



Near-infrared spectroscopy as an access modality

Utilisation de la spectroscopie proche infrarouge comme modalité d'accès

Tom Chau, PhD, PEng
Vice President, Research & Director, Bloorview Research Institute
Professor, Institute of Biomaterials & Biomedical Engineering
University of Toronto, Canada



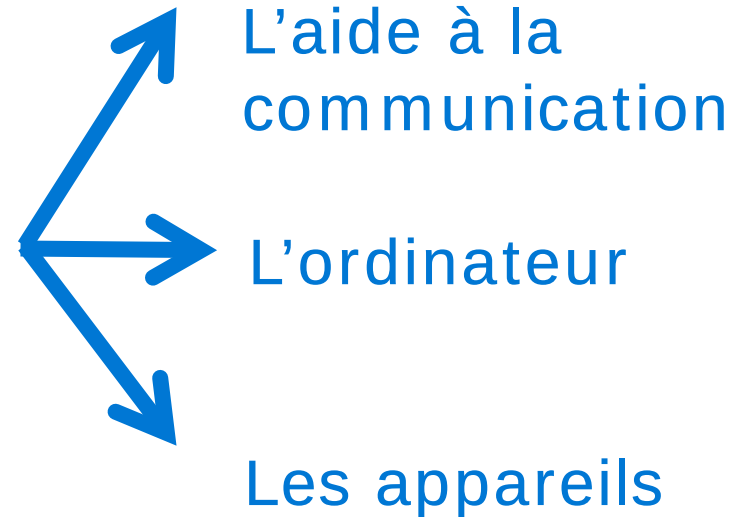
Justification



Justification



technologies
d'accès



Off-the-shelf switches

Contacteurs ou switchs disponibles sur le marché



Investigational motoric pathways

Voies d'accès motrices expérimentales



No motoric alternative

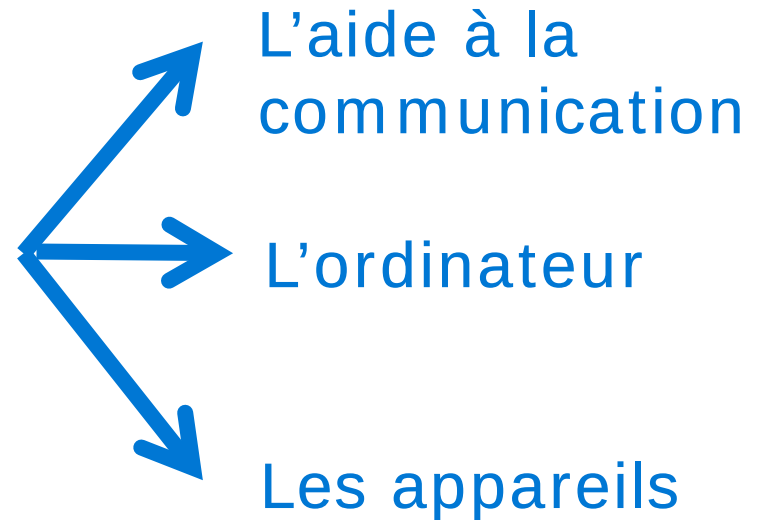
Voies d'accès alternatives



Justification



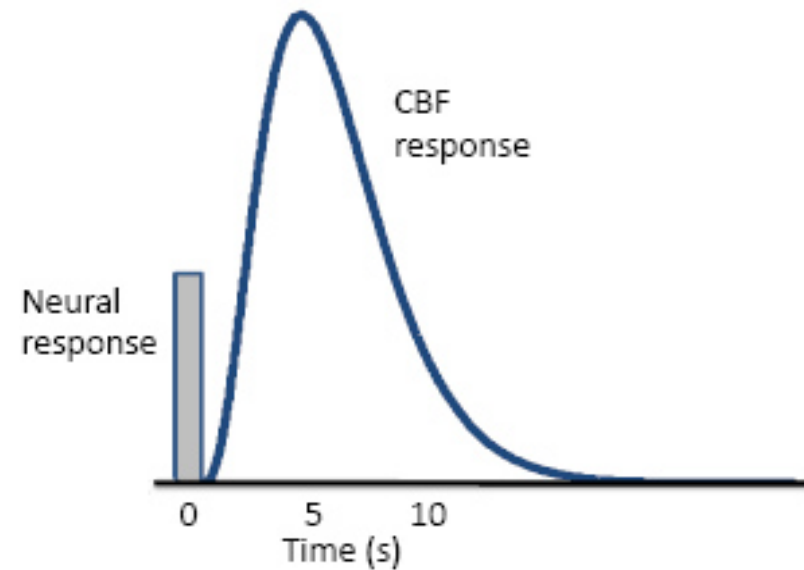
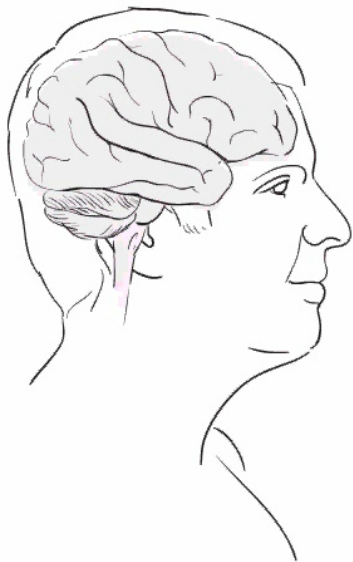
la spectroscopie
proche
infrarouge



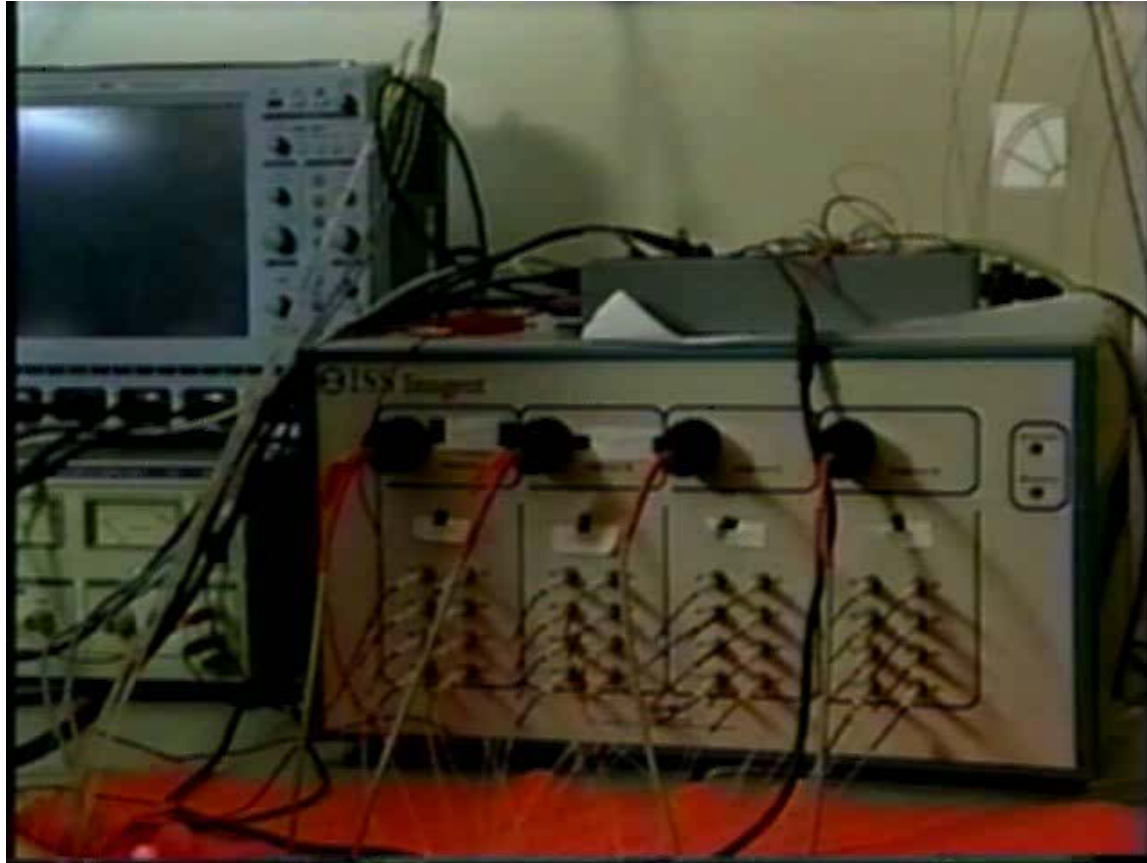
NIRS

Neurovascular coupling

Le couplage neurovasculaire



NIRS – measurement/measures



Decoding drink preference (reactive BCI)

