Feasibility of a child-friendly electrodermal activity sock for measuring parent-child synchrony in toddlers

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Background

Measuring children's psychophysiological states, such as electrodermal activity (EDA), provides important insight into socio-emotional development. To be meaningful in early development, measurements must be tolerable, non-intrusive, and suitable for naturalistic settings. To address this, we developed a child-friendly device —a sock with integrated textile electrodes—that enables comfortable EDA measurement. The device has recently been tested with adult participants (Rahman et al., 2024).

Objectives

- Study the feasibility of the EDA measurement sock in toddlers.
- Explore the feasibility of simultaneous EDA measurement in parent-child dyads during free play and task taking and assessing physiological synchrony between them.

Methods

Participants

The data was collected in Gaze@Toddler - project, which involved toddlers with and without autistic traits and their parents. This ongoing feasibility study included 11 toddlers (aged 24-36 months) and 11 toddlers' parents (8 mother and 3 dad).

Study protocol

EDA was measured during a social interaction session, either including playing with the parent or task making with the researcher while toddler sat on parent's lap.

The toddlers were allowed to choose the preferred sock from a selection, and the caregiver was encouraged to model the process by putting on the sock first.

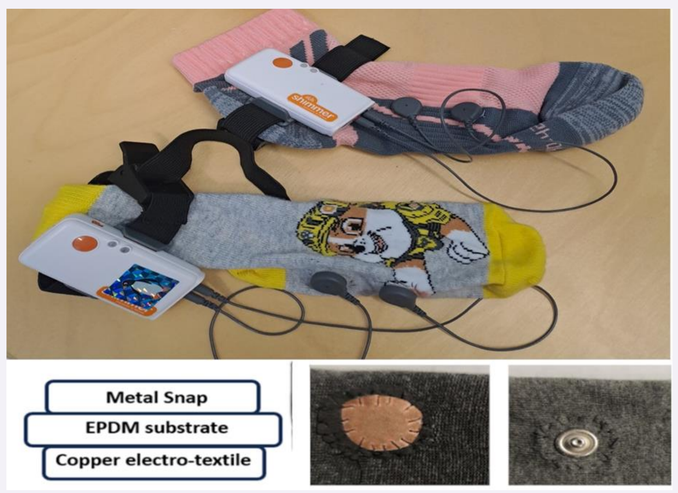

Fig 1. EDA was measured using a Shimmer3 GSR+ device connected via textile electrodes embedded in a soft sock.The electrodes were constructed from copper based electro textile (thickness 0.08 mm; surface resistance < 0.05 ohm/square; 35% copper per 880 g/m²), (modified from Rahman, et al., 2024)

Results

Feasibilty

The sock was well tolerated by toddlers. None of the participants refused to wear the sock and no measurement session was terminated prematurely. Acceptance improved when the caregiver first demonstrated the procedure and when the toddler could select their favourite sock design.

Data analysis

Six dyads were excluded because one or both members had excessive signal artifacts or data collection issues. A total of five toddler-parent dyads were included in preliminary analysis of data. The data used consisted of a 4-minute period of free play and a corresponding period of task making.

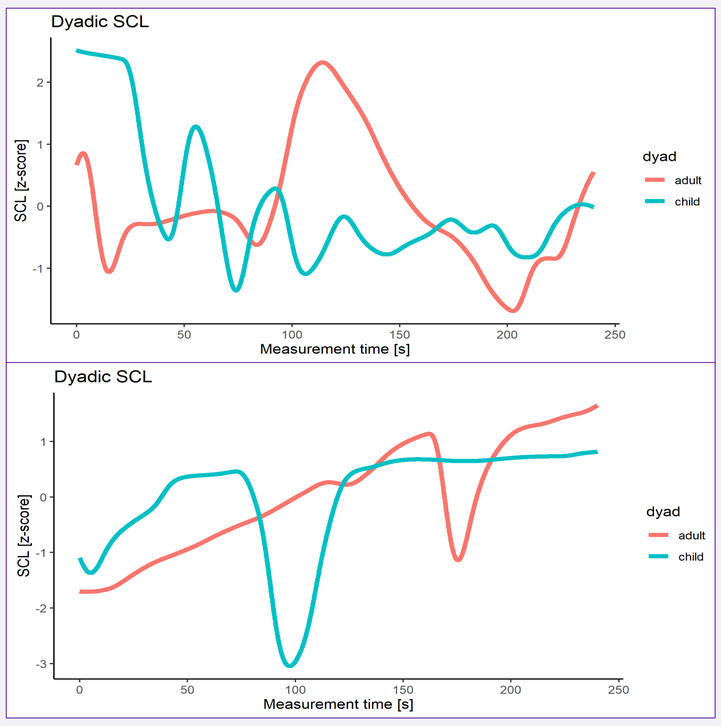

Fig 2. EDA tonic signal intensity variations of the toddler and parent over time for two representative dyads.

Discussion

The results support the feasibility of using a wearable textile-based sock for EDA measurement in toddlers, as evidence by the toddler's acceptance to wear the sock during the measurement process.

Extending the setup to include parents offers a promising means to examine parent–child synchrony during naturalistic play.

However, the data evaluation revealed ongoing signal quality issues that need attention. While initial visual inspection of the physiological data was useful, meaningful analysis requires extending the study with detailed behavioral annotation.

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