

To Hear and to Hold: Maternal Naming and Infant Object Exploration

Lucas Chang
University of California, San Diego
La Jolla, California 92093
Email: l8chang@ucsd.edu

Kaya de Barbaro
MRC Cognition and Brain Sciences Unit
University of Cambridge
Cambridge, UK
Email: kaya@cogsci.ucsd.edu

Gedeon Deák
University of California, San Diego
La Jolla, California 92093
Email: deak@cogsci.ucsd.edu

I. INTRODUCTION

To acquire language, infants must associate the language they hear with concurrent nonlinguistic experiences—the word-world mapping problem. Caregivers help structure the infant’s environment by monitoring infants’ attention and producing speech at informative times. In particular, children’s learning of object names depends on their sensory experiences at times when objects are named. At 18 months, children’s learning of novel words is predicted by the size of the object in their visual field when it is named [1]. However, there is not a direct relationship between infant’s attention to objects in the world and speech produced by caregivers. Infant’s multimodal experiences unfold in interactions with caregivers where both partners’ behavior, including vocalizations, gaze, and manual activity, dynamically structure the visual and auditory scene [2,3].

Already during the first year of life, we know that caregivers name objects for infants using multimodal behavior such as synchronous speech and object motion, and infants may begin to learn their first object words from these structured naming events [4]. However, less is known about how dyadic gaze and hand activity is related to early language experiences as naming events are co-constructed by the activity of both the caregiver and child.

Infants’ coordination of gaze and manual activity changes rapidly during the first year as they become more proficient at reaching, manipulating objects, and flexibly allocating their gaze and hands to things in the world. The emergence of behaviors such as imitation and triadic attention may derive from these changes in activity over the first year [5]. Because naming events involve the gaze and hands of both the infant and the caregiver, their structure might also change along with changes in infants’ object exploration during the first year, as children acquire their first receptive words.

In the current study we recorded play sessions in a longitudinal sample of infants and mothers, and documented the dynamics of infant and mother manual and gaze activity immediately before and after mothers produced naming utterances. We also investigated the relationship between individual differences in sensorimotor activity during object exploration relate to the multimodal context of spontaneous naming events.

II. METHODS

A. Participants

Participants were 40 mother-infant dyads who participated as part of a larger longitudinal study of infant social development (Deák, PI, NSF SES-0527756). Participants’ homes were visited at each month from 4 to 9 months and at 12 months. Only the 4, 6, and 9 month sessions were analyzed for this study. The caregivers’ mean age was 31.9 years (range = 28-38) and the mean education was 15.6 years (range = 14-18).

B. Task and Coding

Infants were placed in modified walkers with a tray in order to control for differences in postural stability. At each session, the mother and infant were given a set of three toys to play with. Mothers were instructed to “play as they normally would” with their infants. Two of the toys were placed in cupholders at the sides of the walker tray. Mothers were instructed to leave one toy on the tray at a time, and to return the others to the cupholders.

Three minutes of the 4, 6, and 9-month sessions were analyzed. Coders annotated the videos frame by frame at 10 Hz for infant gaze to the objects and to the mother’s face, mother gaze to the objects and to the infant’s face, infant hand/mouth

contact with the objects, and mother hand contact with the objects. Mothers' speech was transcribed and utterances containing names for any of the objects were identified. A second coder annotated 20% of sessions, and preliminary analyses show high reliability (Cohen's $\kappa > 0.75$) for all dimensions.

III. RESULTS

Mothers produced more naming events at 6 and 9 months than at 4 months (Mann-Whitney U test, $p < 0.05$). At each month we computed multimodal temporal signatures of mother and infant sensorimotor activity around each naming event. We did this by time-locking all naming events and computing the percent likelihood that infant hands, infant gaze, mother hands, and mother gaze are on the target (named) object, for latencies from -4 to +4 seconds around the utterance onset (fig. 1). To investigate whether naming utterances differed from non-naming utterances, all utterances when the mother was holding a target object were identified and divided into naming and non-naming events, and the proportion of events in which each modality is on that object was computed at each latency. At 9 months, but not 4 and 6 months, infants were significantly more likely to hold target objects after naming than non-naming utterances, starting around 2 seconds after the utterance. For each session, infant hand-hand decoupling, a measure of motor activity, was computed. Decoupling was defined as time spent with infant's hands touching two different objects divided by time spent touching at least one object. Decoupling increased from 4 to 6 and from 6 to 9 months (Mann-Whitney U test, $p < 0.05$). Only at 6 months, decoupling correlated with total naming events ($r = .48$, $p < 0.05$). Additionally, infants in the top 50th %ile of decoupling at 6 months showed the 9-month pattern of increased object holding after naming utterances, and those in the bottom 50th of decoupling did not.

