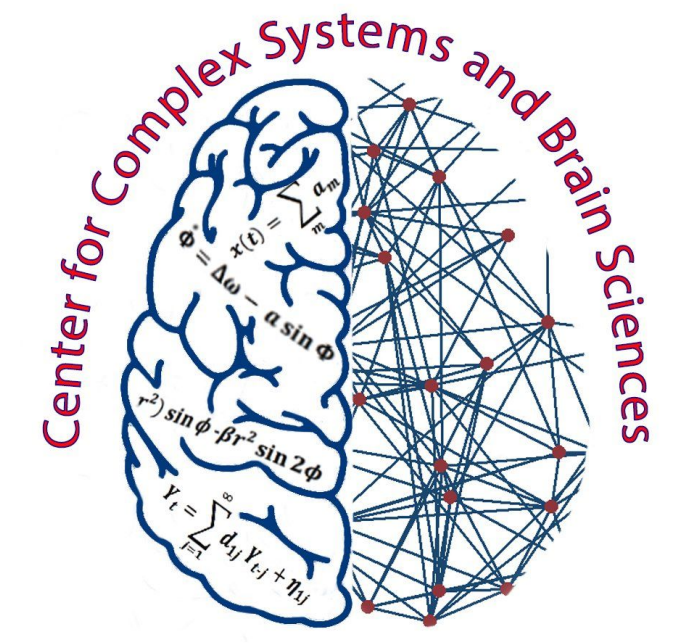


Dynamics of Agency Formation

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BACKGROUND

- In mobile conjugate reinforcement (MCR) studies, an infant is placed into a crib with a mobile hanging from above. Classically, when one of the infant's feet is tethered to the mobile, the infant greatly increases its foot movement rate.
- Bahrck and Watson (1985) noted that this behavior may either reflect **reinforcement learning** or **intentional infant action** but that differentiating between these two possible mechanisms remains "a challenge for future research."
- Comparing quantities of kicking activity in various experimental phases is insufficient for differentiating between these drivers as movement may be spontaneous one moment and intentional the next.
- Recently, Kelso (2016) theorized that if some critical level of coordination between infant and mobile is surpassed, the infant would realize it was controlling mobile motion and *suddenly* increase its foot activity. **Coordination dynamics may reveal the birth of agentic awareness.**

STUDY RATIONALE

- Agency arises out of a realization of a **coordinative relationship** between the organism (here, the baby) and the environment (the mobile).
- Some infants might steadily increase activity during the tethered phase, reflecting a basic sensitivity to the contingency, whereas other infants might also *discover* their control over the mobile, abruptly increasing activity upon discovery.
- Can differences in the magnitude and timing of the peak foot acceleration (greatest change in movement rate) across 1-minute windows be used to identify infants who experience agentic self-discovery?
- Infants who increase their rate slowly (small peak acceleration) are predicted to take longer to reach their peak, continuing to explore the contingency, but not yet realizing their own agency.

METHOD

Participants

- 8 2-4 month-old (full-term) infants, increased foot movement by $\geq 150\%$ during tethering

Materials

- Mobile - two colorful blocks on a wooden arm which rotated when two strings were pulled.
- 3D position of mobile and infant's feet were measured (100 Hz) using Vicon mocap system.

Procedure

MCR paradigm with four experimental phases:

Baseline 1 (mobile stationary -2 min.)

Baseline 2 (experimenter moves mobile - 2 min.)

Coupled (infant connected to mobile - 6 min.)

Decoupled (mobile disconnected, stationary- 2 min)

