

Gesture analysis expands the dimensionality of infant language acquisition research

For at least the last 25 years, looking time measures have provided the vast bulk of the insights we have into the linguistic abilities of infants between 4 and 24 months of age. In this work we propose a new metric to supplement and cross-validate looking time: measures of the motion resulting from infant gesture. We report two studies using two different methodologies that, first, confirm the usefulness of gestural movement as a dependent variable, and, second, demonstrate a correlation between results concerning word/object association made using movement measures and those made using looking time measures. We suggest that, like infant looking, infant movement is not random; it is integrally linked to cognitive functioning in these language tasks, and we demonstrate that examining infant movement can yield insights into language acquisition that were previously unavailable.

Study 1: Gestural responses of 6-month-old infants to language and music stimuli. We coded the voluntary motor behavior of 20 6-month-old infants listening to language (n = 10) or music (n = 10) stimuli, using Anvil, a tool for annotating digital video on user-defined, temporally ordered hierarchical tiers, with the capability of tagging marked intervals with attribute labels. Using a detailed coding system, we labeled the presence, nature and timing of infant responses in four major areas: head, arm, and torso movement, hand and finger gesture, vocalization, and eye gaze. Results revealed meaningful significant differences in infant movement in the two conditions, including torso movement, gaze direction, and nature and timing of vocalizations. These results confirm the viability of measures of infant movement for revealing important differences in infant language and music perception.

Study 2: Movement patterns of 14-month-old infants in a word-object association task. Recent work using looking time in a habituation/dishabituation paradigm shows that 14-month-old infants can associate two nonsense, minimally differing word forms with two novel objects under very specific conditions: if the auditory stimuli are delivered by an Experimenter present in the testing room and if they share gaze with the Experimenter to a significant extent. We used this result as a benchmark against which to validate the use of infant motion as a dependent measure in language acquisition studies. We analyzed the videos taken of each of the infants as they participated in this study, using an algorithm that processes optical flow information to yield a matrix of velocity values (horizontal, vertical, Euclidean motion) for each transition from pixel to pixel in the two-dimensional video. The results for magnitude of motion exactly replicated the very specific looking time results obtained in the original study, strong evidence sanctioning the use of movement measures to investigate infant language acquisition. Further, results for movement along the x-and y-axes also yielded significant differences, providing *new* insights into infant behavior in this setting by allowing a more detailed examination of orientation toward the speaker (x-axis motion) and of postural response (y-axis motion), research parameters that are inaccessible to looking time measures.

These studies showcase the successful application of two different and revealing methods for analyzing infant gestural movement: one, a detailed coding system allowing precise qualitative characterization and measurement of infant movement, the other a non-invasive, simple-to-use video-based algorithmic analysis yielding measures of magnitude and direction of global infant movement. Taken together, the studies demonstrate that infant movement is not random, but does, in fact, vary systematically with the infant's exposure to different stimuli, and further, that measures of infant motion not only support looking time measures, but also yield fresh insights into the cognitive processing of infants involved in language learning tasks. The examination of infant gestural motion opens up access to questions that looking time measures cannot address, and expands and enriches the dimensionality of our understanding of infant language acquisition.