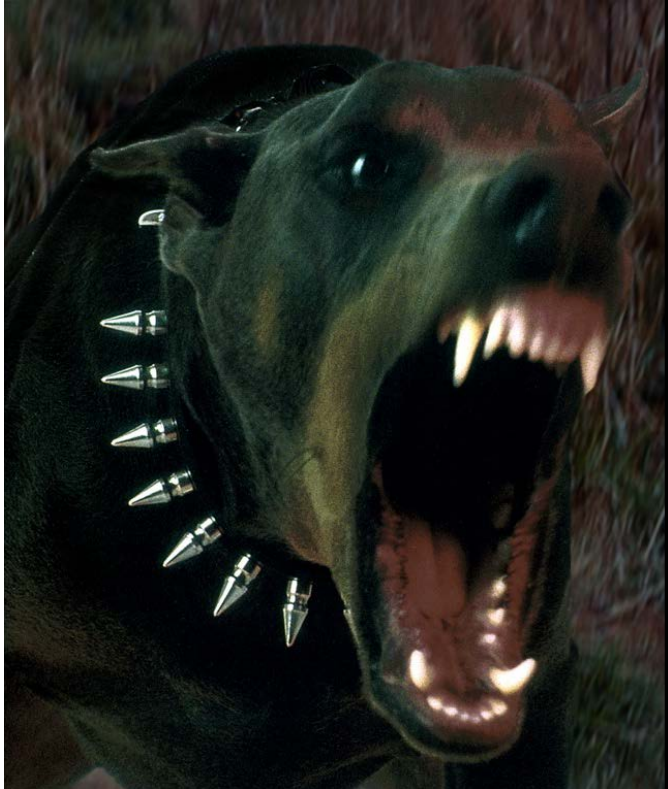
Décodage des préférences

Luu, S. Chau, T. *NeuroReport*. 2009;20(18):1581-1585.
Luu, S. Chau, T. *Journal of Neural Engineering*. 2009;6(1):016003. (8pp).



Decoding emotional response – visual induction
Décodage de la réponse émotionnelle - stimulus visuel

Tai, K. Chau, T. *Journal of Neuroengineering & Rehabilitation*. 2009;6:39. (14 pp).



75 – 96%

Holland Bloorview
Kids Rehabilitation Hospital

Transform Care | Lead the System | Accelerate Knowledge | Inspire our People

Decoding emotional response - auditory induction
Décodage de la réponse émotionnelle - stimulus auditif

Moghimi, S. Kushki, A. Guerguerian, A.M. Chau, T. *Neuroscience Letters*. 2012;525(1):7-11

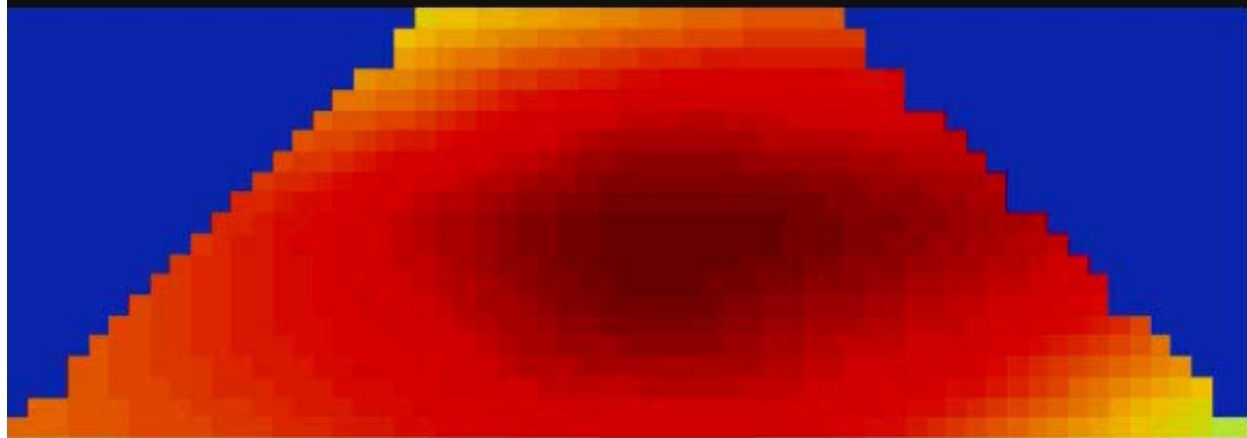
Mohgimi, S. Kushki, A. Power, S. Guerguerian, A.M. Chau, T. *Journal of Neural Engineering*. 2012;9:026022 (8pp).

“In the arms of an Angel” – Sarah McLachlan (HHb)

Moghimi, S. Kushki, A. Guerguerian, A.M. Chau, T. *Neuroscience Letters*. 2012;525(1):7-11

Mohgimi, S. Kushki, A. Power, S. Guerguerian, A.M. Chau, T. *Journal of Neural Engineering*. 2012;9:026022 (8pp).

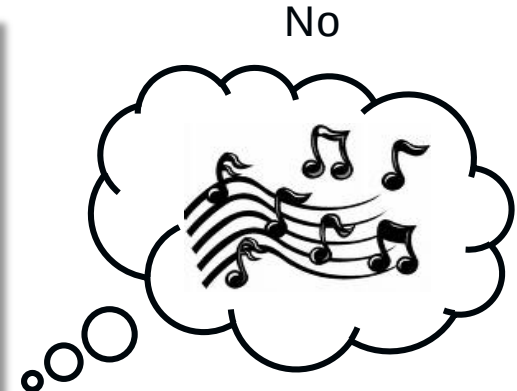
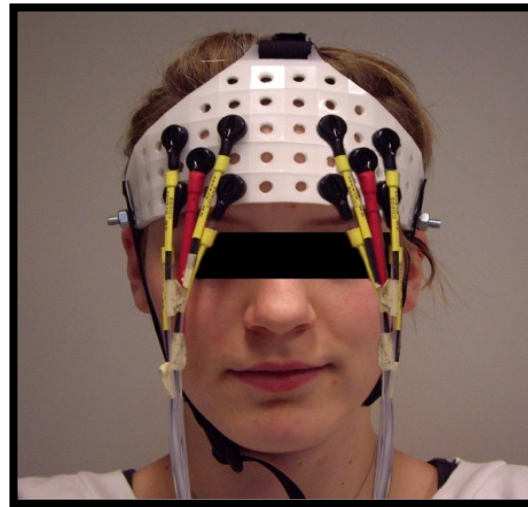
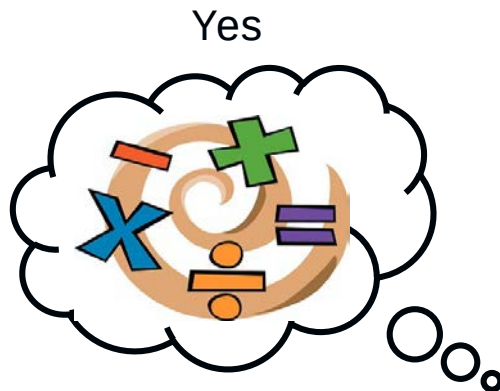
“Swan Lake Waltz” –Pyotr Ilyich Tchaikovsky (HHb)



Mental arithmetic and music imagery (active BCI)

L'arithmétique mentale et l'imagerie musicale

Power, S. Falk T. Chau, T. *Journal of Neural Engineering*. 2010; 7(2):26002 (9pp).