RESULTS

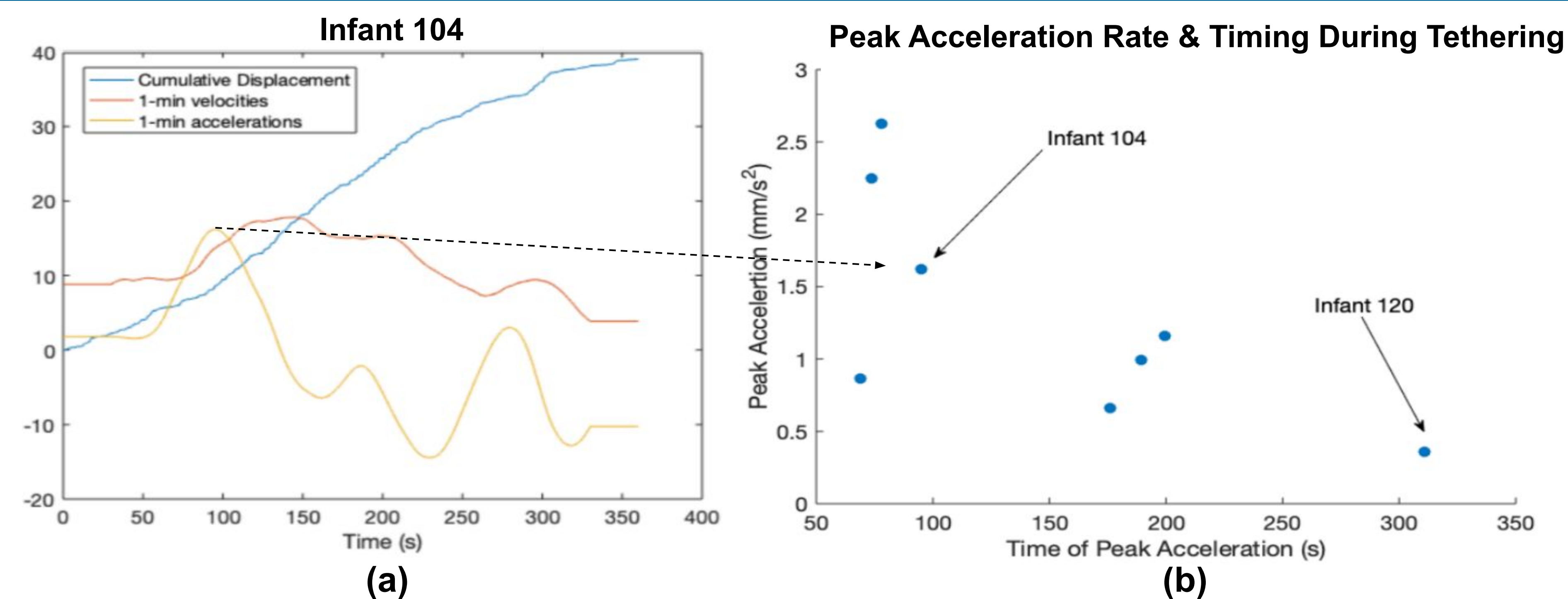


Figure 1. (a) Identifying peak velocity and acceleration. Cumulative displacement of the tethered foot (blue) was differentiated using 1-min. wide moving windows to calculate velocity (red) and acceleration (yellow) for infant 104 (values are scaled to fit in one image). This method allows for precise identification of timing of peak movement rate (red, at 178.22 s) and peak change in movement rate (yellow, at 94.84 s). **(b) Three clusters of dynamically differing infants.** Infants differ in terms of magnitude and timing of peak acceleration (change in movement rate). Generally, earlier peaking is associated with greater peak acceleration.

