vermis were activated.

**Conclusion:** Understanding this complex integration of locomotion at a young age is essential in developing rehabilitation therapies for pathological populations and understanding compensatory mechanisms aging.

## References:

- [1] Lamontagne, A., Paquette, C., & Fung, J. (2007). Stroke affects the coordination of gaze and posture during preplanned turns while walking. *Neurorehabil Neural Repair*, 21(1), 62-67.
- [2] Jahn, K., Deutschlander, A., Stephan, T., Strupp, M., Wiesmann, M., & Brandt, T. (2004). Brain activation patterns during imagined stance and locomotion in functional magnetic resonance imaging. *Neuroimage*, 22(4), 1722-1731.
- [3] La Fougere, C., Zwergal, A., Rominger, A., Forster, S., Fesl, G., Dieterich, M., Jahn, K. (2010). Real versus imagined locomotion: a [<sup>18</sup>F]-FDG PET-fMRI comparison. *Neuroimage*, 50(4), 1589-1598.
- [4] Genovese, C. R., Lazar, N. A., & Nichols, T. (2002). Thresholding of statistical maps in functional neuroimaging using the false discovery rate. *Neuroimage*, 15(4), 870-878.

# Non-causal Gauss Markov based Signal Processing Approaches for Motion Tracking in Shear-Wave Elastography

Mahmoud Derakhshan Horeh<sup>1,2</sup>, Amir Asif<sup>1</sup>, and Hassan Rivaz<sup>1,2</sup>

<sup>1</sup>Department of Electrical and Computer Engineering

<sup>2</sup>PERFORM Centre

Concordia University

In shear-wave elastography [1,2], high intensity focused ultrasound is used to generate mechanical excitation in human tissues to map local variations in stiffness that provide clinically relevant information used, for example, in localizing artificial growths and tumors. The ultrasound excitation generates a shear-wave, which propagates at a speed proportional to the elasticity modulus of the tissues. The movement of the induced shear-wave is recorded by a sequence of ultrasound images, which are pairwise correlated to estimate the displacement and consequently the strain generated on the tissues [1]. The normalized cross correlation (NCC) similarity metric [3] is often used to determine the displacement field.

Despite numerous advantages including free-hand and noninvasive operation [2], existing shear-wave elastography techniques assume specific elastic and isotropic properties for tissues and often ignore ultrasound dispersive, geometric and boundary effects. Such underlying assumptions lead to distortions in the estimated displacement fields. Presence of noise and outliers in unfiltered ultrasound data must also be mitigated to attain sufficient accuracy for successful clinical application of this modality. Our research is focused on developing novel signal processing techniques (based on our earlier work in the Kalman filter and Rauch–Tung–Striebel (RTS) smoother based image restoration and de-noising algorithms) [4] for shear wave imaging from noisy ultrasound displacement data. Based on non-causal Gauss Markov random fields, our techniques provide higher accuracy and have the potential to generate volume rendering similar to computed tomography (CT) or magnetic resonance imaging (MRI) using available 2D ultrasound data.

**Key Words:** Elastography, Motion Estimation, Kalman Filter, Tissue Elasticity, Gauss Markov fields, Non-causal prediction, Rauch–Tung–Striebel smoother.

## References:

- [1] Rivaz, H., Boctor, E., Choti, M., Hager, G., Real-Time Regularized Ultrasound Elastography, IEEE Trans. Medical Imaging, April 2011, vol. 30 pp 928-945.
- [2] Doherty, Joshua R., et al. "Acoustic radiation force elasticity imaging in diagnostic ultrasound." Ultrasonics, Ferroelectrics, and Frequency Control, IEEE Transactions on 60.4 (2013): 685-701.
- [3] Hall, Timothy J., Yanning Zhu, and Candace S. Spalding. "In vivo real-time freehand palpation imaging." Ultrasound in medicine & biology 29.3 (2003): 427-435.
- [4] Asif, A., "Fast Rauch–Tung–Striebel Smoother-Based Image Restoration for Noncausal Images." Signal Processing Letters, IEEE (2004): 371-375.

## The effect of training cessation on cognitive performances in older adults

Lynden Rodrigues<sup>1,2,3</sup>, Tudor Vrincineau<sup>1,2,3</sup>, Nicolas Berryman<sup>3,4</sup>, Laurent Bosquet<sup>3,5</sup>, Sylvie Nadeau<sup>6</sup>, Sélina Lauzière<sup>6</sup>, Lora Lehr<sup>3</sup>, Florian Bobeuf<sup>3</sup>, Marie Jeanne Kergoat<sup>3</sup>, Thien Tuong Minh Vu<sup>3,7</sup>, Louis Bherer<sup>1,2,3</sup>