$77.2 \pm 7.0\%$

Mental math, music imagery and no-control state

L'arithmétique mentale, l'imagerie musicale et l'état de non contrôle

Power, S. Kushki, A. Chau, T. *Journal of Neural Engineering*. 2011;8(6):066004 (14pp).



Power, S. Kushki, A. Chau, T. *Journal of Neural Engineering*. 2011;8(6):066004 (14pp).

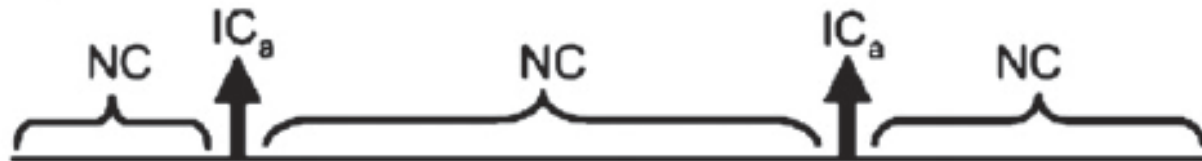


Power, S. Kushki, A. Chau, T. *Journal of Neural Engineering*. 2011;8(6):066004 (14pp).

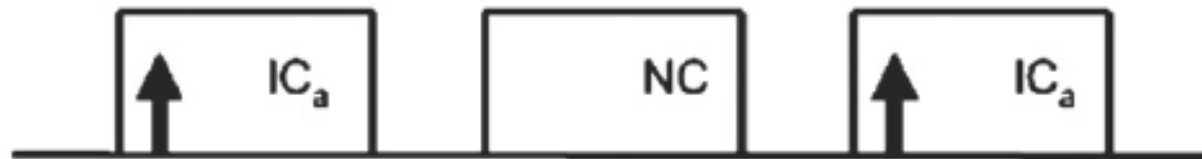
(a) *Synchronous control*



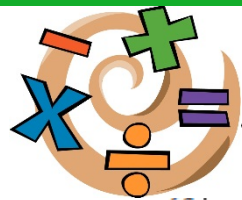
(b) *Asynchronous control*



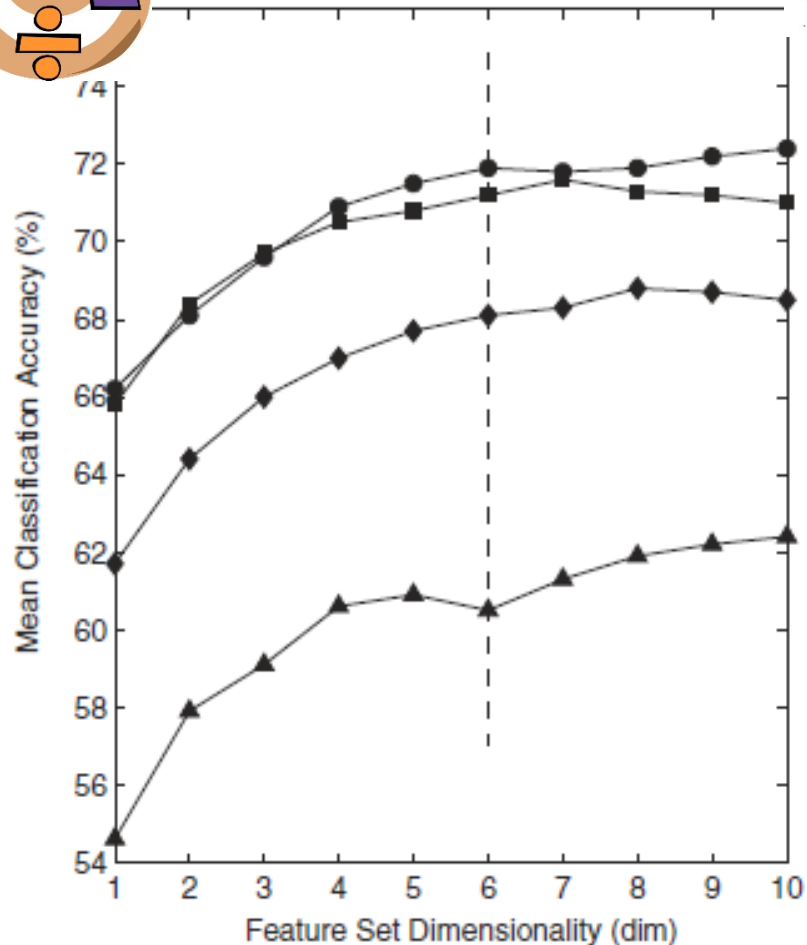
(c) *System-paced control*



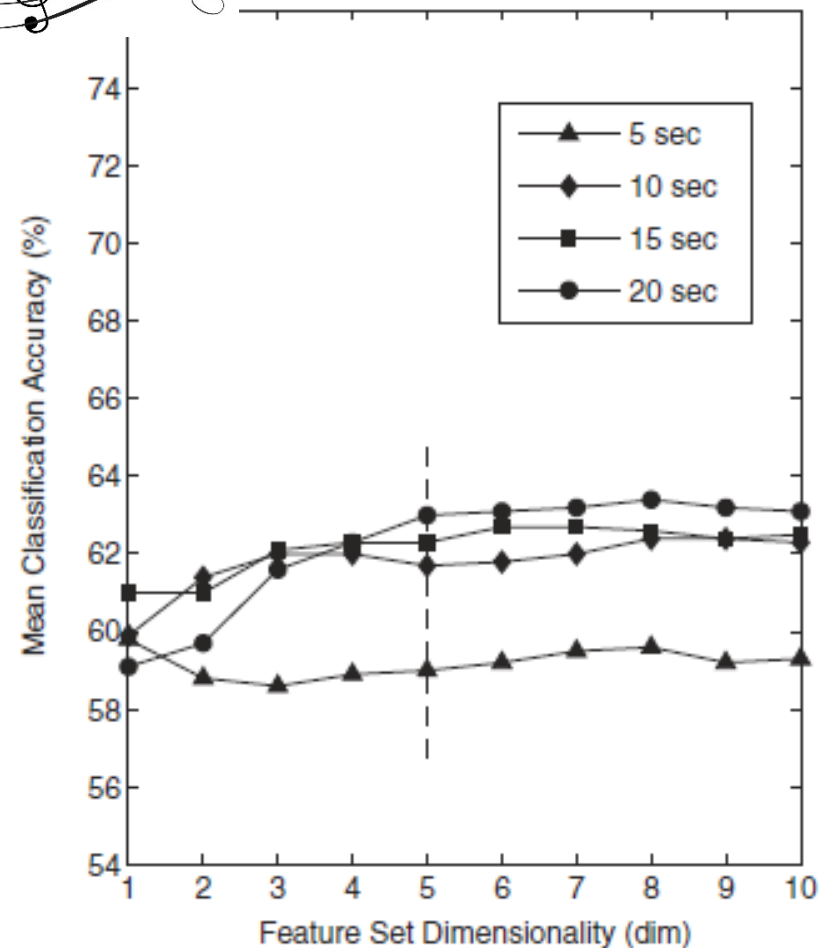
Power, S. Kushki, A. Chau, T. *Journal of Neural Engineering*. 2011;8(6):066004 (14pp).



