Differences in the neural processing of dynamic expressions in toddlers born preterm

Xinge Li, Andrea Ortiz-Jimenez, Rebecca Lipschutz, Brian Biekman, Hana Taha, Dana DeMaster, Susan Landry, Johanna Bick
University of Houston

Introduction

- Given ICD-10, a child is defined as preterm if born before 37 weeks of gestation [1]. There are different severity levels of preterm birth based on gestational age, including extremely preterm (less than 28 weeks, EPT), very preterm (28-32 weeks, VPT), and moderate to late preterm (32 to 37 weeks).
- Children born preterm are at increased risk of cognitive and socio-emotional problems [2]. A few studies have shown poor emotional regulation and engagement [3-4]. However, little is known about the neural correlates underlying such impairments.

The Present Study

- Previous studies indicate that at birth newborns are already sensitive to dynamic facial expressions of emotion, which is fundamental for socio-emotional [5].
- The present study examined the neural correlates of dynamic facial expressions perception in toddlers born preterm.
- We hypothesized, 1) there would be a larger neural response to angry face/threat, 2) there would be a difference in neural response between children born very preterm and extreme preterm.

Methods

Sample

- The sample consisted of 23 toddlers born preterm (13 male children, *M* = 2.20 years, *SD* = 0.50 years, range = 1.43–3.16 years). See table 1 for their gestational age.

Preterm gestation	N
Extreme Preterm - EPT (Gestation of 22-27 weeks)	14 children
Very Preterm - VPT (Gestation of 28-33 weeks)	8 children

Dynamic facial expression task (cont.)

- Stimuli consisted of short 1,000 ms videos of four female actresses (Caucasian, African American, Hispanic and Asian), each posing happy, angry and neutral facial expressions. Children watched videos in which the race of the actress matches the child's race.
- The first 500 ms of the video is the unfolding of each emotional expression while the peak expression remained on the screen for another 500 ms. See Figure 1 for an example of the task conditions.

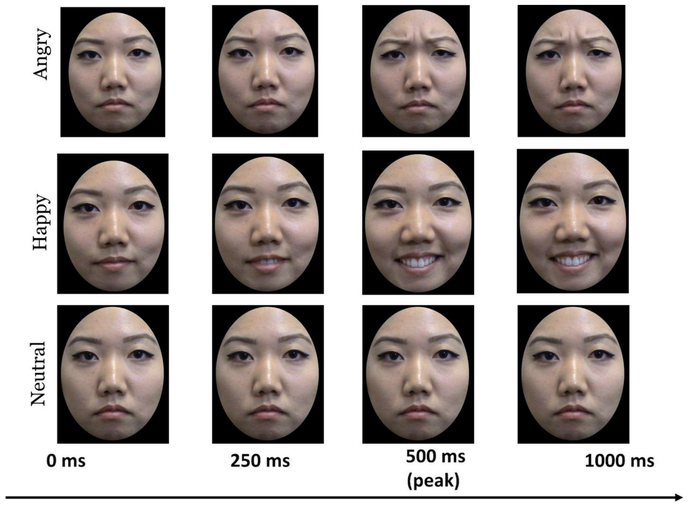


Figure 1

Methods

EEG data collection and analysis

- The electroencephalogram (EEG) was recorded with a 64-electrode actiCap system (Brain Products GmbH) with reference at FCz. The signals were amplified using an actiCHamp with a sampling rate of 1000 Hz. Impedance was checked online prior to the beginning of the session and throughout the task and considered acceptable if lower than 20 KΩ.
- All the data met the impedance criteria, i.e., at least 50% of channels have an impedance lower than 20 KΩ. EEG data were processed using HAPPE software for preprocessing and ERPs analyses [6]. See the diagram in Figure 2 for all the preprocessing steps.
- Data that has at least 10 trials left per condition after preprocessing was analyzed subsequently for ERPs. Fz and Cz were averaged to represent frontocentral electrodes. A time-window of 330-530 ms was chosen to extract Negative component (Nc) based on previous studies [7]. N290, P400 and late positive potential (LPP) were also extracted from given time windows.
- For each of the four components, peak and mean amplitude (μV), and peak latency (ms), were computed and entered in the repeated ANOVA models as dependent variables to test the main effects of task condition and child gestational age as well as their interaction effect.

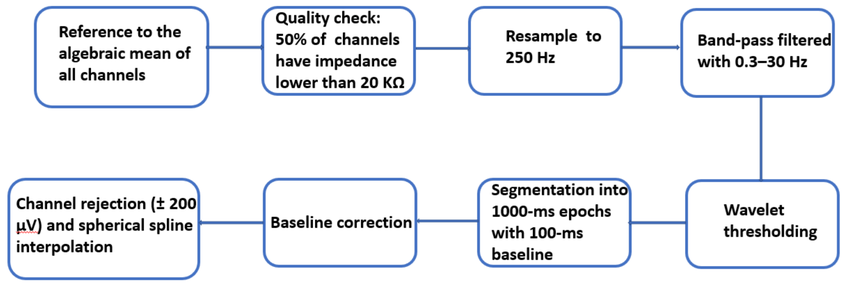


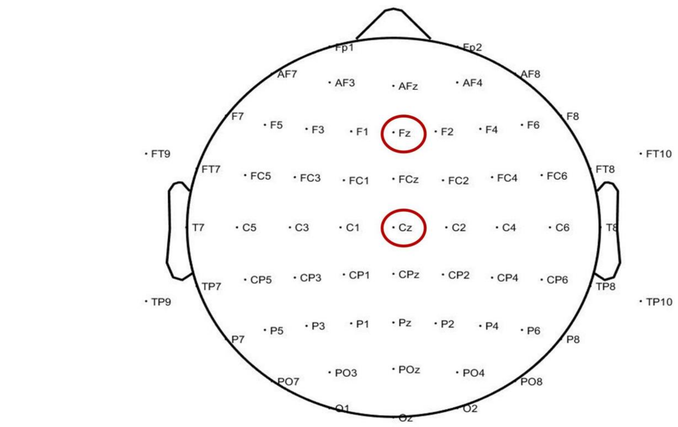
Figure 2

Results

Negative Central (Nc)