<sup>1</sup>Concordia University, Montréal QC; l\_odrig@concordia.live.ca

<sup>2</sup>PERFORM Centre, Montréal, QC, Canada

<sup>3</sup>Institut Universitaire de Gériatrie de Montréal, Montréal, QC, Canada

<sup>4</sup>Sports Studies Department, Bishop's University, Sherbrooke, QC, Canada

<sup>5</sup>Faculté des Sciences du Sport, Laboratoire MOVE, Université de Poitiers, Poitiers, France

<sup>6</sup>École de Réadaptation – Faculté de Médecine, Université de Montréal, Montréal, QC, Canada

<sup>7</sup>Centre Hospitalier de l'Université de Montréal, Département de Médecine, Service de Gériatrie, Montréal, QC, Canada

Different methods of exercise programs, such as combined strength and aerobic (S+A), and gross motor skills (GMS) training, have shown promise in improving the cognitive performance of older adults, particularly in executive function<sup>1,2</sup>.

Adherence to a regimen may be challenging for older adults due to illness, injury or lack of motivation, which may result in periods of training cessation<sup>3</sup>. Training cessations can result in losses of training induced physiological and performance benefits<sup>4</sup>. To study the impact of a cessation period on cognitive performance, we conducted an analysis on an existing dataset collected from a CIHR funded study (PI Bherer) of a previously assembled cohort of 40 older adults (mean age  $\pm$  standard deviation, 70.5 $\pm$ 5.51 years; 67.5% female).

Participants had completed an 8-week long, 3 session-per-week, program in one of three interventions (combined lower body S+A, combined upper body S+A, and GMS), followed by an 8-week training cessation period. Cognitive performance was assessed, at rest, using the Random Number Generation (RNG) test<sup>5</sup>, examining executive function (updating working memory and inhibition). Analysis of RNG scores using two-way ANOVAs (time\*intervention), with repeated measures for time (pre and post-intervention, and post-cessation), revealed all interventions demonstrated maintenance or improvement of RNG inhibition scores post-intervention and post-cessation. However, there was no change or worse performance in working memory post-intervention and cessation.

These findings indicate that a training cessation period may impact, selectively, on cognitive performance, and that gained cognitive benefits could be retained past a period of cessation, regardless of the exercise intervention employed.

### References:

- [1] Berryman, N., Bherer, L., Nadeau, S., Lauzière, S., Lehr, L., Bobeuf, F., ... & Bosquet, L. (2014). Multiple roads lead to Rome: combined high-intensity aerobic and strength training vs. gross motor activities leads to equivalent improvement in executive functions in a cohort of healthy older adults. *Age*, 36(5), 1-19.
- [2] Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults a meta-analytic study. *Psychological science*, 14(2), 125-130.
- [3] Smith, K., Winegard, K., Hicks, A. L., & McCartney, N. (2003). Two years of resistance training in older men and women: the effects of three years of detraining on the retention of dynamic strength. *Canadian Journal of Applied Physiology*, 28(3), 462-474.
- [4] Mujika, I., & Padilla, S. (2000). Detraining: loss of training-induced physiological and performance adaptations. Part I. *Sports Medicine*, 30(2), 79-87.
- [5] Audiffren, M., Tomporowski, P. D., & Zagrodnik, J. (2009). Acute aerobic exercise and information processing: modulation of executive control in a random number generation task. *Acta psychologica*, 132(1), 85-95.

## Learning-induced plasticity in vascular properties in the human brain

Avner Fitterman<sup>1</sup>; Sophia Grahl<sup>2</sup>; Uta Schneider<sup>2</sup>; Christine Tardif<sup>3</sup>; Chris Steele<sup>3</sup>; Pierre-Louis Bazin<sup>2</sup>; Claudine Gauthier<sup>1</sup>;

<sup>1</sup>Concordia University; *PERFORM* centre

<sup>2</sup>Max Planck Institute for Human Cognitive and Brain Science, Leipzig

<sup>3</sup>Douglas Mental Health Institute, Brain Imaging Centre, McGill University  
avner.fitterman@gmail.com

**Introduction.** The brain is a plastic organ, able to undergo structural and functional changes following changing physiological contingencies, such as disease and exercise training [1]. However, the nature of the biological changes that underlie plasticity in the adult human brain is not fully understood. There is evidence suggesting that part of this plasticity is related to vasculature changes. Here, cerebral blood flow (CBF) will be assessed in course of 5 days of learning a motor task [2] to measure this vascular plasticity.

**Methods.** Data were acquired in 18 healthy young adults (9 Males, age=25.7±3.0 years). Data were acquired using arterial spin labeling (ASL) with a single subtraction (QUIPSS) flow-sensitive inversion recovery (FAIR) pulse sequence on a 7-T MRI scanner [3]. Acquisition parameters include: TR/TE/TI1/TI2=4300/9.2/700/1400ms, 3.0x3.0x3.0mm voxels and 30 slices. Quantitative perfusion was obtained using the model in [4].