Mental Arithmetic vs. No-control



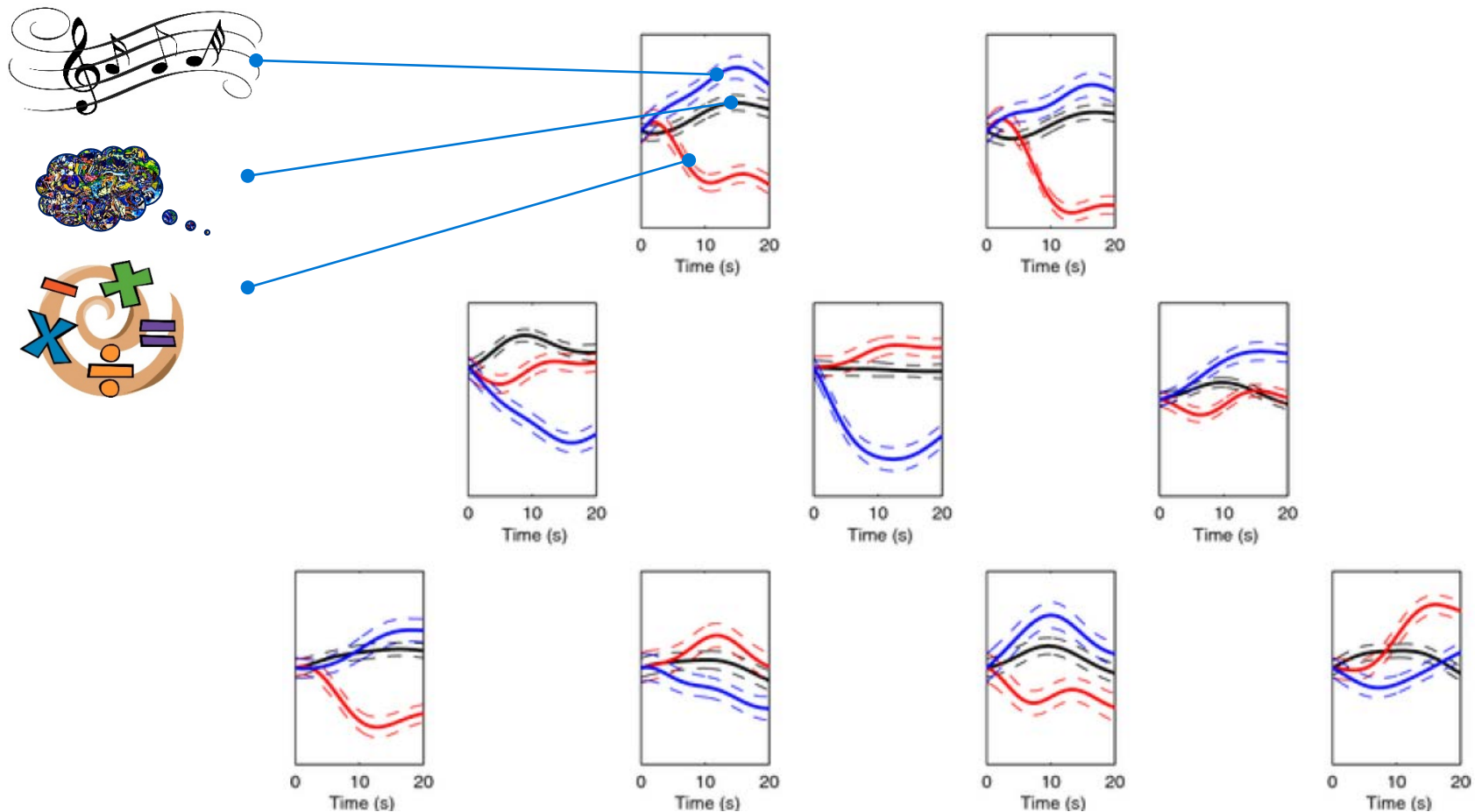
Mental Singing vs. No-control



Power, S.D. Kushki, A. Chau, T. *BMC Research Notes*. 2012;5:141.



Power, S.D. Kushki, A. Chau, T. *BMC Research Notes*. 2012;5:141.



Power, S. Kushki, A. Chau, T. *PLoS ONE*. 2012;7(7):e37791 (12 pages).

lun. mar. mer. jeu. ven. sam. dim.

mars 1 2

3 4 5 6 7 8 9

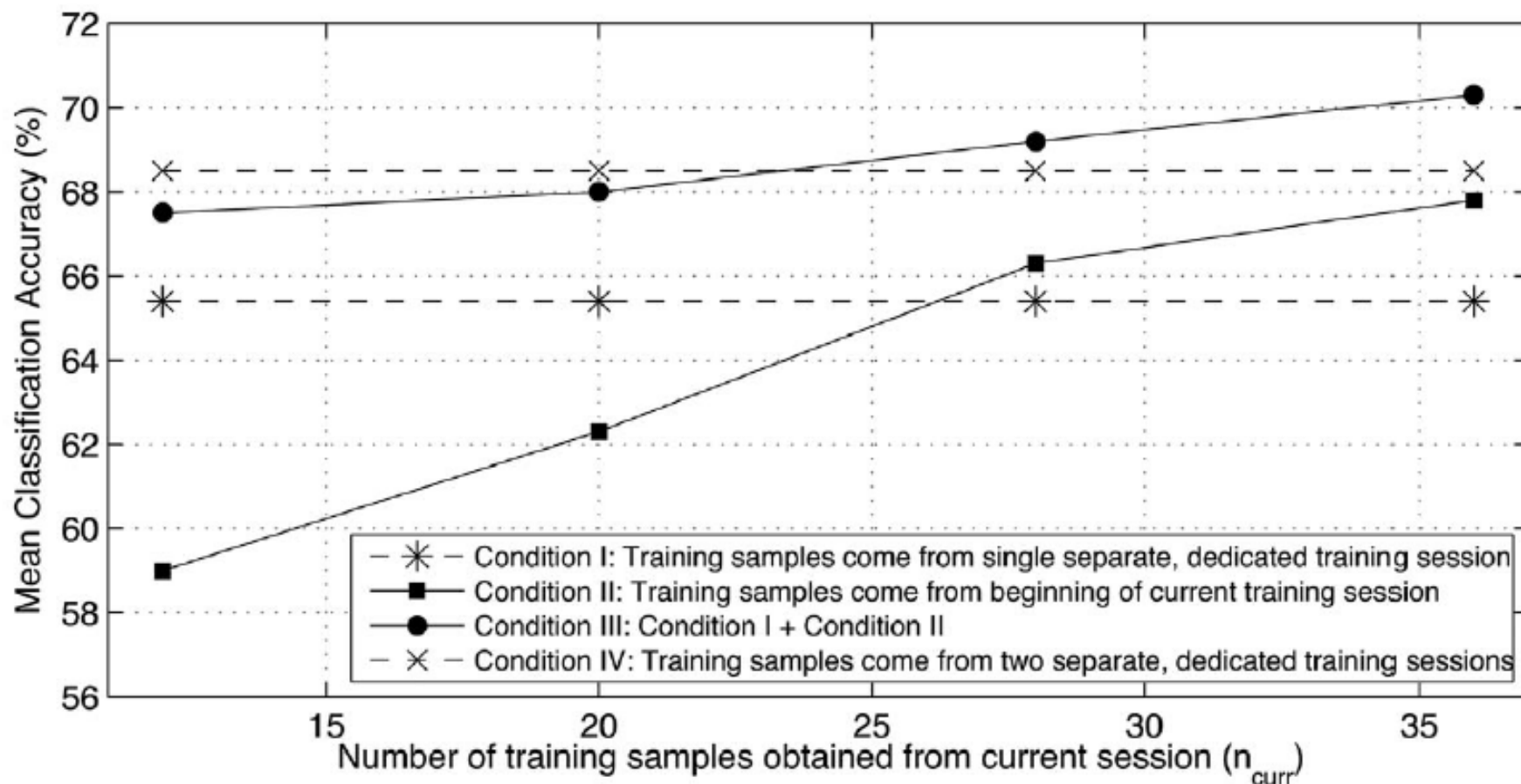
10 11 12 13 14 15 16

17 18 19 20 21 22 23

24 25 26 27 28 29 30

31

Power, S. Kushki, A. Chau, T. *PLoS ONE*. 2012;7(7):e37791 (12 pages).



