

# 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 a contact's behaviors and intentions in order to support strategic control of the actor's behaviors and decisions. Interpreting other's 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 long 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 wherein human subjects controlled the ball in a simplified penalty kick 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 time on both 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 in behavior based **only on analyses of behavioral time courses**. Using multivariate pattern analysis (MVPA), we examined whether local brain regions carried information that predicted trial features (e.g., opponent, outcome, deception 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.

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- The bolded “only on analyses...” above are because Scott, on your revision you had written there “..based on analyses of time courses and xx”, and I wasn't sure what you meant. The only data that was used in the analysis that gave us those clusters were the behavioral time courses – is that what you meant?
  - I changed McKell's “early and late clusters” to “the two strategy-defined clusters”, because we haven't used the terms “early” and “late” to explicitly describe the clusters. Not sure my way is the best, but something along those lines.