**Results.** CBF maps of 18 subjects were obtained. The average CBF value in gray matter averaged over all the subjects is 50.5±7.3 ml/100gr/min. The measured averaged SNR is 83.3±37.2. These values were within the expected physiological range [5] and show higher flow within grey matter as shown previously [3].

**Conclusions.** Preliminary findings show flow values within the expected physiological range throughout grey matter. This represents the first stage of an expanded vasculature investigation to study the vascular plasticity associated with the course of learning of a motor task. Results are expected to show increased CBF in task-relevant areas previously shown to be associated with increased grey matter volume [2].

### References:

- [1] Maass, A. (2014). *Molecular Psychiatry. Vesicular hippocampal plasticity after aerobic exercise in older adults*, 1-9
- [2] Gryga, M. (2012). *Frontiers in Systems Neuroscience. Bidirectional gray matter changes after complex motor skill learning*, 6(37); 1-9
- [3] Eric, C. (1998). *Magnetic Resonance in Medicine. Quantitative Imaging of Perfusion Using a Single Subtraction (QUIPSS and QUIPSSii)*; 39; 702-708
- [4] Buxton, R. (1996). *Magnetic Resonance in Medicine. A General Kinetic Model for Quantitative Perfusion Imaging with Arterial Spin Labeling*; 40; 383-396
- [5] Çavuşoğlu M. (2009). *Magnetic Resonance Imaging. Comparison of pulsed arterial spin labeling encoding schemes and absolute perfusion quantification*; 27 ; 1039-1045

# Associations between pulsatile hemodynamics in the middle cerebral arteries and cardiac-related fluctuations in functional magnetic resonance imaging

Sarah Atwi, MsC<sup>1,2,3</sup>; Andrew D. Robertson, PhD<sup>1,3</sup>; Arron W.S. Metcalfe, PhD,<sup>1,3,4,5</sup>; and Bradley J. MacIntosh, PhD<sup>1,2,3</sup>.

<sup>1</sup>*Sunnybrook Research Institute, University of Toronto, Toronto, ON, Canada; satwi@sri.utoronto.ca*

<sup>2</sup>*University of Toronto, Toronto, ON, Canada*

<sup>3</sup>*Heart and Stroke Foundation Canadian Partnership for Stroke Recovery, Toronto, ON, Canada*

<sup>4</sup>*Brain Sciences, Sunnybrook Research Institute, University of Toronto, Toronto, ON, Canada*

<sup>5</sup>*Centre for Youth Bipolar Disorder, Toronto, ON, Canada*

Pathophysiological links between vascular dysfunction and cognitive decline are becoming increasingly clear. One such example is central arterial stiffening at the aorta, which increases hemodynamic pulsatility causing damage in highly vascularized target organs like the brain. This study tested the hypothesis that pulsatile signals from the middle cerebral arteries (MCA) are directly related to those found in downstream regions of the brain. We measured the MCA pulsatility index (MCA-PI) by transcranial Doppler ultrasound (TCD) and cardiac pulsatility in the brain as indexed by cerebrospinal fluid (CSF) related pulsations (CSF-PI) from a blood-oxygenation level dependent fMRI time series. Older and younger adults (N=34) underwent a multi-echo fMRI (3T Philips scanner) task-based scan immediately followed by a seated resting TCD assessment. We used FMRIB FEAT (V5.0.7) and R (V3.1.1) software to extract the pulsatile features in the fMRI data via a procedure modeled after the CompCor method<sup>1</sup>. Regions of interest were defined based on large artery vascular anatomy. CSF-PI % signal changes were extracted and analyzed against the mean and standard deviation (sd) of MCA-PI. Preliminary results show a correlation between CSF-PI and MCA-PIsd in brain regions corresponding to the right (P=0.024, t=2.37) and left (P=0.005, t=3.01) MCA, but not between mean MCA-PI and CSF-PI. In summary, we established a relationship between arterial stiffening variability in large cerebral arteries and fMRI-derived pulsatility in the brain. Considering arterial stiffness can be improved through lifestyle interventions like exercise, this research may help explain the link between vascular plasticity and brain health.

- [1] Behzadi, Y., Restom, K., Liao, J., Liu, T.T., A component based noise correction method (CompCor) for BOLD and perfusion based fMRI. *Neuroimage*, 37(1), 90-101.