Power, S.D. and Chau, T. *Developmental Neurorehabilitation*. 2013;16(1):67-72.

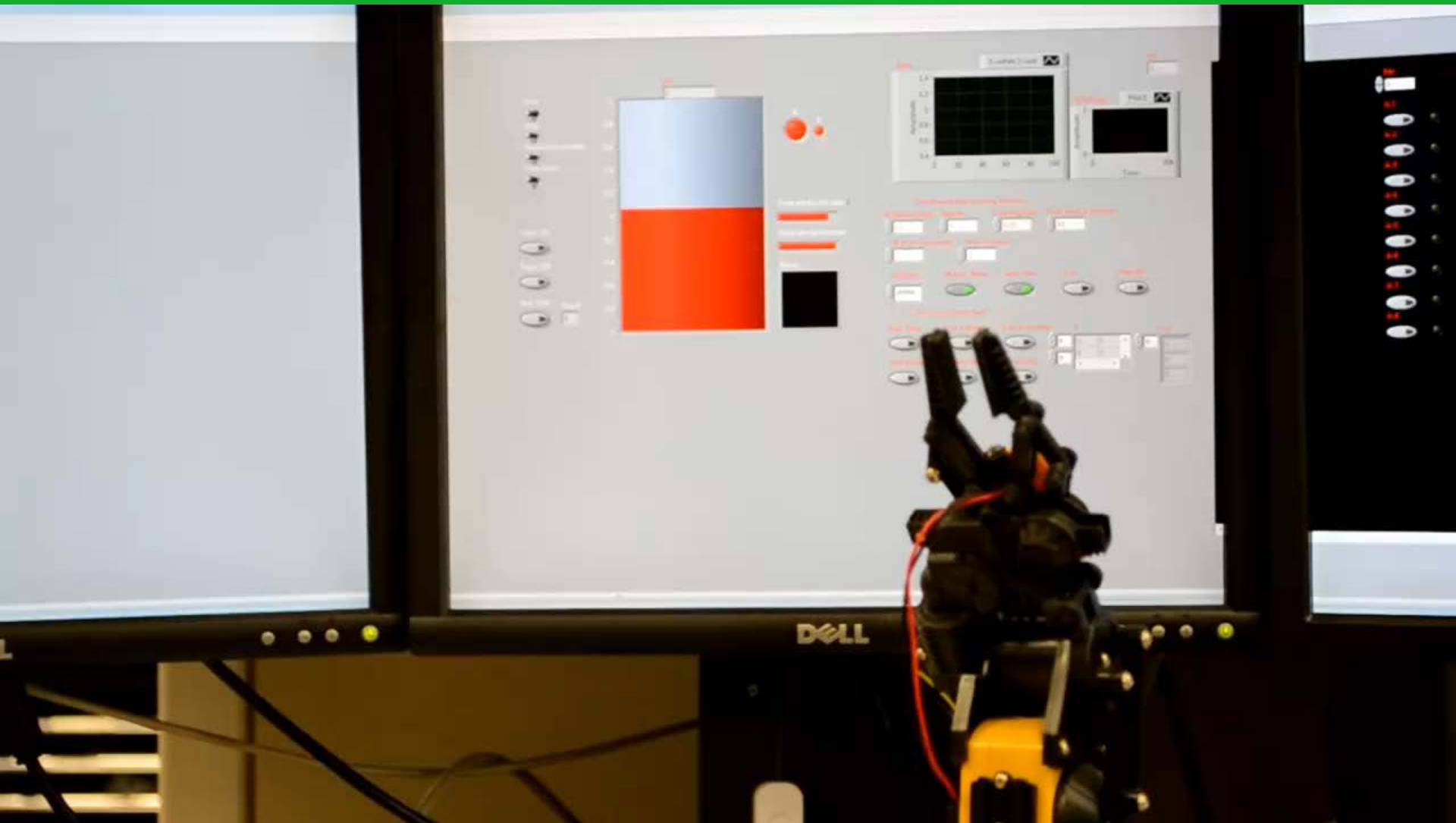


Session number	Response window duration		
	0–20 s	0–15 s	0–10 s
1	74.6*	78.8*	60.6
2	67.6*	62.0	45.6
Average	71.1	70.4	52.8

Real-time NIRS control

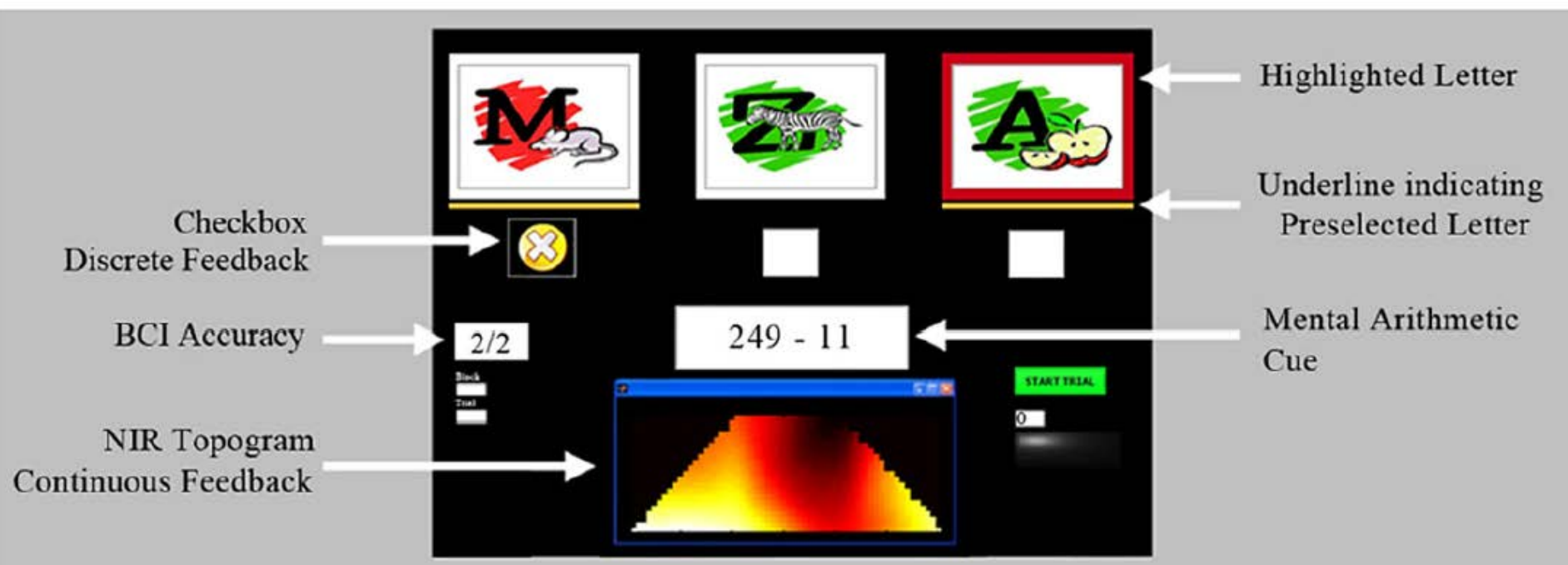
La possibilité d'un contrôle en temps réel basé sur la spectroscopie proche infrarouge

Chan, J. Power, S. Chau, T. *Journal of Near Infrared Spectroscopy*. 2012;20(1):107-116.



Schudlo, L.C. and Chau, T. *Journal of Neural Engineering*. 2014;11(1):016003. (14pp).

Schudlo, LC, Power S, and Chau T. *Journal of Neural Engineering*. 2013; 18;10(4):046018. (14 pp)



Schudlo, L.C. and Chau, T. *Journal of Neural Engineering*. 2014;11(1):016003. (14pp).