- Analysis performed on the Nc **average amplitude** values revealed a significant effect of condition, $F(1,20) = 6.46$, $\boldsymbol{p = 0.019}$, $\eta^2_p = 0.05$.
  - ❖ Post-hoc analyses showed a larger Nc average amplitude in response to **angry faces** (*M* = -3.40 μV, *SD* =3.96) than to **happy faces** (*M* = -1.61 μV, *SD* =3.69), $t(22) = -2.61$, $\boldsymbol{p = 0.016}$, unadjusted, $d = 0.54$.
  - ❖ Post-hoc analyses also showed a larger Nc average amplitude in response to **angry faces** (*M* = -3.40 μV, *SD* =3.96) than to **neutral faces** (*M* = -1.54 μV, *SD* =3.47), $t(22) = -2.82$, $\boldsymbol{p = 0.01}$, unadjusted, $d = 0.59$.
- No significant results were found for the main effect of child gestational age or the interaction effect of task condition and child gestational age. There were no significant results for N290, P400 and late positive potential (LPP).
- The waveform plot depicting grand-average ERPs for Nc in response to happy (green line), angry (red line) and neutral (blue dotted line) expressions at selected electrode locations are shown in Figure 3. The shaded area indicates the time window of 330-530 ms that was used to average Nc amplitude.

Results



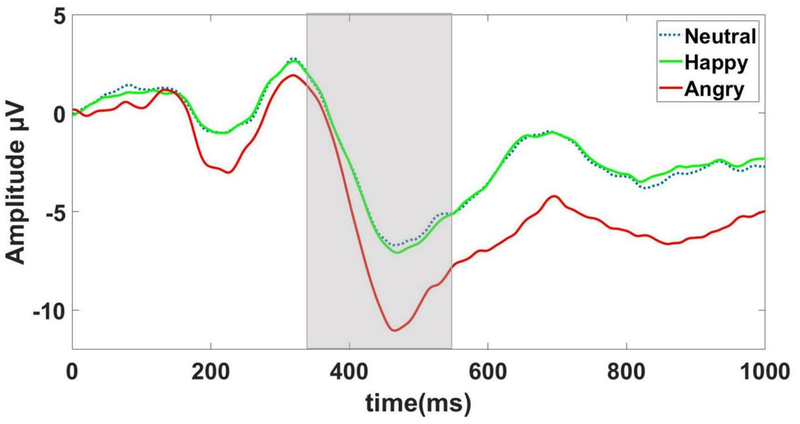


Figure 3

Discussion

- Our results indicate that toddlers born preterm are more sensitive to angry facial expressions than to happy and neutral expressions, given that larger amplitude of Nc reflects greater allocation of attention to threat, supporting our hypothesis I.
- On the other hand, previous infant studies reported larger Nc response to happy facial expressions than to angry expressions at 7 months of age, suggesting infants do not process threat triggered by angry faces [7-8]. Our findings suggest that the development of threat processing and its underlying neural mechanism occur in the early two to three years of life.
- Nevertheless, our study did not find differences in neural response between toddlers born extremely preterm and very preterm. We plan to add a control group to further examine if there is an alteration in neural response to dynamic expressions of emotions in toddlers born preterm.

References

1. World Health Organization (WHO). *International Statistical Classification of diseases and related health problems (rev. 10, vols. 1-2;ICD-10)*. Geneva: WHO, 1992.
2. Aarnoudse-Moens, C. S. H., Weisglas-Kuperus, N., van Goudoever, J. B., & Oosterlaan, J. (2009). Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics*, *124*(2), 717-728.
3. Wolf, M. J., Koldewijn, K., Beelen, A., Smit, B., Hedlund, R., & De Groot, I. J. M. (2002). Neurobehavioral and developmental profile of very low birthweight preterm infants in early infancy. *Acta Paediatrica*, *91*(8), 930-938.
4. Janssens, A., Uvin, K., Van Impe, H., Laroche, S. M. F., Van Reempts, P., & Deboutte, D. (2009). Psychopathology among preterm infants using the Diagnostic Classification Zero to Three. *Acta paediatrica*, *98*(12), 1988-1993.
5. Addabbo, M., Longhi, E., Marchis, I. C., Tagliabue, P., & Turati, C. (2018). Dynamic facial expressions of emotions are discriminated at birth. *PloS one*, *13*(3), e0193868.
6. Lopez, K. L., Monachino, A. D., Morales, S., Leach, S. C., Bowers, M. E., & Gabard-Durnam, L. J. (2021). HAPPILEE: The Harvard Automated Processing Pipeline In Low Electrode Electroencephalography, a standardized software for low density EEG and ERP data. *bioRxiv*.
7. Quadrelli, E., Conte, S., Macchi Cassia, V., & Turati, C. (2019). Emotion in motion: Facial dynamics affect infants' neural processing of emotions. *Developmental psychobiology*, *61*(6), 843-858.
8. Schupp, H. T., Öhman, A., Junghöfer, M., Weike, A. I., Stockburger, J., & Hamm, A. O. (2004). The facilitated processing of threatening faces: an ERP analysis. *Emotion*, *4*(2), 189.

Correspondence regarding this poster should be directed to: Xinge Li (xinge.li@times.uh.edu)