Pivotal Response Treatment Increases Neural Processing Efficiency of Faces in Children with Autism Spectrum Disorder

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Background

Autism Spectrum Disorder (ASD) is a chronic neurodevelopmental condition characterized by a cluster of deficits in social communication and the presence of restricted and repetitive behaviors and interests.

Pivotal Response Treatment (PRT) is an evidence-based, naturalistic behavioral intervention derived from Applied Behavior Analysis. PRT targets “pivotal areas” of a child’s development, domains in which improvement produces significant gains in other areas not specifically addressed by the intervention.

A 4-month course of PRT results in meaningful improvements in pragmatic language, social engagement, and adaptive functioning (Ventola et al., 2014).

Method

Participants: 7 children 4-6 year of age with ASD receiving PRT

Waitlist Control (WLC): 7 children 4-6 year of age with ASD receiving PRT

ERP Analysis:

Component statistics derived from average values across electrodes in a particular cluster and time window: P1 window: 80-150 ms, N170 window: 160-200 ms, P3 window: 250-300 ms

Post-Treatment

No significant effects on P1 amplitude (all Ps > .334)

Significant treatment effect on P1 latency (F1, 6) = 7.269, p < .036, ñ² = .534, qualified by a significant treatment x emotion interaction (F1, 6) = 6.422, p < .044, ñ² = .477

Reduction in P1 latency was significant for neutral faces (p < .021) but not fearful faces (p = .495)

N170

A main effect of treatment (F1, 6) = 6.34, p < .045, ñ² = .514 indicated a change in face processing efficiency following PRT treatment, indexed by right-hemisphere N170 latency

Reduction in N170 latency following treatment only trended toward significance for neutral faces (p = .065) or fearful faces (p = .002) alone

No significant effect was found in the left-hemisphere N170 latency (p = .160)

Left-hemisphere N170 peak amplitude was significantly reduced from pre- to post-treatment (F1, 6) = 14.217, p < .009, ñ² = .703, indicating an attenuated response in the hemisphere not typically associated with face processing

Significant for both fearful (p = .039) and neutral (p = .008) faces

There was no effect of treatment on RN170 peak amplitude (p = .311)

No significant effects of emotion or emotion x treatment interactions on N170 latency or amplitude (all Ps > .388, p > .382)

P3

No significant effects of treatment, emotion or emotion x treatment interactions on P3 average amplitude (all Ps > .459)

ERP Data Acquisition and Collection:

‐ Recorded at 500 Hz

‐ 128-channel Hydrocel Geodesic Sensor net

Figure 1: Experimental Paradigm. Static neutral or fearful faces were presented for 500 ms before they dynamically shifted into a different facial expression. ERP data was segmented to the onset of the static face.

Figure 2: P1, N170, and P3 electrode recording sites. Data were averaged across all electrodes in each cluster (P1, Left N170, Right N170, P3).

Figure 3: Grand average waveform depicting the Left and Right N170 across all participants (N= 7, N= 5 for follow-up) for neutral and fearful faces, at pre-treatment, post-treatment, and 16-week follow-up.

Figure 4: Grand average waveforms depicting the P1 across participants for neutral and fearful faces, pre-treatment, post-treatment and at follow-up

Figure 5: RN170 latency in the subset of children (N= 7) who completed a follow-up assessment (N= 5).

Figure 6: RN170 amplitude in waitlist controls (N = 3)

Table 1: Group Statistics: Subject Age,ADOS score (mean standard deviation), gender (M/F), WLC treatment, Post Treatment, Post-Follow-Up, WLC treatment, Post Treatment, Post-Follow-Up

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>All Trials</th>
<th>Neutral</th>
<th>Fearful</th>
<th>All Trials</th>
<th>Neutral</th>
<th>Fearful</th>
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</thead>
<tbody>
<tr>
<td>N170 latency (ms) Post</td>
<td>100.5 (12)</td>
<td>200.5 (11)</td>
<td>150.5 (10)</td>
<td>100.5 (12)</td>
<td>200.5 (11)</td>
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<tr>
<td>P1 latency (ms) Post</td>
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<td>200.5 (11)</td>
<td>150.5 (10)</td>
<td>100.5 (12)</td>
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<tr>
<td>P3 latency (ms) Post</td>
<td>100.5 (12)</td>
<td>200.5 (11)</td>
<td>150.5 (10)</td>
<td>100.5 (12)</td>
<td>200.5 (11)</td>
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Conclusions

A 16-week course of PRT for young children with ASD resulted in improved efficiency of neural indicators of social perception in the right hemisphere, as well as a less atypical localization and reduced sensitivity N170 response. These findings suggest focal treatment effects on social brain processes. A decrease in the latency of a low-level sensory ERP component (P1 to neutral faces) was found post-treatment, suggesting that PRT caused a more rapid orienting of processing resources to neutral faces

No significant effects on P3 amplitude were observed, perhaps due to large inter-subject variability in the component’s amplitude and shape over the chosen latencies

Follow-up data showed significant improvements in P1 latency, N170 amplitude, or RN170 latency between the end of treatment and a 16-week follow-up evaluation, supporting the hypothesis that the effects of treatment are not limited to the duration of the intervention

RN170 latency at follow-up showed a marginally significant increase from post-treatment, indicating that ongoing treatment may be necessary to maintain this effect

Further study is warranted to relate post-treatment brain responses to loss of behavioral gains from treatment

The preliminary waitlist control results show values trending in the opposite direction of those of the children receiving the intervention, suggesting that observed changes are not simply a function of development

Several effects in the waitlist and follow-up subgroups showed trends toward significance, highlighting the need for larger samples to confirm these findings

These findings provide the first evidence of improved neural efficiency resulting from PRT

In concert with MRI results following a 16-week course of PRT, these ERP findings inform understanding of neuroplastic mechanisms underlying response to behavioral treatments

References


