Pivotal Response Treatment Increases Processing Efficiency for Social Information

Max Rolison, Rachael Tillman, Pam Ventola, Jennifer Foss-Feig, Adam Naples, Hannah Friedman, Devon Oosting, Laura Anderson, Cara Coredeas, Rebecca Doggett, Cora Mukerji, Marika Coffman, Julie Wolf, Kevin Pelphrey & James McPartland

McPartland Lab
Yale Child Study Center, New Haven, CT

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

Pivotal response treatment (PRT) is an empirically validated behavioral treatment for ASD that directly targets social motivation to address deficits in interpersonal interaction and communication.

ERP Data Acquisition and Analysis:
A 4-month course of PRT results in measurable changes in pragmatic language, social engagement, and adaptive functioning, with accompanying changes in regional brain activation (Voos et al., 2012).

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 behavior change associated with positive response to intervention.

We predicted that 1) children would demonstrate improved efficiency in face processing, as indexed by reduced N170 latency, following a 4-month course of PRT, whereas 2) brain activity indexing low-level sensory processing would remain unchanged (P100).

Methods
Participants:
- 5 children with ASD between 4-6 years of age.
- Differential Ability Scale - Second Edition (DAS-II), Global Conceptual Ability Score = 114.2 ± 13.3
- Received PRT for 8 hours per week (6 hours with the child and 2 hours with the parent) for 4 months.

Behavioral Measures:
Administered pre- and post-treatment:
- Autism Diagnostic Observation Schedule (ADOS)
- Social Responsiveness Scale - Parent Report (SRS)
- Vineland Adaptive Behavior Scales, 2nd edition (VABS-II)

Experimental Paradigm:
73 dynamic, computer-generated faces that displayed neutral and fearful expressions.

EEG Data Acquisition and Collection:
- Recorded at 500 Hz pre- and post-treatment.
- 128-channel HydroCel GeodeSciences Net.

Statistical Analysis:
Peak amplitude and latency were analyzed using repeated measures ANOVA.

EEG Data:
- Facial expression (Fear/Neutral)
- Position 
- Static (500 ms)
- Dynamic (500 ms)
- Neural Neutral
- Neural Affective
- Neural Arousal
- Neural Imposible

N170
- A main effect of treatment (F(1,4) = 6.892, p=0.058) indicated a change in face processing following PRT treatment, as indexed by N170 latency. Post-hoc paired samples t-tests were conducted to explore results of the omnibus test:
  - Following treatment, participants demonstrated significantly reduced N170 latency in response to fearful face stimuli (p<0.02).
  - There was no significant change in N170 latency in response to neutral face stimuli (p>0.05).
  - There was no significant change in N170 amplitude (F(1,4) = 2.15, p=.22).

Results
P100
- There was no significant change in either P100 latency or amplitude as a function of PRT treatment (All P’s < 1.26, ps > .32).

Behavioral Table 1: Behavioral Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADOS</td>
<td>114.2</td>
<td>114.2</td>
</tr>
<tr>
<td>SRS</td>
<td>64.2</td>
<td>64.2</td>
</tr>
<tr>
<td>Vineland Socialization</td>
<td>89.6</td>
<td>89.6</td>
</tr>
</tbody>
</table>

Figure 1: Experimental Paradigm

Figure 2: Right N170 and P100 recording sites. Data were averaged across 4 electrodes.

Figure 3: Grand average waveform, depicting the N170 across all participants (N=5) for fear faces, pre- and post-treatment. Waveforms were averaged across 4 electrodes in the right hemisphere.

Figure 4: PRT resulted in reduced N170 latency in response to fearful faces.

Figure 5: PRT resulted in improved social behavior as measured by the ADOS, SRS, and Vineland Socialization Domain.

Conclusions
Pivotal Response Treatment Increases Processing Efficiency for Social Information

Pivotal Response Treatment (PRT) increased processing efficiency for social information. Notably, effects of treatment were reflected in markers associated with core social perception (N170), rather than low-level sensory processes (P100), suggesting focal treatment effects on social-communicative behavior.

These findings provide the first evidence of alterations in processing efficiency resulting from PRT. Because N170 delays are characteristic of ASD, these results suggest improvement in mechanisms related to core social impairments.

Study results emphasize the import of brain-based outcome measures acquired with temporally-sensitive imaging methods.

References


Acknowledgments
NIH R01 MH010173 (McPartland), NIH K23 MH086785 (McPartland), Simmons Foundation 94924 (Pelphrey), NIH R01 MH091309 (McPartland), NARSAD Advocacy Young Investigator Award (McPartland), CTSA Grant Number UL1 RR024139 (McPartland), Autism Speaks Translational Postdoctoral Fellowship (Naples), Allied World (Ventola & Pelphrey), Harris Professorship at the Yale Child Study Center (Pelphrey).