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Temporal Dynamics of Multimodal Multiparty Interactions: A Microgenesis of Early Social Interaction

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ABSTRACT

This project characterizes the development of early social interactions in a longitudinal sample of mothers and their infants. To do this we track the interaction in as a temporal configuration of multimodal, multiparty components, coding a total of 14 dimensions at each frame. Our final goal is to develop methods which we can use to systematically document regularities in the way attention gets organized longitudinally in a large sample of mother-infant dyads. Coding systematically at this scale allows us to ground a developmental account of early social interaction. For this project, we developed 1) ways to reduce the labor intensity of coding frame-by-frame multidimensional data over the entire sample and 2) ways of quantifying complex configural regularities across our sample.

Author Keywords

Infant multimodal development process, attention, triadic, dyadic social interaction, “event-based analyses”.

INTRODUCTION

This project characterizes the development of early social interactions in a longitudinal sample of mothers and their infants. In particular it focuses on infants’ rapidly developing abilities to coordinate attention to objects and people. The period 9-12 months is thought to bring a new ability to coordinate with and share the objects of another persons’ attention—like imitating the actions of a parent or playing a ball tossing game. This has been termed “triadic” or “you-me-it” attention.

Previous research has documented the development of early mother infant interactions by longitudinally tracking the high level construct of “focus of attention”. From these accounts we have a series of binary *performance scores*: early on, the infant can attend to mom, but not toys, then at six months onwards, to toys, but not mom, and finally, at 12 months, they can fluidly attend to both mom and toys [1]. Inherently discontinuous, these results have puzzled researchers eager for a coherent developmental account of the processes that bridge to the triadic “shift” at 12 months [2, 3, p.34]. Previous accounts attribute these novel abilities to a sudden “cognitive shift”: the emergence of the ability to “read” others’ intentions [4]. We argue that the apparently sudden appearance of these high level activities at 12 months may be an artifact of such discontinuous, unidimensional assessments.

Instead, in our work we track such interactions as temporal configurations of multimodal, multiparty components, and consider triadic attention a special configuration of these dimensions, wherein the infant is able to coordinate its attentional resources (e.g. gaze, hands, mouth) in conjunction with the adult’s towards a set of toys. In our analysis, we focus on achievements of social interaction that successfully occur at all ages. For example, in dyads of all ages, infants can direct their gaze, hands, and mouth to nearby toys. However, the scaffolding necessary for this achievement is very different across developmental time. For example, young infants may need maternal manual elaboration of a toy to maintain gaze to it, where older infants may be able to do so in a wider variety of contexts of maternal activity.

In contrast to previous methods, our methods allow for a direct comparison of the moment-to-moment processes by which younger and older dyads coordinate their attentional resources to toys and one another. Specifically, rather than focusing on changing performance, we document the changing participation dynamics: the organization and timing of the micro level components as the dyad gets organized to attend to one another and toys at each age [for examples of shifting emphasis from measuring outcome to tracking participation dynamics, see 5, 6]. This will require tracking the interaction using a much higher number of dimensions than has previously been coded.

Our final goal is to develop methods which we can use to systematically document regularities in the way attention gets organized longitudinally in a large sample of mother-infant dyads. Our video corpus is a sample of 40 mother-infant dyads each in 4 longitudinal sessions in which the infants were four, six, nine and twelve months of age. Cameras recorded three angles during a 7-min "free play" interaction with a set of toys. Coding systematically at this scale allows us to ground a developmental account of early social interaction. For this project we developed 1) ways to reduce the labor intensity of coding frame-by-frame multidimensional data over the entire sample, and 2) ways of quantifying complex configural regularities across our sample. We describe our approach below.

OVERVIEW

We used the qualitative analyses to 1) identify regularities in the way the dyad gets organized to attend to toys and one another at each age and 2) to identify a regularly occurring event that will allow us to easily and quickly identify important segments of the interaction. These segments are important in that they would be able to capture the regularities observed. Initial systematic analyses are a test of the regularities observed as well as of the validity of the events for capturing those regularities. When scaling up to coding and analysis of the 40 dyad subsample, an event based analysis allows us to selectively employ our high dimensional coding scheme: specifically, in only those segments of the interaction that have been pre-identified as most relevant for our questions.

