Using Virtual Reality to Assess Visual-Proprioceptive Integration in Children with Autism Spectrum Disorder

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Background: Proprioception, or awareness of one's own body in space, plays a critical role in motor planning and abnormalities may contribute to features of autism spectrum disorder (ASD) [1]. Limited work has been done to investigate the integration of visual and proprioceptive information in this population [2]. This study utilizes virtual reality to manipulate visual input while proprioceptive input is self-generated with motion by the participant. With this experiment, we investigate whether children with ASD integrate proprioceptive and visual information differently compared to children with typical development (TD).

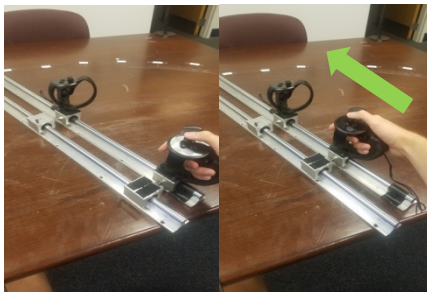

Fig. 1. The Oculus controller slides along track to facilitate participant hand motion

Methods: This task used an Oculus Rift to display a sheet of dots that map onto and move in conjunction with the participant's physical hand. Participants held an Oculus controller that they could freely slide along a rail affixed to a table, and the sheet of dots either mapped exactly onto the hand movement or moved at an angle slightly horizontally offset from the hand. There were six offset options: ±10°, ±20°, and ±30°. After each movement, the participants reported the perceived direction of the dots' motion by adjusting a dial on the controller. Ten children aged 9-17 with ASD and six TD controls have each completed 512 total trials. Our outcome measure was the difference between the true angle and the reported angle of the dots' motion.

Results: In both groups, we found that that the reported direction of the dots was repulsed by the physical hand movement such that incongruency between visual and proprioceptive information was perceived as larger than the true amount. Mixed design ANOVA revealed that the amount of repulsion ($F(2,28)=2.592$, $p=0.032$) varied marginally based on the angle of offset, with larger offsets corresponding to larger repulsions. Positive and negative offsets were collapsed into groups of 10°, 20°, and 30° offsets. The TD and ASD groups did not significantly differ in repulsion for the 10° ($t(14)=.234$, $p=.822$), 20° ($t(14)=.638$, $p=.541$ or 30° ($t(14)=.341$, $p=.742$) offsets. When collapsed across all offsets, differences between groups did not reach significance ($t(14)=.429$, $p=.680$), but overall results trended towards greater repulsions in the TD group.

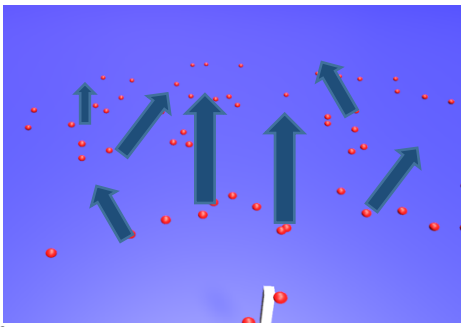

Fig. 2. The motion of the sheet of dots is on average congruent to the hand motion, but individual dots are not

Conclusions: These early results demonstrate that a virtual reality paradigm can be used to assess the integration of visual and proprioceptive information in various populations. Results suggest decreased association of visual and proprioceptive information as the two modalities diverge and become less reliable. A trend toward stronger disassociation in the TD group as compared to the ASD group was consistently detected, suggesting that differences in this association may become more evident with increased study power.

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References:

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