Collecting and analyzing data for understanding the development of triadic attention

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Social interaction is complex

- Social interaction is multidimensional
- Social interaction unfolds in time, on multiple timescales
My research questions

- How do babies learn to participate in shared actions?
  - We learn much informally, from participating in actions with others
  - Imitation and Games occur at the end of the first year
  - No developmental story

- Our approach: capture changing micro dynamics of social interaction to get at HOW this shift happens
Goal of talk

• Show you what I mean by “capturing micro dynamics of activity through time”
• Get you thinking about how this is applicable to your own research in TDLC
  – Social interaction is *probably* present whenever we study about learning
  – Phenomena (e.g. learning; or Gwen’s “Something happened”)
    • Can be described at multiple levels
    • Unfold in time, on multiple timescales
How can we get a better understanding of how learning happens?

• Move from documenting achievements of the system …

• …to capturing how those achievements happen: the “learning trajectories” of the system
Measures of achievement

• Past studies of development of mother infant interaction “achievement focused”
  – Identify a shift in behavior: an achievement
    – Is imitation present?
    – When do they attain imitation?
  – No data to say what factors contributed to achievement

Bakeman & Adamson, 1984
Cohn & Tronick, 1988;
Kaye & Fogel, 1980
Capturing learning trajectories: Triadic Attending

• Imitation is a dyadic level achievement
• Imitation is also an temporal organization of micro level components
  – Attention of mother and infant towards each other and toys
    • Specifying sensory motor embodiments of attending: gaze and manual action
  – Can identify specific features of this coordination
    • E.g. M-I-O coordination: Fluid alternation of gaze between own toy and mom toy
    • “Checking in”
Capturing learning trajectories: Triadic Attending

• Achievement of imitation happens only at 12 months
  – But we can look at dynamics of micro components across longitudinal time
    • Are modalities coupled?
    • How does infant respond to maternal bid?
How can we capture learning trajectories?

– From “pinhole” measures to capturing richer measures of learning through time:
  • Activity across multiple dimensions
    – Level of the phenomenon
    – Layers above or below that might affect the process of the phenomenon
  • Activity on multiple timescales
    – Real-time unfolding
    – Through time: capture learning process

– Research process: First get to know your phenomenon with an observational analysis
Observational analysis

• What is observable?
  – Video
  – Rich visualizations of activity
    • What can you get easily?
    • Code a little and make a visualization
  – Can cycle between these two. At all stages of analysis

Sample 1: observational analysis
• 5 dyads @
  – 4mo, 6mo, 9mo & 12 mo
• 3-4 minutes of free play
Systematic data collection

• Video data
  – Hand coding
    • Con: Time intensive
      – “Event based coding”
      – Start w a subsample, reduce coding
  • Automated measures
    – Sensors, kinect, computer mouse tracking, timing of button press responses
    – Machine vision of video data
      • CERT, Markers on hands
    – Con: is there a standard model for your subject?
    – Con: Often missing macro level events
      • Hand code these
Sample for systematic investigation: 1

- 5 dyads @ 4mo, 6mo, 9mo & 12 mo
- 2-4 minutes of free play

Sample 2 systematic:

- 26 dyads @ 4mo, 6mo, 9mo & 12 mo
- 2-4 minutes of free play
Gaze

• Tray-toys
  – Animate
  – Inanimate
  – Musical

• Partner
  – Face
  – Right / left hands
  – Body

• “Environment”
  – Tray: right/left
  – Environment: right/left/center

• Other
  – Right and left “Point locations”
  – Previous location
Manual Actions

• Tray toy actions for right and left hand independantly
  – Reach
  – Grasp
  – Exploration/Elaboration
    • Fingering
    • Squeezing
    • Looking while turning, etc.
  – Repetitive Rhythmic Arms
  – Contact
  – Passive tactile contact
  – Hover
  – Pointing

Hover / Reach

Grasp

Passive Tactile

“Elaboration”
Final coding on large sample (N=26)

• Gaze (infant only)
• Manual Actions of infant
  – Without specifying both hands if on same
• Facial Affect (drop)
• Mouthing (drop)
• Object Location (drop)
• Add macro layer: imitation and games
  – (So from 12 dimensions to .... 4)
Hand coding video: lessons

- Specifying a coding scheme
  - Spending a lot of time working out a coding scheme vs. road test rough versions
  - Coders input invaluable!

- Establishing reliability
  - Cohen’s Kappa
  - Visualizations
Establishing reliability

Maddi

Sharon

Sophie

5:17 AM 1:02 AM 1:07 AM 1:12 AM 1:17 AM 1:22 AM 1:27 AM
How can we capture learning trajectories?

