Physiological Dynamics During Social Interaction in Children with ASD

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BACKGROUND

Physiological processes underlying social differences in ASD remain poorly understood, with no reliable objective physiological markers currently identified.

Heart rate dynamics are not apparent from behavioral observation alone. Direct gaze elicits within-individual autonomic changes[2], while autonomic coordination between social partners accompanies reciprocal social interaction[1, 3]

Objective: Characterize physiological dynamics and their relationship with quantified behavioral metrics, which may underlie individual differences in social interaction in ASD at two complementary levels:

Within-Individual: How do cardiac dynamics relate to EC?

Between Partners: How are physiological and behavioral signals temporally coordinated within dyads?

Across both: Do patterns vary by diagnosis or social partner?

Term Abbreviations

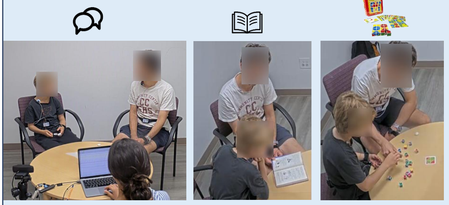
ASD: Autism Spectrum Disorder
IHR: Instantaneous Heart Rate
ECG: Electrocardiogram
TD: typically-developing
EC: eye-contact

METHODS

Participants & Paradigm

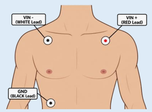
N = 11 children (7 ASD, 4 TD; ages 6-12) completed conversation, puzzle, and book-reading with a parent and unfamiliar adult.

Dyad	N	Age (yrs)	M:F	ADOS Comp. Score	Vineland-3 ABC
ASD/ID	7	9-12	6:1	6.7 (0.98)	74.8 (15.48) (low-adequate)
TD	4	6-12	3:1	NA	NA



Data Collection & Behavioral Coding

ECG, video, and behavioral annotations were continuously recorded and time-synchronized using BIOPAC®.



Mutual EC was coded frame-by-frame by two independent raters with high reliability (PABAK *Md* = .88, range = .70–.94; SD = .066).

ANALYSES

Individual Level

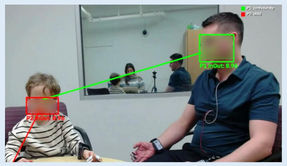
EC Behavior: % time in EC and bouts/min; mixed-effects models tested Diagnosis × Partner.

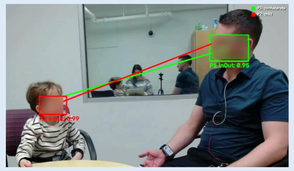
Cardiac Physiology During EC: Child IHR was compared across equal-exposure matched 3-s EC/no-EC segments; as exact child-level permutation test assessed the difference.

Event-Locked Cardiac Dynamics: Within-dyad z-scored IHR was examined around EC onset (−3 to +2 s) and offset (−2 to +3s).

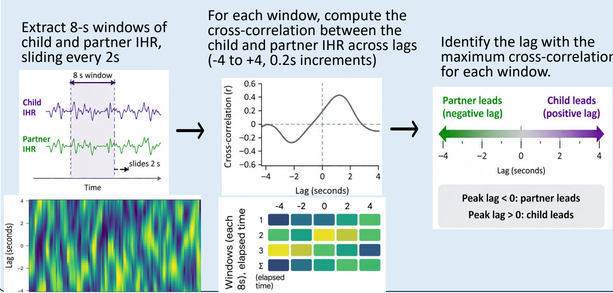
Interpersonal Level

Directional Gaze Dynamics: (Figure 6) Automated gaze estimates (Gaze-LLE) and IHR were analyzed using VAR/VARX Granger models; only parameter-robust effects were interpreted.





Dyadic Cardiac Leading-ness: (Figure 5) Window-lagged cross-correlation (WLCC) quantified child–adult leader/follower dynamics; Wilcoxon tests assessed task effects and surrogate pairings tested dyad specificity.



