Baby FlexEEG: AI-enabled neurotechnology for developmental research & intervention

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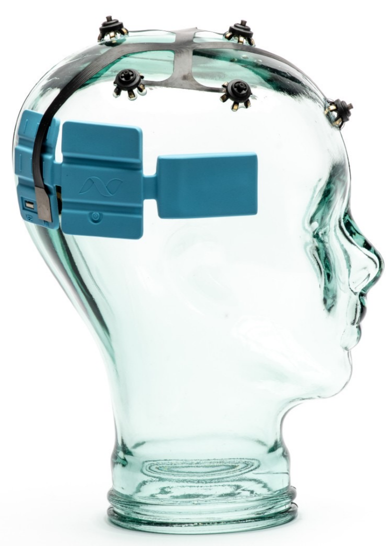
Background & Relevance

Electroencephalography (EEG) is the most widely used and well-established non-invasive technology available for neurodynamical research, neurological monitoring, and neurorehabilitation. **However, portability, cost and ease of use of EEG impede the inclusion of diverse populations in cognitive-motor development research**[1,2].

Barriers to Inclusive Neurodevelopmental EEG Research:

- **Remote locations & Developing Countries**
  - Affordability & accessibility
- **Clinical Settings**
  - EEG adds to tangle of wires
- **Research Lab**
  - Difficult for parents
  - Non-naturalistic environment
- **Wires restrict movement**
- **Movement artifacts --> data loss**



FlexEEG

- **Wireless, unobtrusive, ergonomic, compact, portable, low-cost.**
- **Maximises signal quality.**
- **Built to robustly decode movement-related brain modulations.**

FlexEEG offers a **robust solution** for neurodevelopmental research: **Baby FlexEEG.**