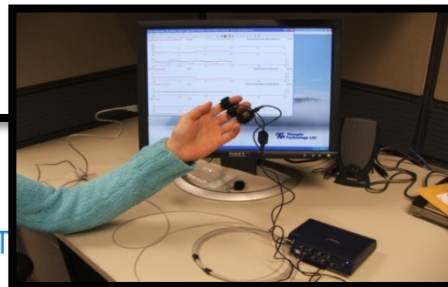
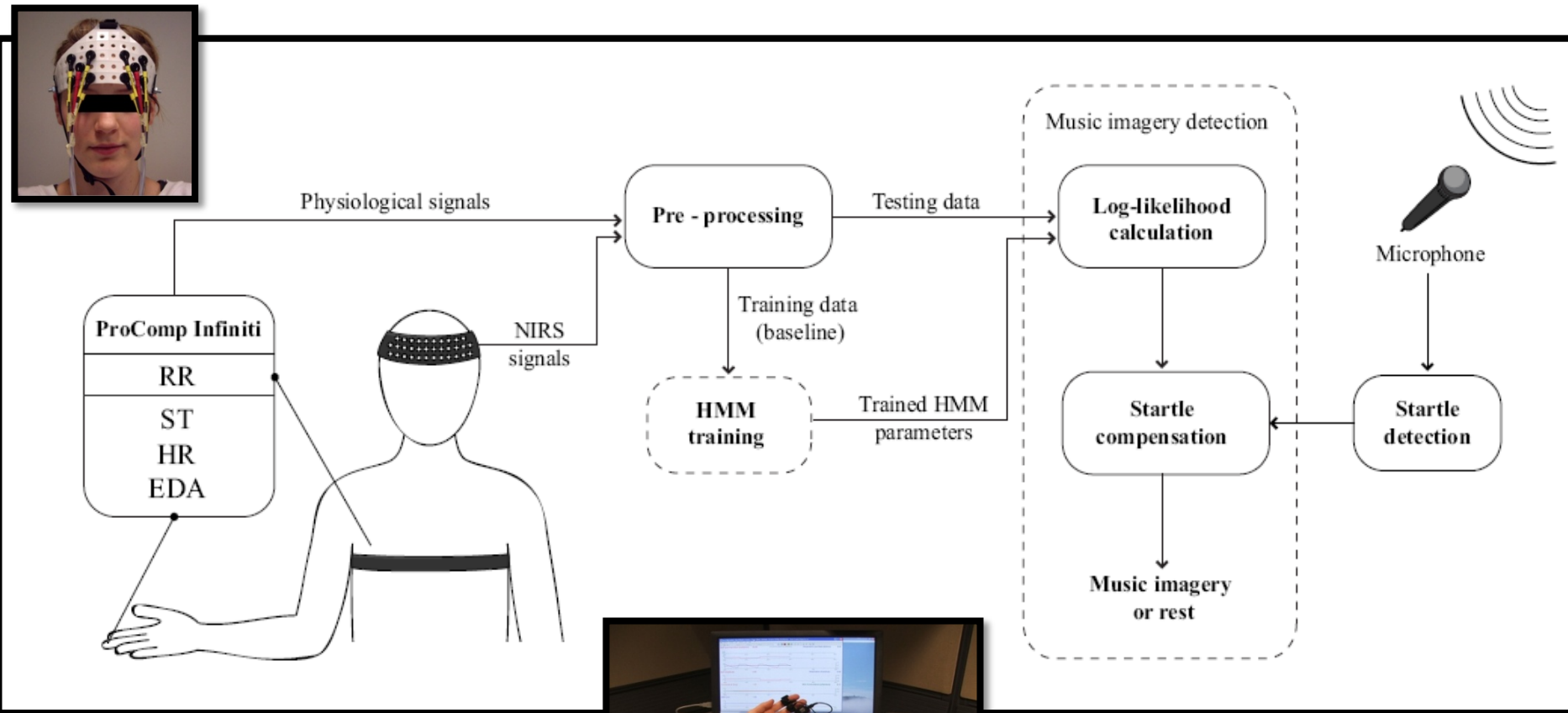
Schudlo, LC, Power S, and Chau T. *Journal of Neural Engineering*. 2013; 18;10(4):046018. (14 pp)



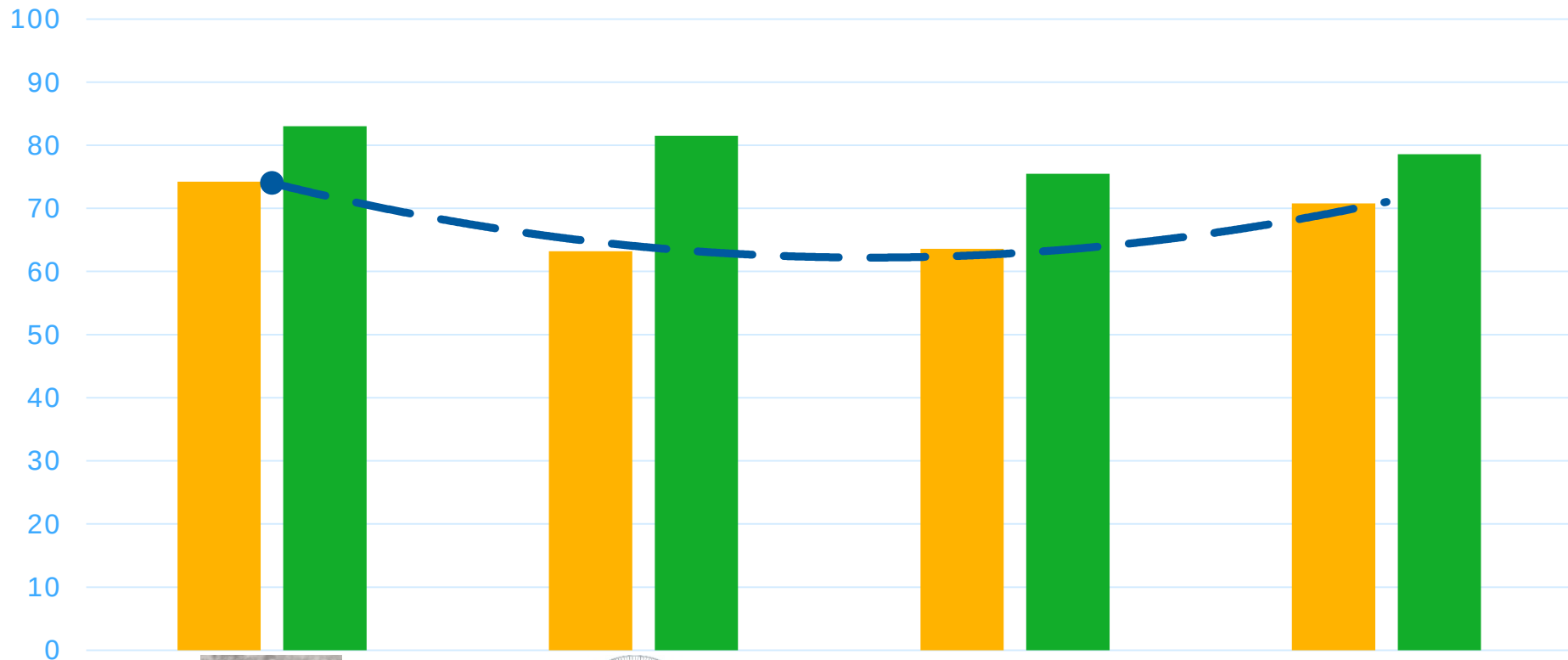
NIRS + ANS

NIRS + les mesures du système nerveux périphérique

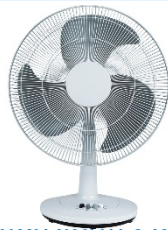
Falk, T. Guirgis, M. Power, S. Chau, T. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*. 2011;19(2):136-146.



Falk, T. Guirgis, M. Power, S. Chau, T. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*. 2011;19(2):136-146.



