Interpersonal Physiological Synchrony based BCI: A Perspective

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Background: Interpersonal physiological synchrony (PS) refers to simultaneous changes over time in a physiological signal recorded from multiple individuals. PS and other forms of associations between signals across individuals have been examined in the context of social relationships and communication. An expected important instigator of PS is that individuals attend to the same external events. Following this principle, we started to work on PS from the viewpoint that PS is a potentially useful marker of attentional engagement to external events. Advantages of PS as a marker are that it does not require labeled, personal training data (as in many other brain-based methods to monitor attention) and that it may be used in real life circumstances where onsets of potentially relevant stimuli are not known. Besides PS in EEG, we examined PS in heart rate and electrodermal activity to potentially augment or even replace the information coming from EEG. This would facilitate recordings in real life. Over recent years, we and others found that PS in EEG, heart rate and/or electrodermal activity varies as a function of attentional instruction [1], as a function of trait-based attentional bias [2] and is also increased by stimuli that are expected to draw attention in a bottom-up way [3]. High PS predicts high cognitive performance [1,4] and PS can be determined using electrodermal activity and heart rate wearables in real life settings [5], signifying the potential practical relevance and feasibility of PS as measure of attentional engagement.

Physiological Synchrony BCI: While it is possible to determine PS in (near) real time, and open-source algorithms for this are already available [6], we are not aware of studies that aim to boost cognitive performance by adapting a system in real time utilizing PS-based information about attention. We think that such PS-BCIs for enhancing cognitive performance may be feasible and valuable, especially in digital education, high cognitive workload, or high vigilance settings, . We outline possible design and usage of different types of PS-based information (at the level of the individual with respect to the group; at the level of the group as a whole), different types of interventions (providing information to the student; adapting a virtual teaching system; providing information to a human teacher) and the ethical considerations associated with these possible applications. We end with stating the most essential open research questions.

References

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