Predicting Infant Body Position in Naturalistic Environments Using Inertial Sensors

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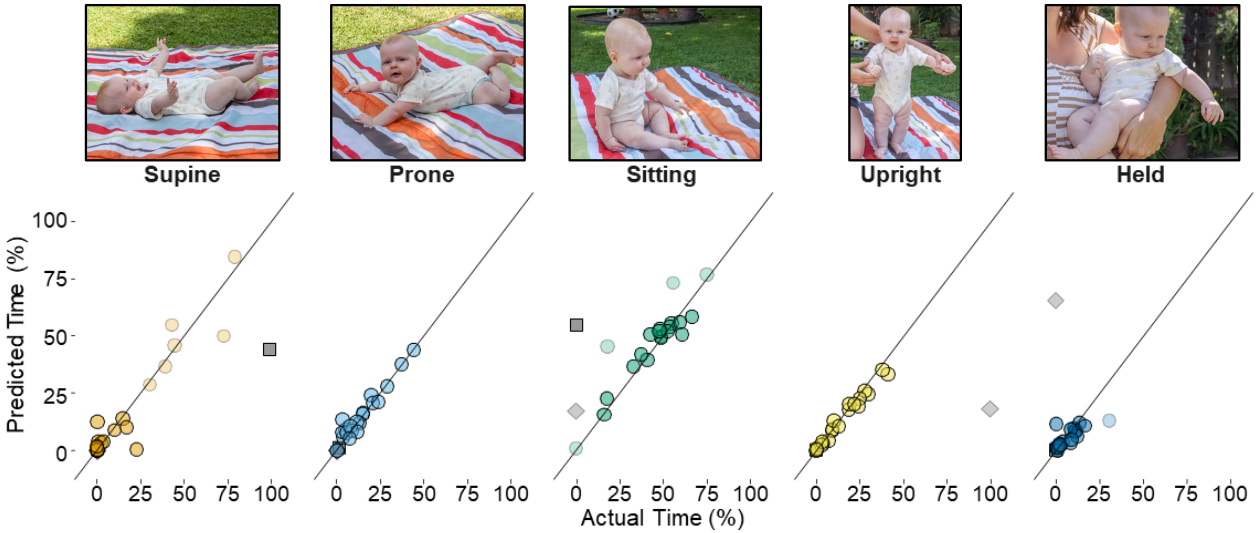
Introduction

- Traditional research methods use video to measure infant motor behavior, but video cannot capture full-day data
- Predicting body position from wearable inertial motion units (IMUs) in the home is a promising alternative to video
- Past work showed that body position predictions from IMUs in a lab setting was accurate (Franchak et al., 2020), but it is unknown how well body position can be predicted in an unsupervised home visit
- When caregivers and infants are free to behave naturally, the variety of motor behaviors increases and may make automated detection more challenging
- **Question:** Is machine learning classification of body position from IMUs reliable when capturing full-day data in the home?

Actual and Model-Predicted Body Position Time was Correlated

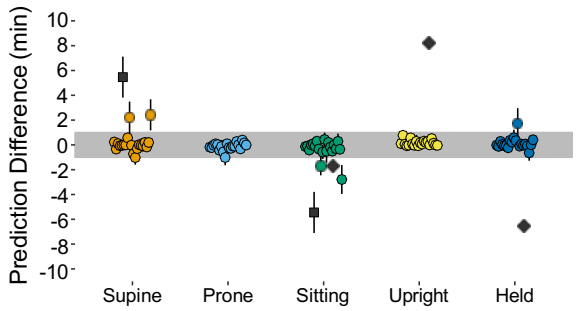


- Each point above shows the actual % of time in each body position coded by researchers (x-axis) versus model predicted time (y-axis) for each session
- Over the entire 90-minute test sessions, the correlation across body positions was $r = 0.80$
- Excluding two outlier sessions (gray diamonds and squares) led to a correlation of $r = 0.95$

Methods

- 32 sessions were gathered from 22 participants (8 4-7 mo. and 14 11-14 mo.)
- Infants wore a pair of leggings with 4 IMUs containing accelerometers and gyroscopes
- An Insta360 camera recorded ~3 hours in the home for hand coding of body position
- Trained coders used Datavyu, a video annotation software, to code body position
- In the first 30 minutes, parents were instructed to run through a set of guided activities to display various body positions (supine, sitting, prone, upright, and held)
- Guided behaviors were used to train machine learning models that predicted later behavior

Prediction Difference



- Prediction difference in minutes (actual time minus predicted time) was calculated for each 10-minute period to show accuracy at a finer time scale
- 88.39% of periods had prediction errors < 1 minute (indicated by gray shaded region)

Conclusion

- Strong agreement between hand-coded body position and model predictions provides evidence that full-day IMU recordings can measure infant body position without the use of video recording
- While it may take a human coder up to 12 hours to code one session of video footage, IMU recordings eliminates large human labor costs, allowing body position to be measured in a fraction of the time
- This methodology is unobtrusive and can allow for other research concerning motor development to be conducted more efficiently in naturalistic situations