Interbrain Neural Synchrony in Cooperation versus Competition

When humans work together on collaborative tasks the neural oscillations in their brains often synchronize [1]. For instance, people with shared attention will exhibit increased temporal synchrony of prefrontal delta and theta oscillations, compared to those working alone [2]. With that said, the results from studies examining interbrain neural synchrony (IBNS) are not clear. On one hand, Fishburn and colleagues[3] found increased IBNS in a cooperative task situation. However, on the other hand, work by Sinha and colleagues[4] have found that IBNS is decreased (as opposed to increased) in pairs of people working against each other.

Recent advances in mobile EEG technology have made it possible to record EEG easily from multiple people at the same time in a wide range of environments [5]. As such, here I propose to use mobile EEG technology to examine IBNS in a large group setting (n = 4+) and explore the difference in IBNS between collaborative and competitive tasks.

Research Question

How does interbrain neural synchrony differ between collaborative and competitive group tasks? To answer this research question, I will conduct two studies as a part of my master's thesis research.

Experiment One: Predicting Performance in a Maze Task using IBNS

Hypothesis: IBNS can predict enhanced performance on co-operative tasks. Specifically, I predict I will see an increase in the coherence in frontal delta and theta oscillations, quantified by phase locking index (PLI) and inter-brain phase coherence (IPC), within teams that perform better.

Methods: Groups of four participants will traverse a computerized maze while we record EEG data. Each participant will control a direction for a cursor as they work together to traverse the maze. This creates the necessity for equal contribution to task success from each participant. EEG data will be preprocessed using standard techniques (e.g., IIR filter, re-referenced, segmented, etc.) and Mortlet Wavelets will be used to extract power. Phase locking index (PLI) and inter-brain phase coherence (IPC) will be computed from these power data. Using partial least squares regression, the relationship between PLI and IPC and behavioural results will be calculated with latent variables.

Predicted Results: I expect that PLI and IPC will predict group performance in the maze game.

Implications: This will demonstrate that IBNS predicts enhanced performance on co-operative tasks.

Experiment Two: The Effects of Cooperation and Competition on IBNS

Hypothesis: In an inter-team competition task, neural indices of IBNS (PLI and IPC) will decrease between competing teams and increase between cooperating team members.

*Methods***:** Two groups of four participants will compete against each other in a "Simon-Says" sequencing task while we record EEG data. Each team will be presented with sequences of twenty squares of four different colours and will have control over responding to one of their teams' four colours. The team must work together to respond to the colours in the sequence as fast as possible. At first, teams will do this without knowledge of their competition. After they have learned the game sufficiently, they will do it while competing against the other team in the same room. As in experiment 1, data will be preprocessed and analyzed for PLI and IPC within and between teams.

Predicted Results: I predict that during competition PLI and IPC will be higher between team members but reduced between competing teams.

Implications: The predicted results would indicate that IBNS is enhanced within a team when they are competing against a different team.

Significance: The two proposed experiments serve to move research on IBNS into larger group settings and exploration of the effects of team competition. Our results would indicate that competition causes teams to become more synchronized, which would cause consequent increases in performance. My research would have implications in education and working culture, where teamwork is becoming increasingly encouraged [6,7]. The proposed experiments would provide the basis for future PhD research, where I would explore the effects of IBNS on specific cognitive processes, such as learning and decision making.

References

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