## **The effect of combined activities on cognitive functions in older adults**

Louiza Kahina Harkouk<sup>1</sup>, Laurence Lai<sup>1</sup>, & Karen Z. H. Li<sup>1</sup>

<sup>1</sup>*Centre for Research in Human Development, Concordia University*

*louiza.k.h@hotmail.fr*

This study examined the combined effect of social activities, physical activities, and cognitive activities on cognitive functions in older adults. Four hundreds and thirty one healthy older adults between the ages of 46 and 79 years old ( $M = 62$ ,  $SD = 4.97$ ) were recruited for their contribution in a larger longitudinal study: the Concordia Longitudinal Retirement Project (CLRP) [1]. The CLRP measures were repeated every year for four years, however the reported data was taken from the third year of the study. To evaluate their engagement in daily social, physical, and cognitive activities, participants completed three questionnaires: including the Everyday Activity Questionnaire (EAQ), the Human Activity Profile (HAP), and the Need for Cognition Scale (NC). Additionally, three neuropsychological tests: including the Montreal Cognitive Assessment (MoCA), the trail making test, and the digit symbol were administered to measure participant's cognitive functions and executive functions. It was expected that the combination of social, physical, and cognitive activities would be more beneficial to cognitive functions and executive functions than any single activity. As anticipated, the results revealed that higher frequency of social, physical and cognitive activities seems to be beneficial to general cognitive functioning (Montreal Cognitive Assessment) and executive functions such as task switching (Trails B – A) ability and processing speed (digit symbol). These results can inform the creation of public health programs for seniors that would target a mixture of social gathering, physical exercise and mentally stimulating activities.

### References:

- [1] Baer, L. H., Tabri, N., Blair, M., Bye, D., Li, K. Z., & Pushkar, D. (2012). Longitudinal associations of need for cognition, cognitive activity, and depressive symptomatology with cognitive function in recent retirees. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, gbs112.

# Characterization of body composition, strength and performance in advanced lung cancer patients using dual energy x-ray absorptiometry: subanalysis of an essential amino acid clinical trial

Jonathan di Tomasso<sup>1,2,3</sup>; Leonard Rosenthal MD<sup>2</sup>; Robert Kilgour PhD<sup>3,4,5</sup>; Antonio Viganò MD<sup>1,2,3</sup>

<sup>1</sup>McGill University; [jonathan.ditomasso@mail.mcgill.ca](mailto:jonathan.ditomasso@mail.mcgill.ca)

<sup>2</sup>McGill University Health Centre

<sup>3</sup>McGill Nutrition and Performance Laboratory

<sup>4</sup>Department of Exercise Science and Science College, Concordia University

<sup>5</sup>PERFORM Centre, Concordia University

**Introduction:** Studies have shown that body composition may be as important as weight in people with cancer[1]. The goals of this study were to characterize changes in body composition, muscle strength and performance in advanced lung cancer patients.

**Methods:** Data was obtained from a randomized, double-blinded, placebo-controlled trial examining the effects of essential amino acid supplementation in people with advanced lung cancer. Three study visits were spaced six weeks apart. Assessments included body composition (dual-energy x-ray absorptiometry), hand grip strength (Jamar hand dynamometer) and, self-rated performance (abridged Patient-Generated Subjective Global Assessment). Sarcopenia classification adapted from Cruz-Jentoft et al[2].

**Results:** Thirty participants enrolled in the trial, 14 assigned to placebo and 16 to active treatment. There were no significant differences in body composition or strength between placebo and active treatment groups. Fifteen participants completed all assessments. Participants gained significant lean mass in legs (12.7 to 13.1kg,  $p < 0.001$ ) and increased their appendicular skeletal muscle index. A trend for improved performance status over time did not reach significance. Those who dropped out weighed more (13.0kg;  $p < 0.01$ ) with more fat (7.0kg;  $p < 0.03$ ) than those who completed the trial. Initially 53% of participants presented with any degree of sarcopenia which remained stable throughout the study.

**Conclusion:** Increases in lean body mass and performance remain possible in advanced lung cancer patients. Sarcopenia is prevalent in this patient population. More research is needed to identify which factors are responsible for changes in body composition, strength and performance in advanced cancer patients.

## References:

1. Baracos, V.E., et al., *Body composition in patients with non-small cell lung cancer: a contemporary view of cancer cachexia with the use of computed tomography image analysis*. The American Journal of Clinical Nutrition, 2010. **91**(4): p. 1133S-1137S.
2. Cruz-Jentoft, A.J., et al., *Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People*. Age Ageing, 2010. **39**(4): p. 412-23.



# Accuracy assessment of time-delay estimation in ultrasound elastography

Mohamad Ghasemi Amidabadi<sup>1</sup>; Dr. Omair Ahmad<sup>2</sup> ; Dr. Hassan Rivaz<sup>3</sup>

<sup>1</sup> *Graduate Research Assistant at IMPACT Group; m\_hase@ece.concordia.ca*

<sup>2</sup> *Full Professor at ECE Department, Concordia University*

<sup>3</sup> *Assistant Professor at ECE Department, Director of IMPACT Group, Concordia University*

Ultrasound elastography involves estimating time-delay between ultrasound radio frequency data as the tissue undergoes deformation, and reveals mechanical properties of tissue [1]. The accuracy of Time-Delay Estimation (TDE) is usually measured by calculating the value of Normalized Cross Correlation (NCC) at the estimated displacement. NCC, however, can be very high at a displacement estimate with large error, a well-known problem in TDE referred to as peak-hopping.

