A multi-variate pattern analysis investigation of strategic thinking and deception in a dynamic, competitive game.

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Abstract

Most successful human interactions depend upon the interpretation of an agent's behaviors and intentions in order to support strategic control of the agent's behaviors and decisions. Interpreting others' actions require many elements of social cognition, including more complex functions like theory of mind. Although there is some consistency in the neural substrates identified as supporting these functions (e.g. the medial-prefrontal cortex and temporal-parietal junction (TPJ)), most tasks employ static or sequential interactions that do not allow investigation of differing levels of social-cognitive engagement on a short time scale. In this study, we adapted a dynamic, competitive game modeled on a simplified penalty kick, wherein human subjects ($N = 29$) controlled a ball, attempting to score against a human- or computer-controlled goalie, while measures of brain activation were obtained using functional magnetic resonance imaging (fMRI). This allowed us to carry out detailed investigation of subjects' interactions with their opponent, the strategies they employ, and how relevant factors change over short and longer time scales. K-means clustering on the difference between the y position of the subject-controlled ball and their human opponent revealed that participant behavior reduced to two clusters, one pair representing early feints and misdirections (i.e., separation between participant and opponent near the start of the trial) and the other representing strategies intended to hide the kicker's intention for as long as possible (i.e., separation only at the end of the trial). These clusters – each further separable into pairs of upward or downward movements – correspond to distinct strategies expressed in behavioral time courses. Play against a computer opponent serves as a non-social baseline with similar strategic interactions. Using multivariate pattern analysis (MVPA), we examined whether local brain regions carried information that predicted trial features (e.g., opponent, outcome, strategy). Confirmatory analyses found that visual regions can be used to classify human from computer opponents at the time the opponent is revealed. MVPA of strategic interaction focused on the neural response difference between the two strategy-defined clusters. Using this dynamic task allows distinction of strategic elements of deception (e.g., timing of movement) from the conditions that elicit deception, the nature of the opponent, and the outcome of the action. The use of dynamic tasks facilitates the study of the nature and characteristics of strategic social interaction on short timescales, opening avenues for causal studies of the supporting neural substrates.