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Exploring the Neural Mechanisms of Communication and Cooperation in Children and Adults

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Abstract : This study was designed to examine how humans are able to teach and learn semantic information as well as cooperate in order to jointly achieve sophisticated goals. Specifically, we are measuring individual differences in how these abilities develop from foundational building blocks in early childhood. The current study adopts a paradigm for novel noun learning developed by Samuelson, Smith, Perry, and Spencer (2011) to a hyperscanning paradigm [Cui, Bryant and Reiss, 2012]. This project measures coordinated brain activity between a parent and child using simultaneous functional near infrared spectroscopy (fNIRS) in pairs of 2.5, 3.5 and 4.5-year-old children and their parents. We are also separately testing pairs of adult friends. Children and parents, or adult friends, are seated across from one another at a table. The parent (in the developmental study) then teaches their child the names of novel toys. An experimenter then tests the child by presenting the objects in pairs and asking the child to retrieve one object by name. Children are asked to choose from both pairs of familiar objects and pairs of novel objects. In order to explore individual differences in cooperation with the same participants, each dyad plays a cooperative game of Jenga, in which their joint score is based on how many blocks they can remove from the tower as a team. A preliminary analysis of the noun-learning task showed that, when presented with 6 word-object mappings, children learned an average of 3 new words (50%) and that the number of objects learned by each child ranged from 2-4. Adults initially learned all of the new words but were variable in their later retention of the mappings, which ranged from 50-100%. We are currently examining differences in cooperative behavior during the Jenga playing game, including time spent discussing each move before it is made. Ongoing analyses are examining the social dynamics that might underlie the differences between words that were successfully learned and unlearned words for each dyad, as well as the developmental differences observed in the study. Additionally, the Jenga game is being used to better understand individual and developmental differences in social coordination during a cooperative task. At a behavioral level, the analysis maps periods of joint visual attention between participants during the word learning and the Jenga game, using head-mounted eye trackers to assess each participant's first-person viewpoint during the session. We are also analyzing the coherence in brain activity between participants during novel word-learning and Jenga playing. The first hypothesis is that visual joint attention during the session will be positively correlated with both the number of words learned and with the number of blocks moved during Jenga before the tower falls. The next hypothesis is that successful communication of new words and success in the game will each be positively correlated with synchronized brain activity between the parent and child/the adult friends in cortical regions underlying social cognition, semantic processing, and visual processing. This study probes both the neural and behavioral mechanisms of learning and cooperation in a naturalistic, interactive and developmental context.

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