Herein, we propose a novel method to assess the accuracy of TDE by investigating the NCC profile around the estimated time-delay. We then train a linear Support Vector Machine (SVM) classifier to assess the quality of TDE. The results on simulation, phantom and *in-vivo* data show the significant improvement of the proposed algorithm compared to the conventional method that uses only one NCC value.

## Reference:

- [1] Ophir, J., et al. "Elastography: ultrasonic estimation and imaging of the elastic properties of tissues." *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine* 213.3 (1999): 203-233.

# Direct analytical estimation of strain elastography from ultrasound radio-frequency data

Mona Omidyeganeh<sup>1</sup>, M. Omair Ahmad· Hassan Rivaz

<sup>1</sup> *Postdoctoral Fellow, Department of Electrical and Computer Engineering, Concordia University, Montreal, QC, Canada; [m\\_omidye@live.concordia.ca](mailto:m_omidye@live.concordia.ca)*

In this paper, a novel scheme to directly calculate a strain elastography estimation from two images of radio frequency (RF) ultrasound data is proposed. Most of the strain estimation methods have a pipeline approach, in which first the tissue displacement field is estimated from RF images, and then a spatial derivative operation is applied. There are two main issues associated with these schemes. First, the gradient operation amplifies the noise, and therefore, smoothing techniques need to be applied. Second, the strain estimation does not take into account the original RF data and it relies solely on the noisy displacement field. We propose a new method that uses both the displacement matrix, calculated using the idea of [1, 2], as well as the RF images to calculate precise strain estimations. A normalized cross correlation (NCC) metric between two equivalent windows around the samples of the pre- and post-compressed frames is utilized to create a dissimilarity measurement [3]. The derivative of NCC considering the strain image is analytically derived employing the chain rule. This allows an effective minimization of the dissimilarity metric with respect to the strain using the gradient descent (GD) optimization technique. The effectiveness of the proposed technique is studied using simulated data, phantom experiments and *in-vivo* patient data. The experimental results confirm that utilizing the information from the RF data significantly improves the strain estimates.

## Example References:

- [1] Rivaz, H., Boctor, E., Choti, M., Hager, G., “Real-time regularized ultrasound elastography,” *IEEE Trans. Medical Imaging*, 2011; vol. 30, pp. 928-945.
- [2] Rivaz, H., Boctor, E., Foroughi, P., Zellars, R., Fichtinger, G., Hager, G., “Ultrasound elastography: a dynamic programming approach,” *IEEE Trans. Medical Imaging*, 2008; vol. 27, pp. 1373-1377.
- [3] Rivaz, H., Collins, D.L., “Near real-time robust nonrigid registration of volumetric ultrasound images for neurosurgery,” *Ultrasound in Medicine and Biology*, 2015, vol. 41, pp. 574-587.

# **A low-cost camera-based transducer tracking system for freehand three-dimensional ultrasound imaging**

Mohammad M. Baba<sup>1</sup>; Otmane Ait Mohamed<sup>1</sup>; Falah Awwad<sup>3</sup>; Mohammad I. Daoud<sup>4</sup>

<sup>1</sup>*Concordia University, Montreal, Canada; e-mail: {mo\_baba,ait}@encs.concordia.ca*

<sup>2</sup>*United Arab Emirates University, Al-Ain, United Arab Emirates*

<sup>3</sup>*German Jordanian University, Amman, Jordan*

Freehand three-dimensional ultrasound (3D US) imaging is commonly used for clinical diagnosis and therapy monitoring [1]. In this technique, accurate tracking of the US transducer is a crucial requirement to develop high-quality 3D US volumes. However, current methods for transducer tracking are generally expensive and inconvenient [2]. This work presents a low-cost camera-based system for tracking the US transducer with six degrees of freedom. In this system, two orthogonal cameras with non-overlapped views are mounted on the US transducer. During US scanning, the cameras are employed to track artificial features attached to the patient skin. A 3D surface map is constructed based on the tracked features and the 3D poses of each camera with respect to the skin are extracted separately. The estimated poses of the two cameras are spatially combined to provide accurate and robust pose estimation of the US transducer. In particular, the fusion of the estimated poses by the two cameras is performed using Kalman filtering based technique, which is a popular optimization technique in motion tracking. The camera-based tracking of the US transducer has been applied to synthesize freehand 3D US volumes. The performance of the proposed system is evaluated by performing in-vitro 3D US imaging experiments and quantifying the synthesized US volumes. The results demonstrate that two points in the 3D US volume separated by a distance of 10 mm can be reconstructed with an average error of 0.35 mm and a volume of a cylinder can be estimated within an error of 3.8%.

