Auditory Change Detection and Cognitive Functioning in Institutionalized and Foster Care Children in Brazil

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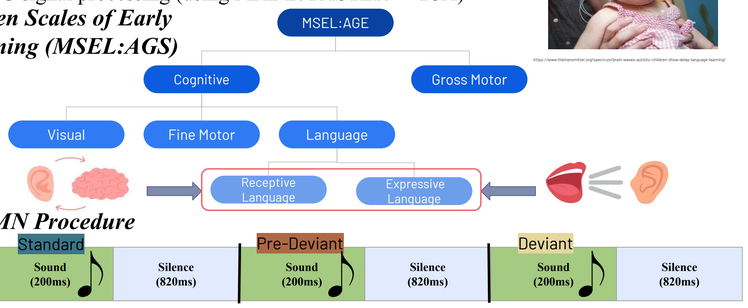
Introduction

- Child development is shaped by the environment in which children are raised, yet many children around the world have unsatable caregiving environments.
- Previous research suggests that institutional care overall negatively impacts the development of children in a variety of domains including psychosocial, cognitive, brain, and attachment. (Johnson, Browne, & Hamilton-Giachritsis, 2006; MacLean, 2003; Nelson, Fox, & Zeanah, 2014)
- In the present investigation, we explored how foster care versus institutional care may shape brain and cognitive development.
  - Specific interest in language development in a new region and historical context
  - We measured how electroencephalogram (EEG) data from the Mismatch Negativity (MMN) Task and cognitive functioning through the Mullen Scales of Early Learning (MSEL:AGS) are correlated at baseline (before randomization into care groups) and 12 months after placement.
- This study adds to the literature by examining the impact of institutional development.

Methodology

- Baseline (1-25 months old): 52 participants
- 12 month follow up: 18 participants
  - Foster Care Group: $n = 10$. Care As Usual Group: $n = 8$
- EEG had 128 electrodes; Hydrocel Geodesic Sensor Net (HGSN)
- EEG signal processing (using MADE: FASTER → ICA)

Mullen Scales of Early Learning (MSEL:AGS)



MMN Procedure

Figure 1. Baby sits in front of speaker and hears either "ba" or "da". We compare how their brain activity changes based on the sound presented.

Baseline MMN Difference Wave Visualization

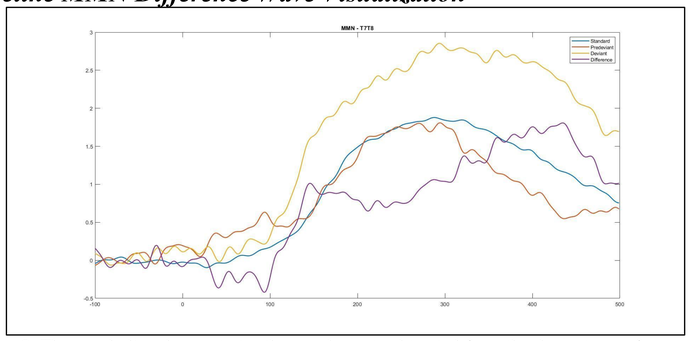


Figure 2. The purple line demonstrates the pre-deviant subtracted from the deviant waveforms, which was positive indicating a positive response in the T7T8 region on average in our participants at the baseline assessment.

Results

Relations between MMN and Receptive Language ($r = -0.091$, $p = 0.526$)

Relations between MMN and Expressive Language ($r = -0.102$, $p = 0.476$)

Relations between Expressive and Receptive Language ($r = 0.486$, $p < 0.001$)

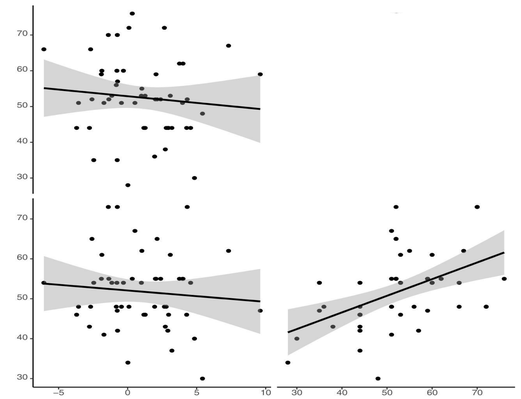


Figure 3. Slight, non-significant negative Pearson correlation for avg. MMN difference wave and language scores. Strong, significant positive correlation between receptive and expressive language scores.