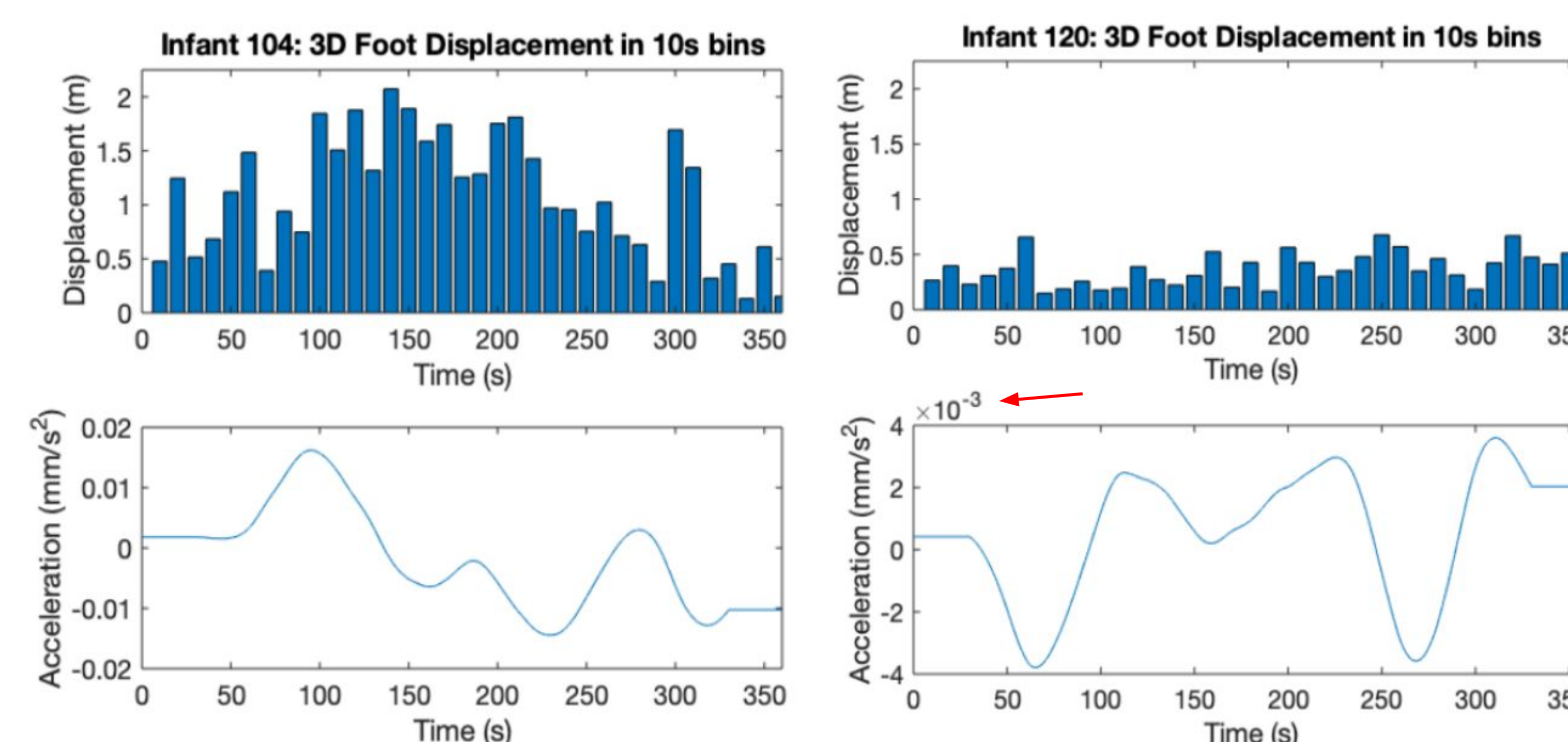


Figure 2. Displacement & Acceleration. In the top panels, 3D foot displacement is plotted in 10s windows for infants 104 and 120. Acceleration (1-min.-wide moving windows) is plotted at the bottom. Though both infants double foot activity from the first minute of the tethered phase to their maximum tethered phase movement rate, only 104 displays a *sudden* increase in activity rate suggesting his discovery of his agentic abilities.

RESULTS cont...

- Three clusters of infants emerged: infants who peaked in acceleration early, midway or late in the tethered phase. Average total displacement rate increases for early, midway and late peakers were 281%, 175% and 151%, respectively.
- Timing of peak was inversely related to magnitude of peak acceleration and extent of total increase across the tethered phase.
- Both infants 104 and 120 nearly doubled the activity of the foot connected to the mobile during the tethered phase relative to their baseline rates. However, unlike infant 104 who *suddenly* doubled activity over just one minute of tethering, infant 120 *slowly* increased her activity rate (see Figures 1b & 2).

DISCUSSION

Infants may be similar in terms of magnitude of change in activity but differ in terms of dynamics. The current findings support Kelso's (2016) hypothesis and suggest that some infants may be sensitive to sensorimotor contingencies, but not yet make the leap to discovery of themselves as agents.

Though the path to self-discovery depends on individual intrinsic dynamics, group patterns emerged. Critically, the three clusters of dynamically differing infants hint that there may be more than two possible states pertaining to agency: formed or unformed. If viewed from right to left, Figure 1b may be a first group portrait of the process of agency formation. Quasi-agentic states and intermediate exploration stages may precede full discovery of self-agency.

REFERENCES

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