## **References:**

- [1] Fenster, A., Parraga, G., & Bax, J. (2011). Three-dimensional ultrasound scanning. *Interface focus*, 1(4), 503-519.
- [2] Prager, R. W., Ijaz, U. Z., Gee, A. H., & Treece, G. M. (2010). Three-dimensional ultrasound imaging. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine*, 224(2), 193-223.

## **No evidence of neurodegeneration in areas of decreased cerebral grey matter in chronic pain patients**

FB Pomares<sup>1</sup>; T Funck<sup>2</sup>; N Feier<sup>1</sup>; S Roy<sup>1</sup>; A Daigle-Martel<sup>3</sup>; M Ceko<sup>4</sup>; S Narayanan<sup>2</sup>; D Araujo<sup>2</sup>; A Thiel<sup>2,5</sup>; N Stikov<sup>3</sup>; MA Fitzcharles<sup>6</sup>; P Schweinhardt<sup>1,7</sup>

Florence POMARES, postdoctoral research fellow, Alan Edwards Centre for Research on Pain and Faculty of Dentistry, McGill University, [florence.pomares@mcgill.ca](mailto:florence.pomares@mcgill.ca)

<sup>1</sup> *Alan Edwards Centre for Research on Pain and Faculty of Dentistry, McGill University,*

<sup>2</sup> *McConnell Brain Imaging Centre, Montreal Neurological Institute, McGill University*

<sup>3</sup> *Institute for Biomedical Engineering, École Polytechnique and Montreal Heart Institute*

<sup>4</sup> *University of Colorado at Boulder*

<sup>5</sup> *Jewish General Hospital*

<sup>6</sup> *Division of Rheumatology and Alan Edwards Pain Management Unit, McGill University*

<sup>7</sup> *Departments of Anaesthesia and Neurology, McGill University*

Grey matter changes observed in chronic pain are frequently interpreted to reflect neuronal degeneration although studies investigating the cellular underpinnings of grey matter changes are lacking. Magnetic resonance imaging is the gold standard for investigation of grey matter changes in clinical populations; however it does not provide information on the cellular underpinning of the grey matter changes.

Fifty-one post-menopausal women (age range: 50-75 years), 26 with chronic widespread pain (fibromyalgia) and 25 matched healthy controls were investigated using multi-model imaging. Voxel-based morphometry was used to investigate grey matter volume changes, flumazenil positron emission tomography to assess neuronal integrity, magnetic resonance spectroscopy to assess neuronal viability in the anterior cingulate cortex, and quantitative T1 imaging was used to investigate water content changes.

Grey matter decreases were observed in the posterior cingulate cortex, precuneus, anterior cingulate cortex, bilateral insula, medial prefrontal cortex, precentral gyrus, fusiform gyrus, and medial temporal lobe. Grey matter increases were found in the angular gyrus, cuneus and postcentral gyrus. Two different mechanisms are involved in the grey matter changes in patients 1) in regions of decreases, water content partly explained grey matter volume but neuronal integrity or viability did not; 2) in regions of increases, in addition to water content, flumazenil binding potential explained a significant amount of the variance.

By combining several imaging modalities, this study indicates that decreases in cerebral grey matter are unlikely to be related to neurodegeneration. Further, different processes appear to be responsible for grey matter increases and decreases.

## How do assessments of activities of daily living address executive functions: A scoping review

Frédérique Poncet<sup>1-3</sup>, Bonnie Swaine<sup>3,4</sup>, Elisabeth Dutil<sup>3,4</sup>, Mathilde Chevignard<sup>2,5</sup>, Pascale Pradat-Diehl<sup>1,2</sup>

<sup>1</sup>APHP, Service de Médecine Physique et de Réadaptation. Hôpital Pitié-Salpêtrière, Paris, France

<sup>2</sup>Groupe Recherche Clinique Handicap cognitif et réadaptation après lésion cérébrale \_ Université Pierre et Marie Curie, France

<sup>3</sup>Centre for Interdisciplinary Rehabilitation Research of Greater Montreal (CRIR) – Centre de réadaptation Lucie-Bruneau, Canada

<sup>4</sup>School of rehabilitation, Université de Montréal

<sup>5</sup>Department of Rehabilitation for Children with Acquired Brain Injury. Hôpitaux de Saint Maurice, Saint Maurice, France

### First Author :

Frédérique Poncet, PhD.