• Collect richer measures of behavior through time
  – Activity across multiple dimensions
  – Activity on multiple timescales

• In analysis, capture dynamics
  – Dynamics across multiple dimensions of behavior
  – Dynamics on multiple timescales

Research process: Cycle between visualizations and quantifications
Visualizations: What dynamics become visible to the researcher?

4mo Dyad: 100sec of freeplay
Visualizations: What patterns become visible to the researcher?

- Infant–object
- Decoupled modalities

12mo Dyad: 20sec of freeplay
Use visualization to identify quantitative measures that can capture those dynamics.

Repeated Measures ANOVA: F(2.3, 53.5) = 21.98, p = 0

Proportion of Session Coupled:

October 11 gaze hands Coupling data, N = 26

October 11 RH LH Coupling data, N

Repeated Measures ANOVA: F(1.96, 37.33) = 18.55, p = 0
Visualizations: What patterns become visible to the researcher?

- Mother-infant-object
  - Distributed attending: “Just checking-in”

12mo Dyad: 20sec of freeplay
Visualizations: What dynamics become visible to the researcher?

4mo Dyad: 100sec of freeplay
Dyad006 at 4mo: Toy attending by participant & modality

On Tray

#Modalities in contact with toy

Mom “out”
ID Maternal Bids; measure infant response

Sum modalities to “Maternal-bid toy” vs. Total engaged modalities

Dyad 006 @ 9mo
Parameters for maternal bid calculation: SMART features

Mom

Inf

5.5s: Other Engaged Toy Search

5s: New Bout

1s: Neg Buffer

5s: Bid expires

5s: Inf Negotiation
Each dyad contributes multiple macro level events at each session: capture micro level dynamics within each one

Y axis: Count infant modalities to novel vs. total modalities engaged

006 @ 4mo

006 @ 6mo
Sometimes you can have too much data

4 months
6 months
9 months
12 months
Response to bid: each dyad median Proportion to Novel across session

Response to bid for each dyad Average Median prop to novel

P<.01

P<.001

P<.15
Retain more detail: Response to Maternal Bid: All Bids, all 4-month dyads

In 50% of bids at 4mo infants completely switch over to mom’s toy

Bins: Proportion attending to maternal bid toy
Infants always attend to mother’s actions on toys

Bins: Proportion attending to maternal bid toy

Increasingly, infants attend to maternal actions with less and less sensory motor contact

<table>
<thead>
<tr>
<th></th>
<th>4mo</th>
<th>6mo</th>
<th>9mo</th>
<th>12mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.06 (0.68, 1.66)</td>
<td>0.95 (0.56, 1.61)</td>
<td>1.03 (0.57, 1.86)</td>
<td>0.82 (0.67, 1)</td>
</tr>
<tr>
<td>β</td>
<td>0.37 (0.23, 0.60)</td>
<td>0.61 (0.42, 0.88)</td>
<td>0.89 (0.67, 1.19)</td>
<td>1.73 (1.58, 1.9)</td>
</tr>
</tbody>
</table>
Thesis: Results summary

Instead of a mysterious “shift” from no triadics to imitation

Across the first year, infants gradually

- Decouple sensory motor modalities more
- Shift from transitioning all modalities to maternal bid toy to distributing attention across multiple toys
Thesis: Methods summary

• Previous studies
  – Qualitative shifts in high level behavioral outcomes / “products”
  – No traction for understanding why shifts happen

• Our study
  – Capture developmental changes in temporal configurations across micro dimensions of interactions
    • Continuous measures that SPAN the entire age range
  – Provides traction for continuous developmental account
  – Demystifies underlying process of the qualitative shift
Next steps: Capturing more dynamics. Infant: not just distributing attention between but also increasing alternations currently at visualization stage ..
Dyad006 at4moCountModalities Mo−Inf Cross Recurrence

Time (seconds)

0 50 100 150 200 250

0 50 100 150 200 250
Other domains: Richer measures of behavior through time

- Identify regularly occurring events that capture your phenomenon
  - Triadic: Response to “Maternal bid”
  - Experimental trials
  - Interaction between RUBI and child
  - HW problem
  - Synchrony between two brain areas

- What other dimensions must get coordinated for your phenomenon?
  - “More micro” :
    - E.g. for individual’s success at learning: Gaze, facial expressions, gestures, arousal, motor trajectories, activity of individual brain areas, arousal, genetics, etc
  - “More macro”:
    - Feedback from teacher in the form of language and nonverbal communication, classroom dynamics, family dynamics

- How do the components come together differently during the course of learning? Across the learning trajectory?
Other domains: Richer measures of behavior through time

• Does the student make the correct response VS.
  – How do non-verbal behaviors relate to the flow of conversation
  – and whether or not a student eventually grasps the material?

• Does the baby “prefer” right or left stimulus? VS.
  – What are the dynamics of the gaze direction trial by trial?
  – How do changes in heart rate covary with changes in gaze direction?