QUALITATIVE ANALYSES

We have completed an extensive qualitative analysis of a subsample of 5 interacting dyads each in 4 longitudinal sessions in which the infants were four, six, nine and twelve months of age. The results of the qualitative analysis are a description of typical dyadic profiles at each session surrounding two key segments of interaction *1) How does the infant get organized to attend to the toys at each age?* And *2) How does the infant respond to the actions of the mom?* These were our successful achievements upon which we could ground our developmental account of triadic attention: they occurred at each age, but the way in which they occurred were very different across ages. Broadly, the order of which modalities are engaged, the infant's capacity to divide its attention and recover from interruptions, whether the same interventions by the mom were supportive or disruptive, etc. appeared to vary systematically with ages. The regularities that we identified reveal an increasing autonomy and complexity of the infants' abilities leading up to the 12 month "shift" to triadic attention. Based on these observations, we identified the moment that a mother introduced a novel toy (MINT) and the following unfolding dyadic organization as an event that would capture the developmental changes we wished to capture.

Systematic Coding

We systematically coded three minutes of each session for the purposes of a quantitative testing of our predictions from the qualitative analysis and testing of the MINT event. Coding was done using human coders using commercially available software. In systematic analyses, we coded 14 dimensions, including: Maternal Gaze, Right hand, Left hand, Affect; Infant Gaze, Right hand, Left hand, Affect and Mouth, the location of the three toys, as well as the vocalizations of mom and infant. Each dimension was coded frame by frame at 10 frames per second (FPS), although not all dimensions were coded with mutually exclusive and exhaustive codes. Each dimension had a number of distinctions. For example, for hands we have differentiated between reach, grasp, contact, passive tactile contact, hover, actions on the toys (specified for type of action, e.g. bang, hit, squeeze), as well as certain types of toy motion.

During the creation of each coding scheme, we used commercially available timeline making software in order to represent multiple coders' annotations of the same video segments in a colorful and visible way. This allowed us to very easily visually assess where mismatches occurred and thus easily pinpoint where the coding schemes needed further specification or alternatively where individual coders needed to be more careful about the coding criteria.

PATTERN IDENTIFICATION AND QUANTITATIVE ANALYSES

We also used the timeline software to visualize the components of the interaction in order to further identify and specify regularities in the multimodal multiparty configurations.

Precise specification of the regularities is important for creating quantifiable features that can be used to test observational results. We have created a set of features that correspond to the various regularities observed in the qualitative analyses. These configurations capture complex multidimensional configurations that occur in real time. Based on our qualitative analyses, it is precisely these sorts of features that we believe will differentiate older and younger dyads. For example, we observed a slow, rigid sequence of modalities in typical four month olds, where gaze to toy preceded and co-occurred with manual contact, followed by mouthing of toy. Additionally, infant gaze remained locked to toy for majority of contact. We can quantify this complex configuration of multidimensional components by calculating features such as the following 1) the percent likelihood that infant gaze contact with toy occurs before infant left or right hand, and 2) the ratio of the duration of infant gaze contact with toy relative to infant manual contact with toy.

Features are based on observations from individual sessions, but all features will be calculated at each session, such that there is a single numerical value associated with each feature for each MINT event. These features can be averaged across infants of the same ages in order to then make comparisons across the ages. These features thus provide a test of our proposed trajectory of changes between the four, six, nine and twelve month dyads. Systematic verification of these qualitatively observed regularities will thus ground theoretical claims of increasing complexity.

This feature-based analysis is event-based in that the features are calculated within the boundaries given by the event. Specifically, the unfolding interaction following each MINT provides the dyad a chance to organize the infants' attention to the novel toy being introduced by the mom. It is the particulars of the interaction following the MINT that we wish to quantify in order to test our qualitative observations. However it is an empirical question how much of the interaction following the MINT will be needed to best capture the predicted regularities. This is critical for scaling our analyses up to the 40-dyad sample, as the labor intensive nature of coding will only allow us to code those segments of the interaction which are necessary for calculating features. Our systematically coded subsample will thus function as 1) a preliminary test of our qualitative observations and 2) a testing ground for precisely defining the start and end boundaries of the MINT events for high dimensional coding and feature calculation for the 40-dyad sample.

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