Postdoctoral fellow

frederique.poncet@umontreal.ca

1. Laboratory for Adult Development and Cognitive Aging \_ Department of Psychology, Concordia University
2. Groupe Recherche Clinique Handicap cognitif et réadaptation après lésion cérébrale \_ Université Pierre et Marie Curie, France
3. Centre for Interdisciplinary Rehabilitation Research of Greater Montreal (CRIR) – Centre de réadaptation Lucie-Bruneau, Canada

**Introduction:** Executive functions (EF) allow persons to adapt to situations arising in daily life and can be affected following acquired brain injury (ABI). Measuring the impact of dysexecutive syndrome on the accomplishment of activities of daily living (ADL) requires specific assessment tools, but choosing the right tool may be difficult.

**Purpose:** To conduct a scoping review on how assessments of ADL address EF and dysexecutive syndrome in persons with ABI.

**Method:** A scoping review of peer-reviewed and grey literature published until August 2014 was conducted. Using a systematic procedure, literature was selected, results were charted, and tools were analysed with respect to their goals, underlying models. The analysis also included how tools considered components of EF according to Lezak's model. This model is particularly interesting because it operationally defines four broad functional categories related to EF in the accomplishments of all activities (i.e. volition, planning, purposive action and actual performance).

**Results:** 12 tools, developed either to assess EF in ADL, independence in ADL considering EF (n=4) or ADL capacities (n=7), were identified and analysed according to multiple criteria. Two tools consider the volition component, nine assess a person's ability to plan, 4 assess **carrying out activities** and 4 tools assess **effective performance** of task execution. Only one tool (i.e. ADL-Profile) assesses all components of Lezak's model.

**Conclusions:** This review provides important information about existing tools to assist in tool selection and clinical decision-making related to ABI and EF.

## Effects of combined physical exercise and cognitive training on executive functions and dual-task performance in older adults

Laurence Desjardins-Crépeau<sup>1,2</sup>, Maxime Lussier<sup>2</sup>, Sarah Fraser<sup>3</sup>, Karen Z.H. Li<sup>4</sup>, Nicolas Berryman<sup>5</sup>, Laurent Bosquet<sup>6</sup>, David Predovan<sup>1,2</sup>, Marie-Jeanne Kergoat<sup>2,7</sup>, Thien T.M. Vu<sup>7</sup> & Louis Bherer<sup>2,4</sup>.

<sup>1</sup>*Department of Psychology, Université du Québec à Montréal ; desjardins.laurence@gmail.com*

<sup>2</sup>*Centre de recherche de l'Institut universitaire de gériatrie de Montréal*

<sup>3</sup>*Interdisciplinary School of Health Sciences, Ottawa University*

<sup>4</sup>*PERFORM Centre and Department of Psychology, Concordia University*

<sup>5</sup>*Sport Studies Department, Bishop's University*

<sup>6</sup>*Faculté des sciences du sport, Université de Poitiers, France*

<sup>7</sup>*Centre hospitalier de l'Université de Montréal (CHUM)*

Several studies have reported benefits of exercise interventions [1] and cognitive training [2] on cognitive performance in older adults, but the effect of combining both interventions has rarely been studied. In this study, 76 healthy older adults were randomly assigned to one of the 4 combinations 1) aerobic training and dual-task training; 2) aerobic training and computer lessons; 3) stretching training and dual-task training; 4) stretching training and computer lessons. Pre and post-test assessment involved physical functioning, neuropsychological tests and computerized dual-task. Results show improved performance neuropsychological test of executive control (switching) after cognitive training, but no substantial added benefits of the aerobic training. In the computerized dual-task, results showed overall improvement in accuracy of responses in older adults participating in either physical or cognitive intervention. Results of the present study support the benefits of dual-task training and aerobic training on dual task performance, but suggest no additional benefits of combining both types of intervention on cognitive performance.

1. Bherer, L., K.I. Erickson, and T. Liu-Ambrose, *A review of the effects of physical activity and exercise on cognitive and brain functions in older adults*. *J Aging Res*, 2013. **2013**: p. 657508.
2. Belleville, S. and L. Bherer, *Biomarkers of Cognitive Training Effects in Aging*. *Curr Transl Geriatr Exp Gerontol Rep*, 2012. **1**(2): p. 104-110.

# **Longitudinal impact of cardiovascular training on cerebral activity of older people measured by fNIRS during concurrent walk and working memory tasks**

Thomas Vincent<sup>1</sup>, Elisabeth Charlebois-Cloutier<sup>2</sup>, Frédéric Lesage<sup>6</sup>, Anil Nigam<sup>3,4</sup>, Louis Bherer<sup>1,2</sup>, Sarah A. Fraser<sup>2,4,5</sup>

<sup>1</sup>*Department of psychology and PERFORM Center, Concordia University, Montreal, Canada.*

<sup>2</sup>*Research Center of the Geriatric Institute, Montreal, Canada.*

<sup>3</sup>*Faculty of medicine, University of Montreal, Canada.*

<sup>4</sup>*EPIC Center, Montreal Heart Institute, Montreal, Canada.*

<sup>5</sup>*The Interdisciplinary School of Health Sciences, University of Ottawa, Ottawa, Canada*

<sup>6</sup>*Département de Génie Électrique, École Polytechnique de Montréal, Montréal, Canada*

In the elder population, there is evidence that a well-functioning neurovascular coupling (NVC) is linked to the preservation of gait speed (Sorond 2011) and that Cardiovascular fitness is associated with better executive functions (Dupuy 2015). The current study aimed to evaluate fitness and NVC by testing the impact of cardiovascular training on divided attention during walking. To characterize NVC, functional Near-Infrared Spectroscopy (fNIRS) measurements are recorded while participants perform tasks involving working memory (WM) and walk.