Did MMN differ between groups or across time points?

- *MMN amplitudes did not significantly change from baseline to follow-up and did not differ between infants in foster care versus institutional care*
- *Time points, group, and any interaction between the two were not significant. So there is not currently enough proof to confidently say that caregiving environment altered their development in this task.*

Statistics:

- Baseline to follow-up ($F(1, 16) = 0.867$, $p = 0.366$)
- Foster care versus institutional care ($F(1, 16) = 0.835$, $p = 0.374$).
- No interaction was found ($F(1, 16) = 0.374$, $p = 0.549$)

Fisher Z Test

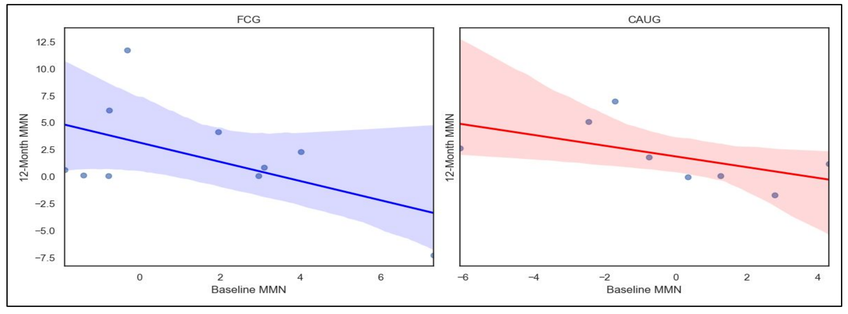


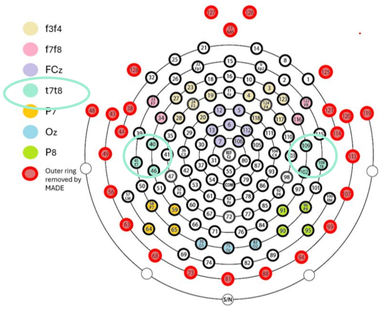
Figure 4. The Fisher Z score examined how the participants' MMNs correlated over time (Z = 0.078, p = 0.938). The Foster Care Group is defined as FCG and the Care As Usual Group is defined as CAUG.

Discussion

1. **MMN is an auditory distinction task…not a direct measure of language development → non-significant correlations**
   - MMN = auditory change detection and pre-attentive sensory processing (Todd et al., 2010; Fox et al., 2024)
     - MMN *is* associated with attention, perturbed cognition, and personality, rather than language specifically (Fox et al., 2024; Näätänen et al., 2014)
     - Language functioning = multiple neural systems
       - → more research is needed to explore different elements of language development in the brain (Martin, 2003)
2. **MMN is a finicky developmental tool→ obscure group differences**
   - Young infants = positive mismatch response (MMR),
     - polarity transitions toward a more negative response later in development (Kushnerenko et al., 2002; Näätänen et al., 2014;)
   - Variability in amplitude and latency is expected due to rapid neural maturation and individual differences during infancy (Morr et al., 2002; Fox et al., 2024; Garrido et al., 2009)
3. **Underpowered samples**
   - Repeated measures ANOVA with small samples may be underpowered to detect subtle developmental changes.
4. **Confirmed measures for MMN and MSEL:AGS**
   - Our measure outputs followed the expected form that mirrored previous research (see Figure 2 and Figure 3)

Future Work

- Larger samples and longer follow-up periods beyond 12 months.
- Other language assessments may help clarify brain–behavior relations.
- Future studies could also examine frontal MMN components to capture later attentional processing, since the present study focused on the T7T8 region which captures temporal processing.
- This work establishes the feasibility of using MMN and Mullen language scores in EI3 and provides a foundation for future analyses.



Acknowledgements

I would like to thank all of the teams who helped collect this data, as well as the Neurocognitive Development Lab, the Child Development Lab, and my thesis committee (Dr. Riggins, Dr. Fox, Dr. Gilbreath, and Dr. Roesch) for continued assistance with this project. This research was supported by José Luis Egydio Setúbal Foundation/ Instituto Pensi, David Rockefeller Center for Latin American Studies Harvard University, Harvard Lemann Research Fund (Lemann Foundation), Maria Cecilia Souto Vidigal Foundation, Lumos Foundation, USAID/ JSI/ Partnership Plus (PP-GM-003), Two Lilies Fund, Bernard VanLeer Foundation, and Alana Foundation.

References

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