Holland Bloorview
Kids Rehabilitation Hospital



Transform Care



Lead the System

Accelerate Knowledge

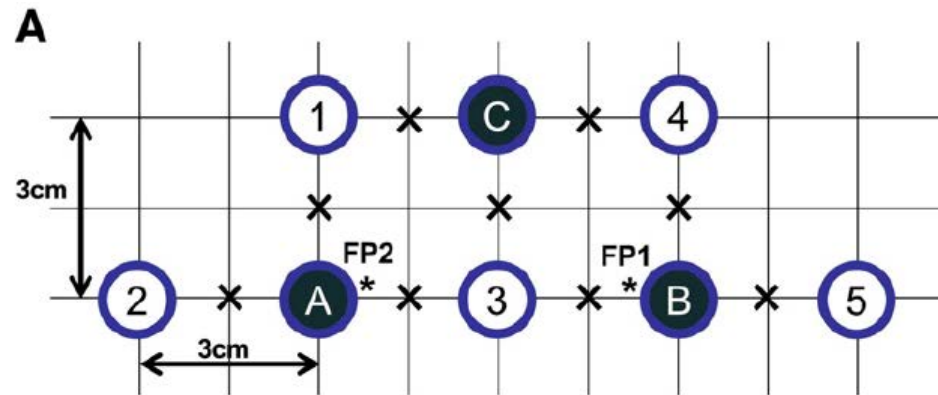
Inspire our People



NIRS + TCD

NIRS + l'échographie Doppler transcrânienne

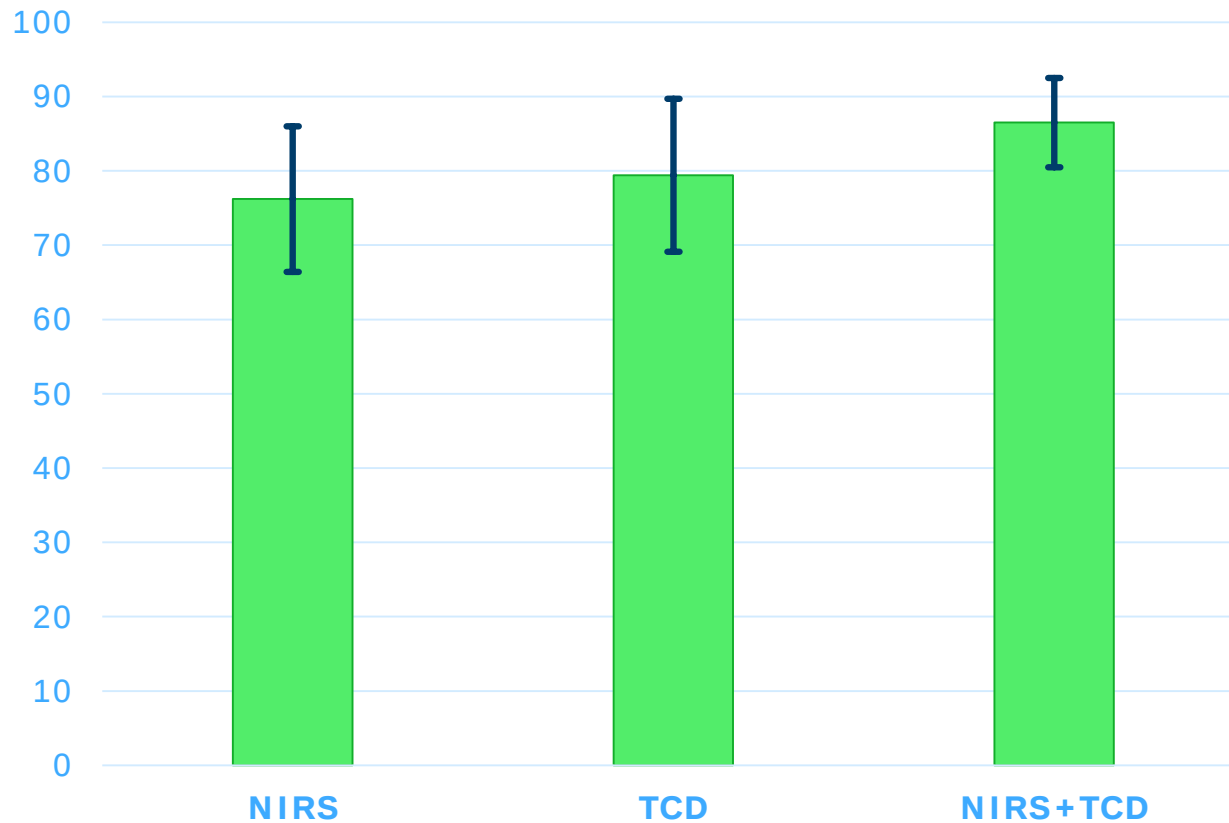
Faress, A. Chau, T. *NeuroImage*. 2013;77:186-194



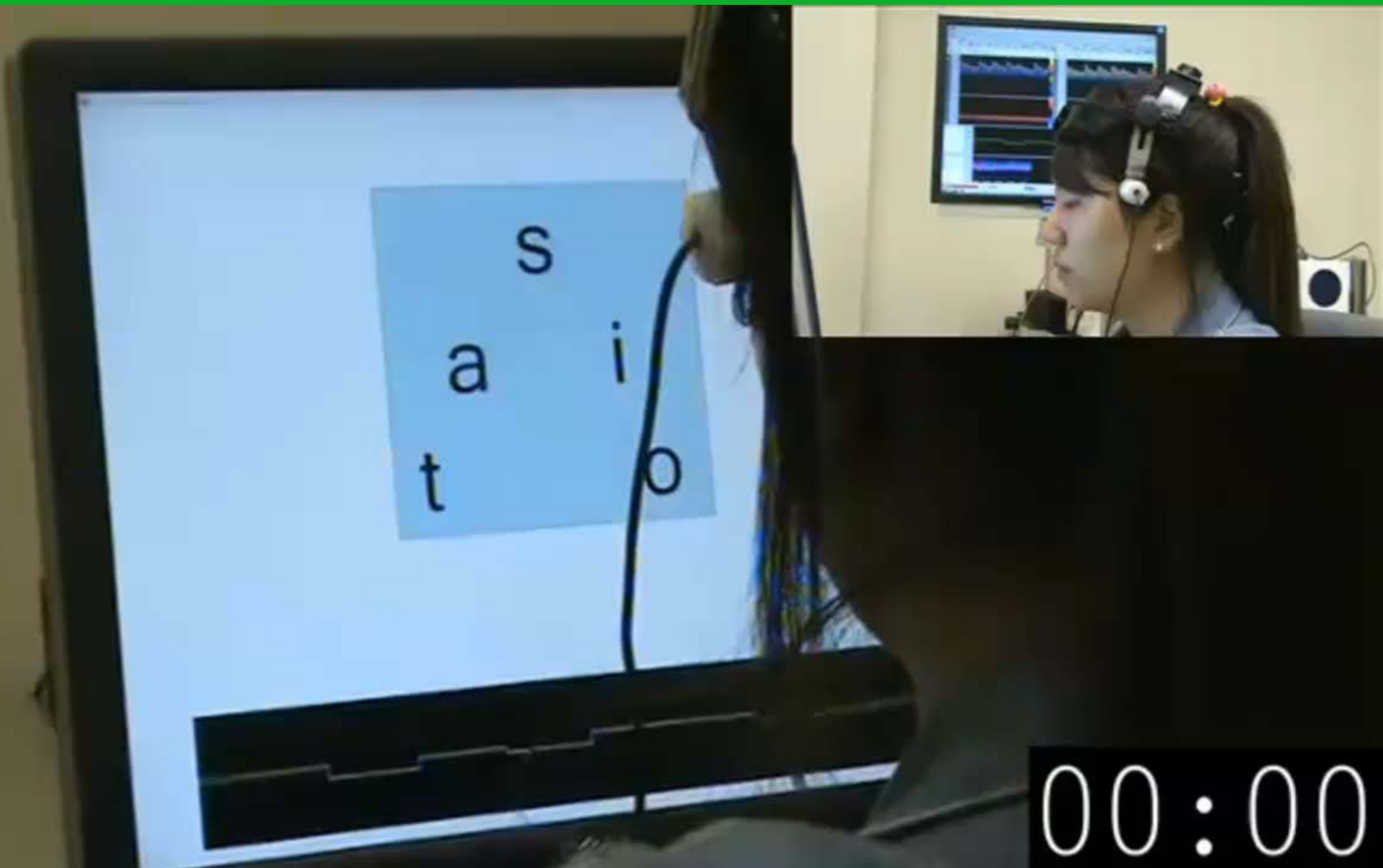
Faress, A. Chau, T. *NeuroImage*. 2013;77:186-194



Faress, A. Chau, T. *NeuroImage*. 2013;77:186-194



Lu, J & Chau, T. *Frontiers in Human Neuroscience*. In Press.