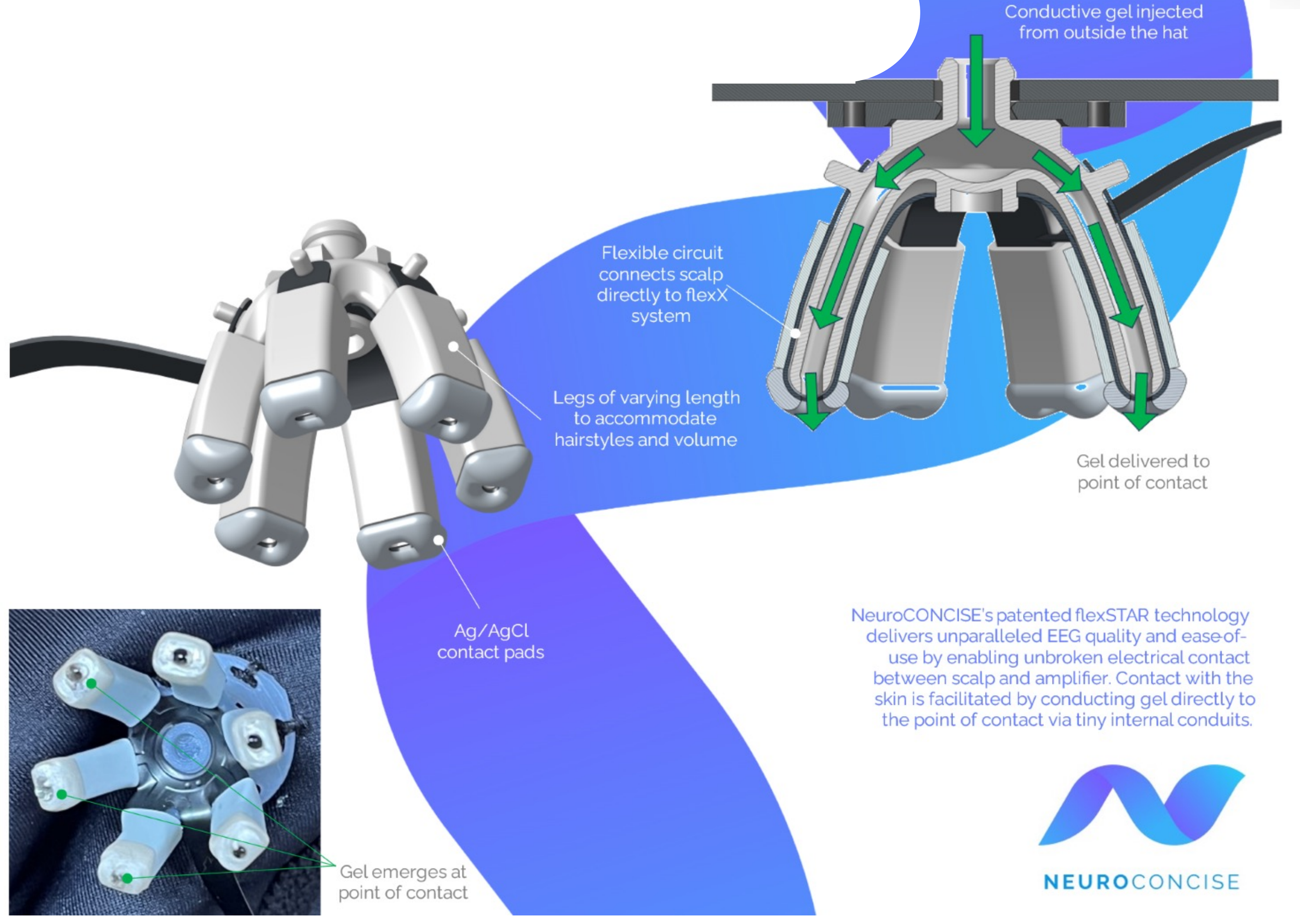


Fig. 1. UK-based neurotechnology company **NeuroCONCISE** developed the **FlexEEG** system, an unobtrusive, **wireless EEG** built on a flexible printed circuit board concealed in soft mouldable materials that fold around the head making it **ergonomic, compact and portable**.

Method

NeuroCONCISE will customize the cutting-edge FlexEEG system for use with infants to create **Baby FlexEEG** which will lower barriers to **ecologically valid neurodevelopmental research in diverse settings and populations. Baby FlexEEG** will feature soft electrodes that enable minimal gel use, accommodate various hair types, afford **fast setup,** and **maximize infant comfort / safety**.

Using Baby FlexEEG, we will investigate neural signatures of a core developmental process: the emergence of goal-directed action. By physically connecting an infant's movement to that of a toy mobile (Fig. 2), measuring the infant's response and quantifying infant~mobile *coordination*, we have been able to clarify how goal-directed action emerges spontaneously from the *relation* between the organism and the environment[3,4].

But what does a moment of goal discovery look like in the infant brain? Here, we propose to directly investigate this question by measuring brain activity during infant~mobile testing using our novel Baby FlexEEG system. We will perform a baby~mobile pilot study (10 full-term and 10 pre-term infants at 52-56 weeks of conceptual age).