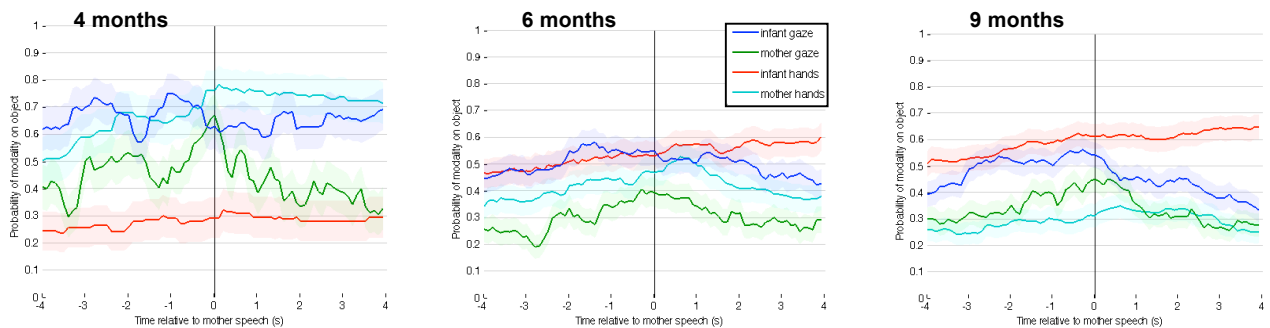


Fig. 1: Probability of each partner's hands and gaze being on the target object, time-locked to naming events and collapsed across all events and all sessions. Shaded area represents 95% confidence interval around binomial proportion.

IV. CONCLUSION

Over the course of the first year, infant manual activity becomes more prominent during naming events, replacing mother's manual activity. From 4-6 months, infant gaze to named objects becomes more temporally specific around naming events. From 6-9 months, infants begin to show increased holding after naming compared to non-naming utterances. A measure of sensorimotor activity (manual decoupling) correlates with number of naming events and earlier appearance of typical 9-month patterns of gaze and hands activity around naming events at 6 months. Thus, experience with naming events typical of 9-month dyads co-emerges with changes in manual activity with objects. Future research in early vocabulary acquisition should take account of the language environment as multimodal and dynamic on multiple timescales.

ACKNOWLEDGMENT

This material is based upon work supported by the National Science Foundation (NSF) Graduate Research Fellowship under Grant No. (NSF grant NO. DGE-1144086), the NSF under Grant No. SES-0527756, and by the Temporal Dynamics of Learning Center.

REFERENCES

- [1] Yu, C., & Smith, L. B. (2012). Embodied attention and word learning by toddlers. *Cognition*, 125(2), 244-262.
- [2] Deak, G. O., Krasno, A. M., Triesch, J., Lewis, J., & Sepeta, L. (2014). Watch the hands: infants can learn to follow gaze by seeing adults manipulate objects. *Developmental science*, 17(2), 270-281.
- [3] Yu, C., & Smith, L. B. (2013). Joint attention without gaze following: human infants and their parents coordinate visual attention to objects through eye-hand coordination. *PLoS one*, 8(11), e79659.
- [4] Gogate, L. J., Bolzani, L. H., & Betancourt, E. A. (2006). Attention to Maternal Multimodal Naming by 6-to 8-Month-Old Infants and Learning of Word-Object Relations. *Infancy*, 9(3), 259-288.
- [5] de Barbaro, K., Johnson, C. M., Forster, D., Littlewort, G., & Deak, G. (2012, November). Sensory-motor dynamics of mother-infant-object interactions: Longitudinal changes in micro-behavioral patterns across the first year. In *Development and Learning and Epigenetic Robotics (ICDL), 2012 IEEE International Conference on* (pp. 1-2). IEEE.