Current research
Projets en cours

Operant conditioning

Un paradigme de conditionnement opérant



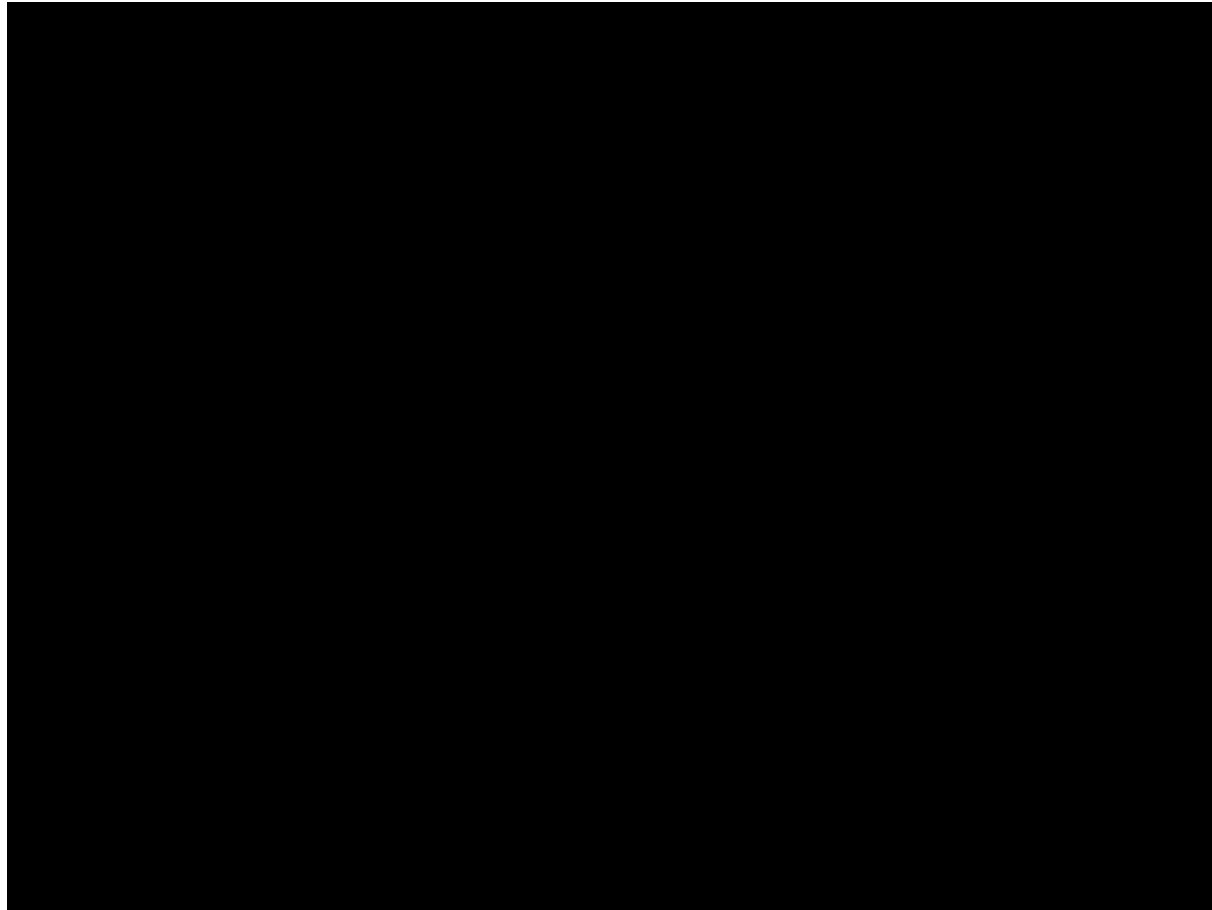
Distributed activation

L'activation répartie



Distributed activation

L'activation répartie

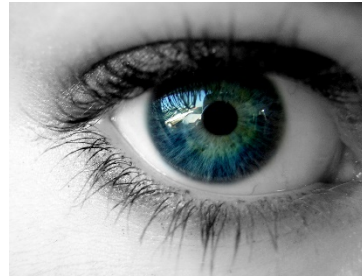


Key learnings

Ce qu'il faut retenir

Reactive BCI

Interfaces cerveau-ordinateur réactives



Active BCI

Interfaces cerveau-ordinateur actives

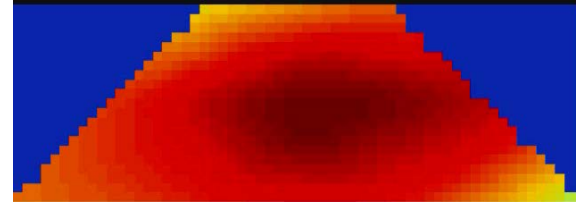


Key learnings

Ce qu'il faut retenir

Hemodynamic response

la réponse hémodynamique



Multi-session training

combiner les données
d'entraînement

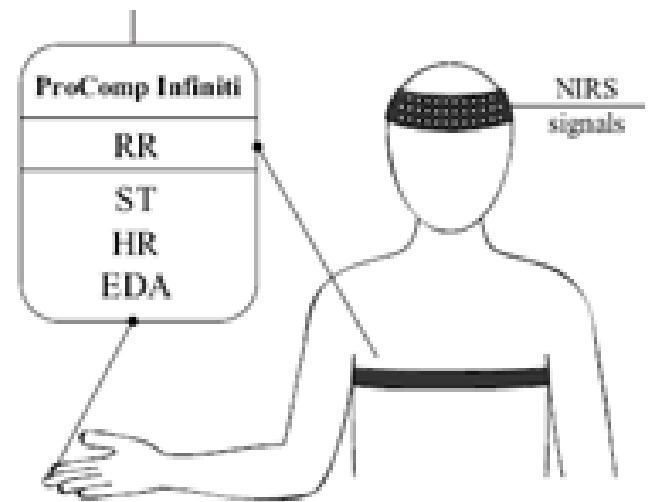


Key learnings

Ce qu'il faut retenir

NIRS + other physiological signals

L'association de la spectroscopie proche infrarouge avec les autres signaux physiologiques



Opportunities Débouchés



Opportunities Débouchés



Opportunities Débouchés



Our hope Notre espoir



Acknowledgements

Remerciements

Graduate students / étudiants

Dr. Sarah Power
Dr. Saba Moghimi
Jennifer Kohlenberg, MSc, MD
Larissa Schudlo, MSc
Sabine Weyand, MSc
Stephanie Liddle, MSc
Justin Chan, MSc
Kelly Tai, MSc
Sheena Luu, MSc
Ahemd Faress, MSc

Staff / ingénieurs

Ka Lun Tam, MEng, PEng
Pierre Duez, MSc
Fanny Hotze

Post-doctoral fellows / postdoctorants

Dr. Tiago Falk
Dr. Azadeh Kushki

Holland Bloorview
Kids Rehabilitation Hospital



Canada Research
Chairs



Canada Foundation for Innovation
Fondation canadienne pour l'innovation

Remad
Foundation