RESULTS

For Figures 1-5: TD child ASD child

Individual Level Results

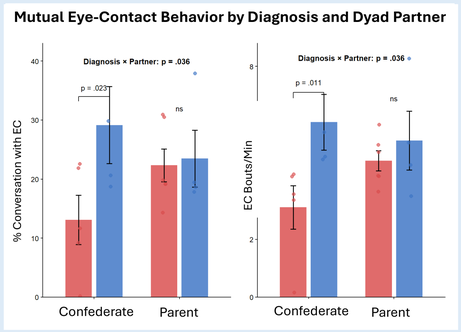


Figure 1. Diagnosis × Partner interactions emerged for EC duration and frequency (both p = .036), with ASD-TD differences during confederate but not parent interactions.

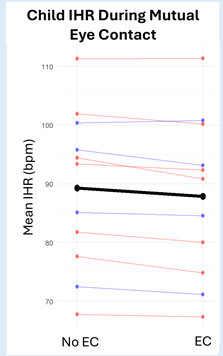


Figure 2. IHR was lower during naturalistic EC than no EC (Δ = −1.41 bpm, p = .004) and remained lower after equal-exposure matching across 1,000 selections of 3-s segments (Δ = −1.48 bpm; exact permutation p = .017).

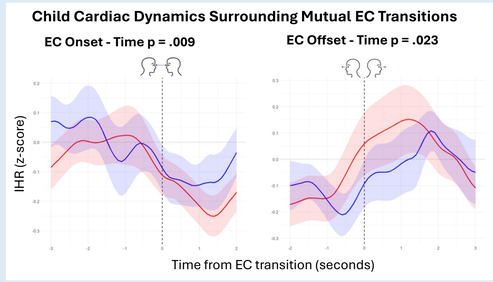


Figure 3. Standardized IHR decreased following EC onset (p = .009) and increased following offset (p = .023), with no significant diagnosis differences; Mean: ~15 EC events/dyad

Figure 4. Raw HR did not differ between ASD and TD children (p = 1.00).

Interpersonal Level Results

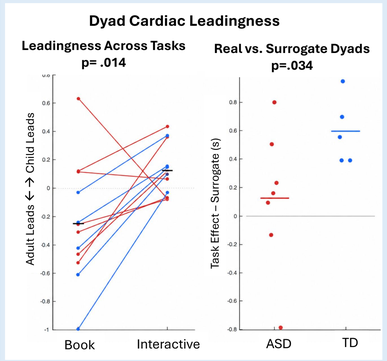


Figure 5. Leading-ness shifted from partner-led during book reading to child-led during interactive tasks (p = .014) exceeding surrogate estimates (p = .034).

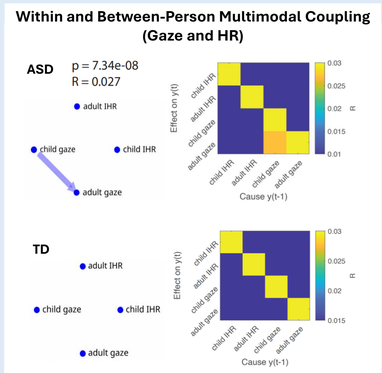


Figure 6. Child gaze predicted subsequent adult gaze in ASD dyads; the TD effect did not reach significance.

PRELIMINARY RESULTS

Mutual EC was associated with cardiac dynamics, with IHR lower during EC, and changing around EC transitions.

Social context shaped interpersonal dynamics: gaze behavior varied by partner, while cardiac leadingness varied with interaction structure.

Together, these preliminary findings demonstrate measurable cardiac and interpersonal dynamics surrounding social engagement and highlight social context and temporal organization as important targets for understanding social physiology in ASD; larger samples are needed to evaluate diagnostic differences.

FUTURE DIRECTIONS

Expand the sample. Increase power to evaluate diagnostic, partner, and context effects.

Extend multimodal within-person modeling. In collaboration with the Parra Lab at CCNY, examine within-person coupling among HR, gaze, body movement, and speech.

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