Pivotal Response Treatment Improves Neural Efficiency for Social Perception in Children with Autism Spectrum Disorder

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Background

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by difficulties in social interaction and communication

Pivotal Response Treatment (PRT) is a naturalistic behavioral intervention with empirical support for effectiveness in teaching social communication skills to children with ASD
- PRT directly targets social motivation to address challenges in interpersonal interaction and communication
- A 4-month course of PRT results in meaningful improvements in pragmatic language, social engagement, and adaptive functioning (Ventola et al., 2014a)
- More normative neural responses following PRT were observed, indexed with fMRI (Ventola et al., 2014b)

Treatment outcome in terms of neural efficiency has not yet been studied

The current study used event-related potentials (ERPs) to examine the temporal dynamics of social perception following PRT
- We predicted that children would demonstrate improved social processing efficiency, as reflected in decreased N170 latency, following a 4-month course of PRT

Method

Participants:
- 7 children 4-6 year of age with ASD receiving PRT
  - Subset of 3 in waitlist control (WLC) group
- Received PRT for 16 weeks
  - 8 hours per week (6 hours with the child and 2 hours with the parent)

	Mean	SD
Age	5.6	0.91
ADOS	17.9	6.5
DAS-II	112.3	11.4

Experimental Paradigm:
- Participants viewed computer-generated faces showing neutral and fearful affect
- EEG recorded at 4 time points:
  - Waitlist Control
  - Pre-Treatment
  - Post-Treatment
  - Four-Month Follow-Up

Figure 1: Experimental Paradigm

Fixation (250 ms)
Static (500 ms) • Neutral • Fear
Dynamic (500 ms) • Neutral • Affective • Impossible
Blank (1000 ms)

EEG Data Acquisition and Collection:
- Recorded at 500 Hz
- 128-channel Hydrocel Geodesic Sensor net

Statistical Analysis:
- Peak amplitude and latency were analyzed using repeated measures ANOVA
- 2 within-subjects factors:
  - Treatment (Pre/Post)
  - Emotion (Fear/Neutral)
- Paired samples t-tests for WLC vs. Pre and Follow-up vs. Post conditions
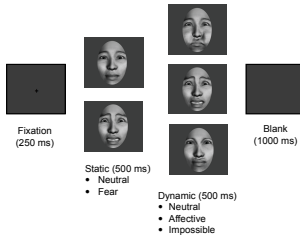
Method

ERP Analysis:
- P1 and N170 are ERP components associated with early sensory response and face structural encoding, respectively (Rossion et al., 2011)
- P1 and N170 peak amplitude and latency were compared across fear and neutral stimuli, pre- and post-treatment, as well as four months prior to treatment and four months after treatment termination in a subset of children
- ERPs were segmented to static face stimuli and extracted over the right occipitotemporal region
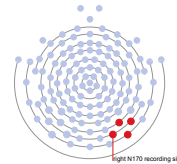

Figure 2: Right N170 and P1 recording sites. Data were averaged across 4 electrodes

Results

Post-Treatment
N170
- A main effect of treatment [$F_{(1,6)} = 11.34$, $p=0.015$] indicated a change in face processing efficiency following PRT treatment, indexed by N170 latency
  - Significant reduction in N170 latency following treatment for both neutral ($p=0.027$) and fearful ($p=0.029$) face stimuli
- There was no significant change in N170 amplitude [$F_{(1,6)} = 2.71$, $p=.15$]
P1
- There was no significant change in either P1 latency or amplitude as a function of PRT treatment (All F's < 0.88, p's > .38)
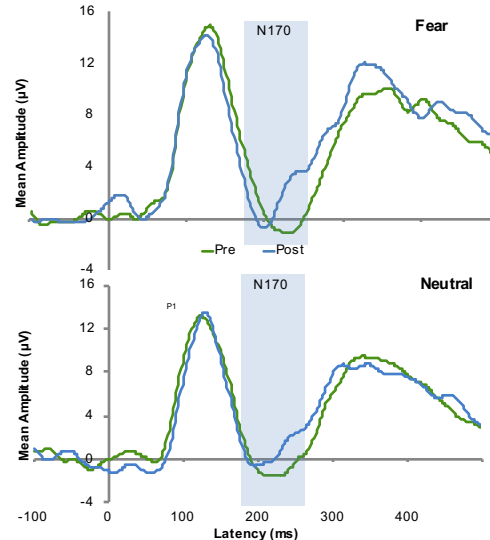

Figure 3: Grand average waveform depicting the N170 across all participants (N=7) for fear and neutral faces, pre- and post-treatment
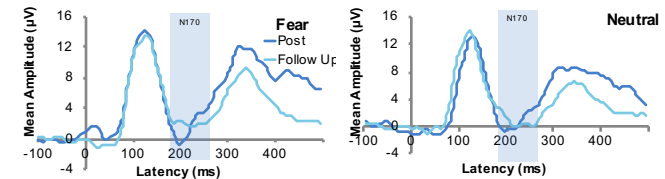
Results

Figure 4: Grand average waveforms depicting the N170 across participants for fear and neutral faces, post-treatment and at follow-up

Follow-Up
- Subset of 5 children
- Reduced N170 latency maintained 16-weeks after end of treatment

Waitlist Control (WLC)
- Subset of 3 children
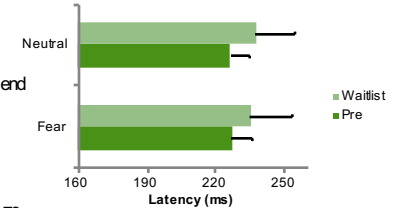- No significant change in N170 latency across 16-week period prior to start of treatment

Figure 5: N170 latency in waitlist controls

Conclusions

- A 16-week course of PRT for young children with ASD resulted in improved efficiency of neural indicators of social perception (N170), with no effect on low-level sensory processes (P1)
  - These findings suggest focal treatment effects on social brain processes

- The waitlist control results suggest observed change is not simply a function of development, demonstrating the efficacy of PRT intervention

- These findings provide the first evidence of improved neural efficiency resulting from PRT
  - In concert with fMRI results following a 16-week course of PRT, these ERP findings inform understanding of brain mechanisms underpinning positive response to behavioral treatment

References
Rossion, B., & Caharel, S. (2011). ERP evidence for the speed of face categorization in the human brain: Disentangling the contribution of low-level visual cues from face perception. Vision Research, 51(12), 1297–1311.
Ventola, P., Friedman, H. E., Anderson, L. C., Wolf, J. M., Oosting, D., Foss-Feig, J., . . . Pelphrey, K. A. (2014a). Improvements in social and adaptive functioning following short-duration PRT program: a clinical replication. J Autism Dev Disord, 44(11), 2862-2870.
Ventola, P., Yang, D. Y., Friedman, H. E., Oosting, D., Wolf, J., Sukhodolsky, D. G., & Pelphrey, K. A. (2014b). Heterogeneity of neural mechanisms of response to pivotal response treatment. Brain Imaging Behav, 1-15.