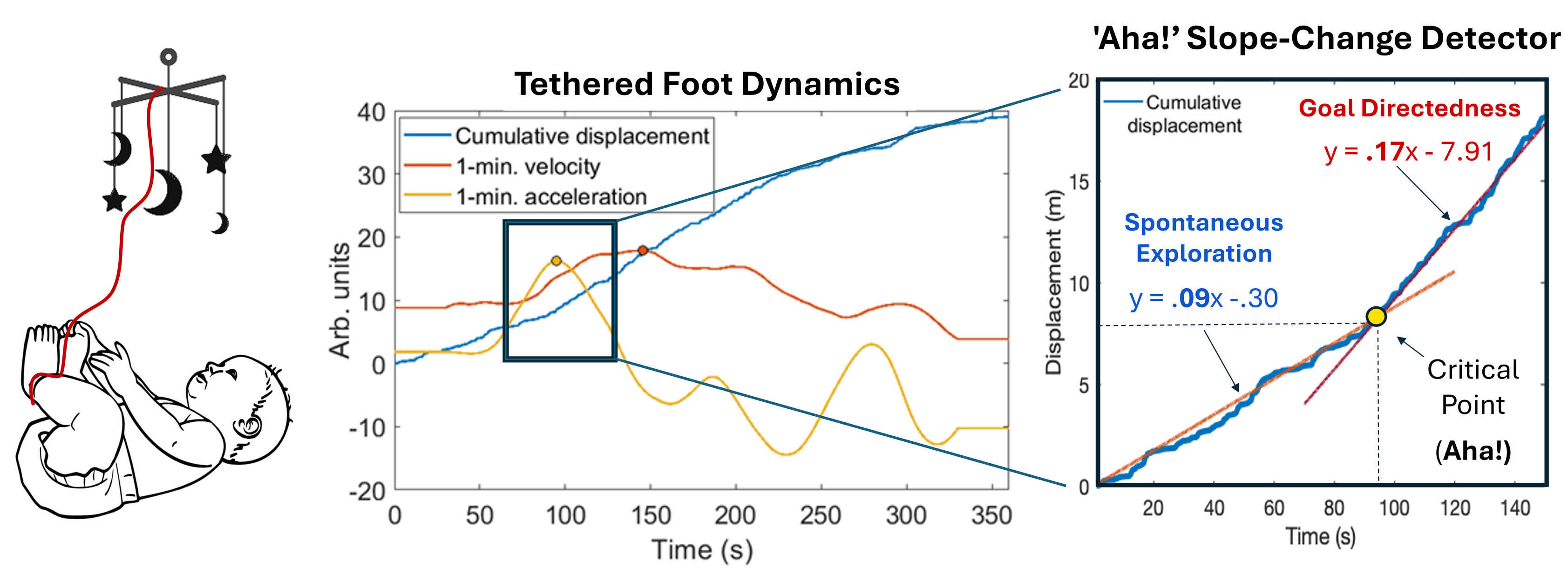
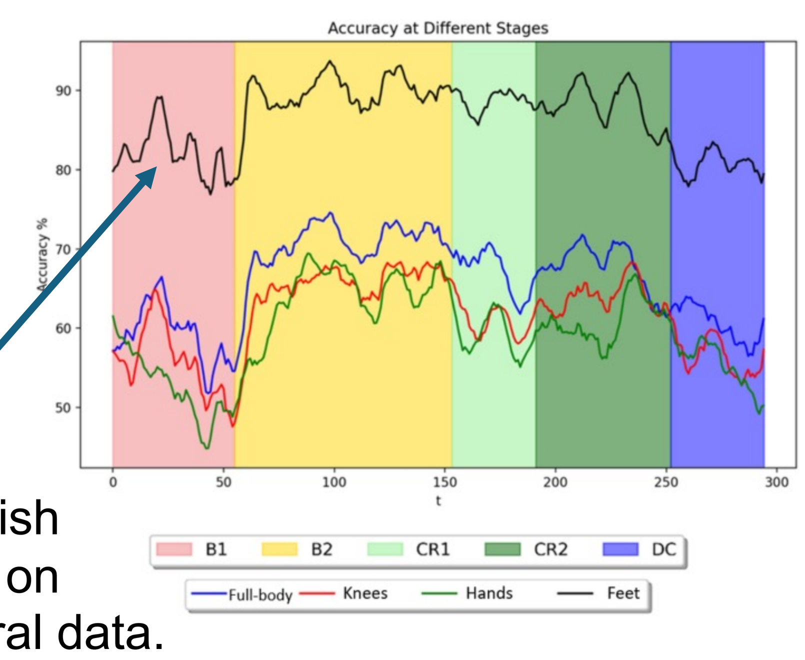


Fig. 2. An infant's foot is tethered to a mobile (left). A sustained burst in movement of the tethered foot at ~90s suggests this infant suddenly discovered it could make the mobile move by virtue of tight infant~mobile coupling via the tether (*i.e.,* doubling of slope, right panel). This 'Aha!' moment represents a critical transition of spontaneous movement into purposeful action - the emergence of agency[3,4].

Analysis & Expected Outcomes

We aim to identify neuromarkers of the 'Aha!' moment from infant movement data using AI and CD analysis. Our recent study found that interaction with the environment, significantly influences infant behaviour, especially at the feet, the end connector (Fig. 3).

Fig. 3. Leading-edge AI tools analysed snippets of 3D infant movement through various manipulations of the infant~mobile functional relationship (shaded columns). AI analysis showed that infant-mobile interaction most profoundly affected the body at the site of its connection to the world: the feet.



- Using advanced AI, we will distinguish full- and pre-term infants based on their movement, coordinative & neural data.
- Unravelling the way individual infants discover how to stabilize control over the environment will reveal basic **principles of brain organization and environmental adaptation**.
- These findings will inform novel **early, personalized interventions** for neurodevelopmental disorders.

References.

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