Supervised Classification of Intended Behaviors Using Electroencephalography (EEG) from Freely-Behaving Infants: Early findings.

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A posited analog of the mirror neuron system (MNS) in humans has been thought to be involved in imitation and action understanding. Furthermore, research has investigated desynchronization of the mu rhythm (a 7-13 Hz rhythm found over the sensorimotor cortex) as a potential neurophysiological correlate of MNS activity. However, few have examined the development of the MNS in human infants, and even less have studied MNS development under freely-behaving conditions in which infant subjects can interact naturally with the experimenter and the surrounding environment. Moreover, most studies rely on assumptions from the hypothesized MNS in humans by focusing on specific brain areas, delay times with respect to the onset of a generated or perceived action, or pre-defined frequency bands. Thus, in this study we aim to use scalp electroencephalography (EEG) and inertial sensors to study MNS development in freely-behaving infants by using a data-driven parametric models to characterize, recognize and predict goal-oriented behaviors intended by the infant.

A 64-electrode active EEG scalp cap was used to measure brain activity in eight 6-24 month-old infants during freely-behaving interactions with the experimenter. Four inertial motion units (IMUs) were placed on the wrists, head, and torso of the infant as well as two IMUs on the experimenter's wrists to monitor bodily movements. Based on the spectrum of behaviors exhibited by each infant, the following behaviors were identified, extracted, and analyzed for all infant data acquired: attentive rest, action-observation, action-imitation, exploration, reaching-to-grasp, and reaching-to-offer. These segmented behaviors were further analyzed using the α- , β-, and δ- bands of the EEG signal in the infants/toddlers.

Time lags of band-specific EEG data were supplied as features to a machine learning algorithm that computed locality-preserving Fisher's discriminant analysis (LFDA) to reduce the dimensionality of EEG features into a more classifiable subspace which was subsequently modeled using a Gaussian mixture model (GMM) classifier to predict each segmented behavior. Using this approach, greater-than-chance overall classification accuracies were computed for each infant. Thus using band-specific, lag-based EEG data as features and a machine-learning algorithm to generate a classifiable model is feasible for predicting infant behavior.

Overall, this work contributes towards understanding the development of cognitive and neural processes that allow humans to decode the behaviors of others for the internalization of sensorimotor experience.

This research was supported by NIH NICHD Award PO1HD064653.