Title: Social and Nonsocial Visual Outcome Prediction Errors in Autism Spectrum Disorder (ASD)

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Introduction: Many individuals with ASD report preference for routines and even anxiety associated with unexpected changes (Gotham et al., 2013; Kanner, 1943). This behavioral rigidity is thought to reflect an attempt to minimize environmental unpredictability. These results fall in line with theories characterizing ASD as a disorder of prediction, which suggest that impairments in predictive abilities may underlie core ASD traits, such as insistence on sameness (Sinha et al., 2014). Specifically, ASD deficits in predictive abilities may be linked to reward learning dysfunction (Schultz, Dayan, & Montague, 1997). The current study utilizes eye tracking to examine ASD responses to visual prediction errors, specifically responses to violations of learned associations involving both social (faces) and nonsocial (high autism interest (HAI) objects) stimuli.

Method: Twenty-six adolescents with ASD (age $M = 14.72, SD = 1.62$) and 18 typically-developing control (TDC) adolescents (age $M = 14.81, SD = 2.08$) were enrolled in the study. All participants completed an outcome expectancy eye tracking task, in which predictive cues were shown to indicate the location of upcoming social (faces) or nonsocial (HAI objects) stimuli. For example, a blue square indicated that the stimulus would appear on the right side of the screen, whereas a red circle indicated that the stimulus would appear on the left. These rules were learned prior to completing the eye tracking task. Differences in gaze durations towards learned locations and presenting locations were recorded to examine group-differences in response to rule violations. Social and nonsocial stimuli were presented within separate tasks. Additionally, parent-reported clinical measures of ASD symptomatology were collected.

Results: Repeated measures ANOVA analyses revealed a significant Group (ASD, TDC) × Expectancy (Violation, No Violation) × Rule Adherence (Rule Followed, Rule Not Followed) interaction, $F(1,42) = 10.65, p = 0.002, \eta^2_p = 0.20$. Specifically, individuals with ASD spent more time focusing their gaze on the “incorrect” location (i.e., the presented stimuli) and less time on the “correct” learned location that was empty during violation trials compared to TDC participants. This effect did not appear to be further moderated by Stimulus Type (i.e., Social vs. Nonsocial), $F(1,42) = 1.55, p = 0.221, \eta^2_p = 0.04$. Additional correlation analyses showed significant negative correlations between time spent looking at the empty, correctly-learned location and scores on the following clinical report measures: RBSR Ritualistic Behavior Total, $r(42) = -.31, p = .044$; SCQ Total, $r(42) = -.30, p = .044$; and SRS-2 Raw Total, $r(42) = -.39, p = .010$. These results suggest that as ASD symptom severity increases, time spent looking at the learned location during violation trials decreases.

Discussion: Taken together, these findings indicate that individuals with ASD may find rule violations less salient compared to TDC individuals, as they directed their gaze to the learned location relatively less frequently during violation trials. However, these findings were not moderated by stimuli type (i.e., social vs. nonsocial). These results corroborate the theory that ASD may be reasonably characterized by broad impairments in predictive ability. Finally, the negative correlation between gaze responses during violation trials and ASD symptomatology links attenuated visual responses to rule violations with greater ASD symptom severity. Overall, these findings may have implications for reward learning abilities of individuals with ASD.

References/Citations: