Visual temporal integration windows in 2-year-old toddlers with and without autism

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Introduction & Motivation

The Temporal Integration Window (TIW) is a basic ‘unit’ of temporal processing: stimuli within the same window are integrated; in different windows, segmented (VanRullen 2016; Wutz et al. 2016).

Differences in TIWs can affect how one perceives the world, contributing to developmental differences and neurodevelopmental disorders, such as autism spectrum disorder (ASD).

Previous work has been inconclusive. Farzini et al. (2011) found slower processing in infants with Fragile X Syndrome (the most common single gene cause of autism), whereas Falter et al. (2012) found that adults with ASD had increased temporal resolution. But do these results reflect differences in temporal processing, per se, or differences in general (e.g. visual/engagement) factors? Measuring both integration and segmentation – i.e. the TIW – in the same paradigm & individual isolates temporal processing.

We measured TIWs in typically developing 18–36-month-olds and toddlers diagnosed with ASD.

TIWs have only been studied in adults and school aged children (Wutz et al. 2016; Freschi et al., under review). No work has directly investigated TIWs in TD toddlers and toddlers diagnosed with ASD.

Methods

We investigated TIWs in 88 18–36-month-olds and 65 toddlers (18–36-month-olds) with ASD. Participants were excluded if they did not receive a diagnosis (additional 15 participants).

Participants were presented with a 4s sequence of two displays (ABAB…), each exposed for a parametrically-varied stimulus onset asynchrony (SOA). This project was supported by a grant from the National Institute of Mental Health (R21MH117787).

Participants were presented with a 4s sequence of two displays (ABAB…), each exposed for a parametrically-varied stimulus onset asynchrony (SOA). If the target was fixated, the trial was coded as correct. Participants were also coded as correct if they responded to the item that was included on the ‘test’ display. This is driven primarily by the boys (boys with ASD have lower difference scores than TD boys (p < 0.03)).

Overall, we found much longer TIWs (~100–150ms) in 18–36-month-olds than previously found in TD 5–7 year olds and adults (~70 ms) (Freschi et al., under review).

Toddlers with ASD had higher temporal resolution than age-matched TD controls, suggesting a greater ability to segment visual information in time, at the cost of integrating information into a unitary representation.

Conclusion

Overall, we found much longer TIWs (~100–150ms) in 18–36-month-olds than previously found in TD 5–7 year olds and adults (~70 ms) (Freschi et al., under review).

Toddlers with ASD had higher temporal resolution than age-matched TD controls, suggesting a greater ability to segment visual information in time, at the cost of integrating information into a unitary representation.

This effect interacted with gender: boys with ASD drove the effect. While TD males have been shown to have higher temporal resolution, e.g. shorter motion discrimination thresholds (Murray et al. 2018) than TD females, we did not find a main effect of gender. Further research is required here.

Participants

<table>
<thead>
<tr>
<th></th>
<th>Sample (n)</th>
<th>TD mean (SOA)</th>
<th>ASD mean (SOA)</th>
<th>p</th>
<th>Effect size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>17.71</td>
<td>18.90</td>
<td></td>
<td>0.04</td>
<td>0.32</td>
</tr>
<tr>
<td>24</td>
<td>19.11</td>
<td>19.31</td>
<td></td>
<td>0.09</td>
<td>0.33</td>
</tr>
<tr>
<td>26</td>
<td>19.42</td>
<td>19.31</td>
<td></td>
<td>0.02</td>
<td>0.30</td>
</tr>
<tr>
<td>28</td>
<td>19.72</td>
<td>19.31</td>
<td></td>
<td>0.09</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Search performance, for integration & segmentation-defined targets, as a function of rate (SOA)

<table>
<thead>
<tr>
<th>SOA (ms)</th>
<th>TD Hit Rate (%)</th>
<th>ASD Hit Rate (%)</th>
<th>Difference Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>60</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>150</td>
<td>40</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Visual search eye-tracking task

Based on 'missing dot' displays (Di Lollo 1980; Wutz et al. 2016).

Difference scores indicate the ASD group has faster temporal processing (p < 0.04).

Difference scores did not change with age, in either group.

Acknowledgement & References

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