Our cohort included healthy controls (no cardiovascular risk [CVR]), patients with one or more CVRs and patients who have had a coronary incident. All patients were regular members of the EPIC center, a preventive cardiology exercise center, which provides a comprehensive programs of community exercises for seniors and those at risk of metabolic or coronary conditions. The final cohort comprised 58 right-handed older adults aged 60 years and older.

The Walking-Thinking paradigm consisted of three conditions: single WM task (Cog- 2-back), single walking task (Walk) and concurrent walking and WM task (Dual: 2-back and walk). This Walking-Thinking paradigm was performed before and after a 6-month follow up period.

After fNIRS signal preprocessing, [HbO] and [HbR] variations that correlated with the experimental paradigm were computed using a GLM-based approach. Results show a network involving bilateral ventro-medial prefrontal cortices and medial dorsolateral prefrontal cortex with increasing extent across the Walk, Cog, and Dual conditions, respectively. By comparing pre- and post- measurements, an overall decrease in the network extent was observed, potentially implying a higher NVC efficiency.

## Changes in MEG scale free dynamics in patients with temporal lobe epilepsy

Aydin Ü.<sup>1</sup>; Pellegrino G.<sup>2,3</sup>; Hedrich T.<sup>2</sup>; Kobayashi E.<sup>3</sup>; Lina J.-M.<sup>4,5</sup>; Grova C.<sup>1,2,3</sup>

<sup>1</sup>*Multimodal Functional Imaging Lab, Department of Physics and PERFORM Centre, Concordia University, Montreal, Québec, Canada; umit.aydin@concordia.ca*

<sup>2</sup>*Multimodal Functional Imaging Lab, Biomedical Engineering Department, McGill University, Montreal, Québec, Canada*

<sup>3</sup>*Neurology and Neurosurgery Department, Montreal Neurological Institute, McGill University, Montreal, Québec, Canada*

<sup>4</sup>*Département de Génie Électrique, École de Technologie Supérieure, Montreal, Québec, Canada*

<sup>5</sup>*Centre De Recherches En Mathématiques, Montreal, Québec, Canada*

Most biological signals can be characterized by their scale-free dynamics, meaning that they consist of arrhythmic signals with no preferred frequency (scale invariance), exhibiting frequency spectrum that follows power laws. For a multifractal model, an H-value (Hurst-parameter) between 0.5 and 1 characterizes a signal with long-range dependencies. Decreased H-values were reported during tasks, thus reducing long-range dependencies and suggesting increased efficiency for quickly adapting to changes [1]. In certain diseases such as Alzheimer's and epilepsy increased H-values were reported in effected brain regions [1,2]. In this study, we investigated the differences in scale-free dynamics between patients with lateralized temporal lobe epilepsy and age/gender matched healthy controls using the resting state data acquired with magnetoencephalography. We used coherent maximum entropy on the mean method to calculate the activity on the cortex and a wavelet leader based formalism to calculate the H-values from this activity. We selected 4s long epochs around interictal epileptiform discharges (IEDs) as well as epochs with no distinguishable IED (baseline epochs). For epilepsy patients, H-values at ipsilateral, as determined by source localization at the time of the IED, and contralateral homologous regions were calculated for IED and baseline epochs. We observed: i) higher H-values at ipsilateral in comparison to contralateral regions; ii) smaller mean global (whole brain) H-values in IED epochs in comparison to the baseline; iii) increased mean global H-values in epilepsy patients in comparison to the healthy controls at the baseline, suggesting increased long-range dependencies and lower efficiency. Our preliminary results suggest that scale-free dynamics could be used as a new biomarker of epilepsy without the need to record IEDs. We are also adapting this methodology to be used on Electroencephalography and functional magnetic resonance imaging data, and it might have direct applications on studies concerning aging and sleep.

### References:

- [1] He BJ. (2014) Scale-free brain activity: past, present, and future. *Trends Cogn Sci*, 18, 480-487.
- [2] Monto S, Vanhatalo S, Holmes MD, Palva JM. (2007) Epileptogenic neocortical networks are revealed by abnormal temporal dynamics in seizure-free subdural EEG. *Cereb Cortex*, 17, 1386-1393.