POSTDOCTORAL PROPOSAL IN NEUROSCIENCE AND ARTIFICIAL INTELLIGENCE

Modeling shift from efficient to inefficient divided attention using EEG/fMRI/MEG

Advisor (s):

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Net salary: 2700€ per month with some teaching

Duration: 2 years

DESCRIPTION

Optimal distribution of attention is a key issue in our everyday-life multitasking activities. It relies on a tradeoff between exploration and exploitation attentional policies to select and maintain attentional focus on the relevant streams of information while remaining alert to unexpected changes. Several studies have identified some neural correlates supporting such attentional dynamics. For instance, top-down and bottom-up types of attention are respectively delineated by the dorsal and ventral neural networks that are in close interaction with the anterior cingulate cortex for resource allocations. Efficient divided attention results in an enhancement of task relevant networks activity via cross frequency coupling in the theta and gamma band and enhancement of secondary task networks activity at different phase to that of primary task networks. However, when task demand exceeds mental capacity, the homeostasis between the ventral and dorsal pathways is disrupted, leading to the suppression of non-primary task relevant network (via increased alpha oscillations) and decreased frequency coupling between theta and gamma in primary task networks. Although this shielding mechanism can prevent from mental overload and distractions, missing critical information can have devastating consequences in real-life scenarios such as driving or operating an aircraft (eg. auditory alarms).

The candidate is expected to design and conduct experiments to investigate the shift from efficient to non-efficient divided attention between the visual and the auditory modality. These

experiments will be conducted 1) in the lab using fMRI and high-density 2) under highly ecological conditions with portable EEG.

The candidate is expected to perform state-of-the-art analyses including effective connectivity and to apply inverse reinforcement learning (IRL) technics to 1) estimate the efficient (optimal) and non-efficient (sub-optimal) policies with respect to best expected distribution of attention. 2) to predict long-term attentional efficiency.

The ideal candidate will have a strong background in Neurosciences, brain imaging (EEG or/and fMRI/MEG), signal processing, artificial intelligence for automated learning and planning. She/he will have to work in strong collaboration with the three other researchers (2 PhD students, 1 post doc) funded by the ANITI program. This research will be conducted within the stimulating environment of Neuroergonomics lab at ISAE-SUPAERO (25 researchers), the Artificial and Natural Intelligence Toulouse Institute. The candidate will have the opportunity to have a long stay in Cinet (Osaka/Japan) at Daniel Callan's research department to conduct the fMRI or MEG experiment.

References

- Durantin, G., Dehais, F., Gonthier, N., Terzibas, C., & Callan, D. E. (2017). Neural signature of inattentional deafness. Human brain mapping, 38(11), 5440-5455.
- Dehais, F., Rida, I., Roy, R. N., Iversen, J., Mullen, T., & Callan, D. A pBCI to Predict Attentional Error Before it Happens in Real Flight Conditions.
- Tombu, M. N., Asplund, C. L., Dux, P. E., Godwin, D., Martin, J. W., & Marois, R. (2011). A unified attentional bottleneck in the human brain. Proceedings of the National Academy of Sciences, 108(33), 13426-13431.
- Doesburg, S. M., Roggeveen, A. B., Kitajo, K., & Ward, L. M. (2007). Large-scale gamma-band phase synchronization and selective attention. Cerebral cortex, 18(2), 386-396.
- Arora, Saurabh and Doshi, Prashant (2018). A survey of inverse reinforcement learning: Challenges, methods and progress. arXiv preprint arXiv:1806.06877

APPLICATION PROCEDURE

Formal applications should include detailed cv, a motivation letter and transcripts of bachelors' degree.
Samples of published research by the candidate and reference letters will be a plus.
> applications should be sent by email to: advisor email
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