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Dual EEG of social interaction: a machine learning approach to the two-brain problem

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Dual-EEG of social interaction: a machine learning approach to the two-brain problem

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Introduction

The underlying neural mechanisms of real-time social interactions remain largely unknown. Recent approaches have begun to depart from studying individuals in isolation, and onto exploring behavioural and neural processes in paradigms involving two or more people engaged in an interaction (Konvalinka et al., 2010; Sebanz et al., 2006). However, only a small number of recent studies have explored what goes on in brains of two people simultaneously as they interact (Astolfi et al., 2010; Dumas et al., 2010; De Vico Fallani et al., 2010; Lindenberger et al., 2009). The question still remains whether such quantification can better reveal the neural signatures of social cognition. In our study, we wanted to address this question by quantifying whether we gain more information about the interaction from the two brains.

Methods

32-channel dual-EEG was measured from 9 pairs of participants as they engaged in an interactive finger-tapping task. They were asked to synchronize with an auditory signal coming from the other member of the pair or the computer, by tapping with their right index finger. They experienced two conditions: an interactive 'coupled' condition, each receiving feedback of the other person's tapping; and an 'uncoupled' computer-control condition, each receiving feedback from a non-responsive computer. Time-frequency analysis was carried out for the 0.5-30 Hz range for both conditions. Machine-learning approaches were used to identify the brain signals driving the interaction. The raw-power at 10 Hz range during tapping emanating from electrodes of member one and member two were used as features. We combined data from both participants in each pair, and applied logistic regression using feature selection in order to classify the two conditions. Furthermore, we computed cross-correlations between the inter-tap intervals of the two participants' behavioural tapping data, taking lag -1 and lag +1 correlations coefficients to determine the leader and the follower of the interaction.

Results

Time-frequency analysis revealed a left-motor and right-frontal suppression at 10 Hz during task execution, when carrying the task out interactively in contrast with the uncoupled computer-driven task. The classification identified the first seven (frontal) electrodes consistently as good classifiers, with 85-99% accuracy. There was a tendency for one member's frontal electrodes to drive the classifier over the other's, which predicted the leader of the interaction in 8/9 pairs.

Conclusions

This study reveals new neural mechanisms underlying two-person interactions. It also shows how analyzing two interacting brains can give better classification of behaviour; and hence that the whole of two brains is indeed better than the sum of its parts, at disentangling neural signatures of interaction.

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