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Exploring the Neural Correlates of Different Interaction Types: A Hyperscanning Investigation Using the Pattern Game

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Abstract : Hyperscanning affords a unique insight into the brain dynamics underlying human interaction by simultaneously scanning two or more individuals' brain responses while they engage in dyadic exchange. This provides an opportunity to observe dynamic brain activations in all individuals participating in interaction, and possible interbrain effects among them. The present research aims to provide an experimental paradigm for hyperscanning research capable of delineating among different forms of interaction. Specifically, the goal was to distinguish between two dimensions: (1) interaction structure (concurrent vs. turn-based) and (2) goal structure (competition vs cooperation). Dual-fMRI was used to scan 22 pairs of participants - each pair matched on gender, age, education and handedness - as they played the Pattern Game. In this simple interactive task, one player attempts to recreate a pattern of tokens while the second player must either help (cooperation) or prevent the first achieving the pattern (competition). Each pair played the game iteratively, alternating their roles every round. The game was played in two consecutive sessions: first the players took sequential turns (turn-based), but in the second session they placed their tokens concurrently (concurrent). Conventional general linear model (GLM) analyses revealed activations throughout a diffuse collection of brain regions: The cooperative condition engaged medial prefrontal cortex (mPFC) and posterior cingulate cortex (PCC); in the competitive condition, significant activations were observed in frontal and prefrontal areas, insula cortices and the thalamus. Comparisons between the turn-based and concurrent conditions revealed greater precuneus engagement in the former. Interestingly, mPFC, PCC and insulae are linked repeatedly to social cognitive processes. Similarly, the thalamus is often associated with a cognitive empathy, thus its activation may reflect the need to predict the opponent's upcoming moves. Frontal and prefrontal activation most likely represent the higher attentional and executive demands of the concurrent condition, whereby subjects must simultaneously observe their co-player and place his own tokens accordingly. The activation of precuneus in the turn-based condition may be linked to self-other distinction processes. Finally, by performing intra-pair correlations of brain responses we demonstrate condition-specific patterns of brain-to-brain coupling in mPFC and PCC. Moreover, the degree of synchronicity in these neural signals related to performance on the game. The present results, then, show that different types of interaction recruit different brain systems implicated in social cognition, and the degree of inter-player synchrony within these brain systems is related to nature of the social interaction.

Keywords : brain-to-brain coupling, hyperscanning, pattern game, social interaction
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