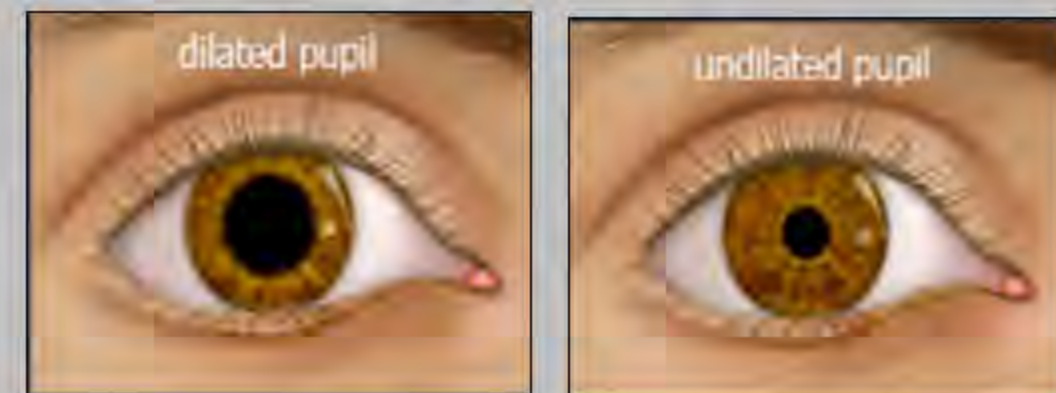


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INTRODUCTION

- Pupil dilation is a physiological response that refers to the automatic expansion of the pupil.
- Pupillary response to visual and auditory stimuli is a reliable indicator of cognitive operations including preference¹, mental load², and emotional arousal³.



- Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication and peer interactions⁴.

- The current study measured pupillary responses to social and non-social information to understand the underlying cognitive processes involved in social information processing in ASD and how these differ from typical development (TD).

- It has been hypothesized that individuals with ASD show cognitive differences that are specific to social communication.

RESEARCH OBJECTIVES

1. To characterize pupillary responses to social and non-social information in ASD and TD.
2. To determine whether pupillary responses to social stimuli could meaningfully predict group membership.

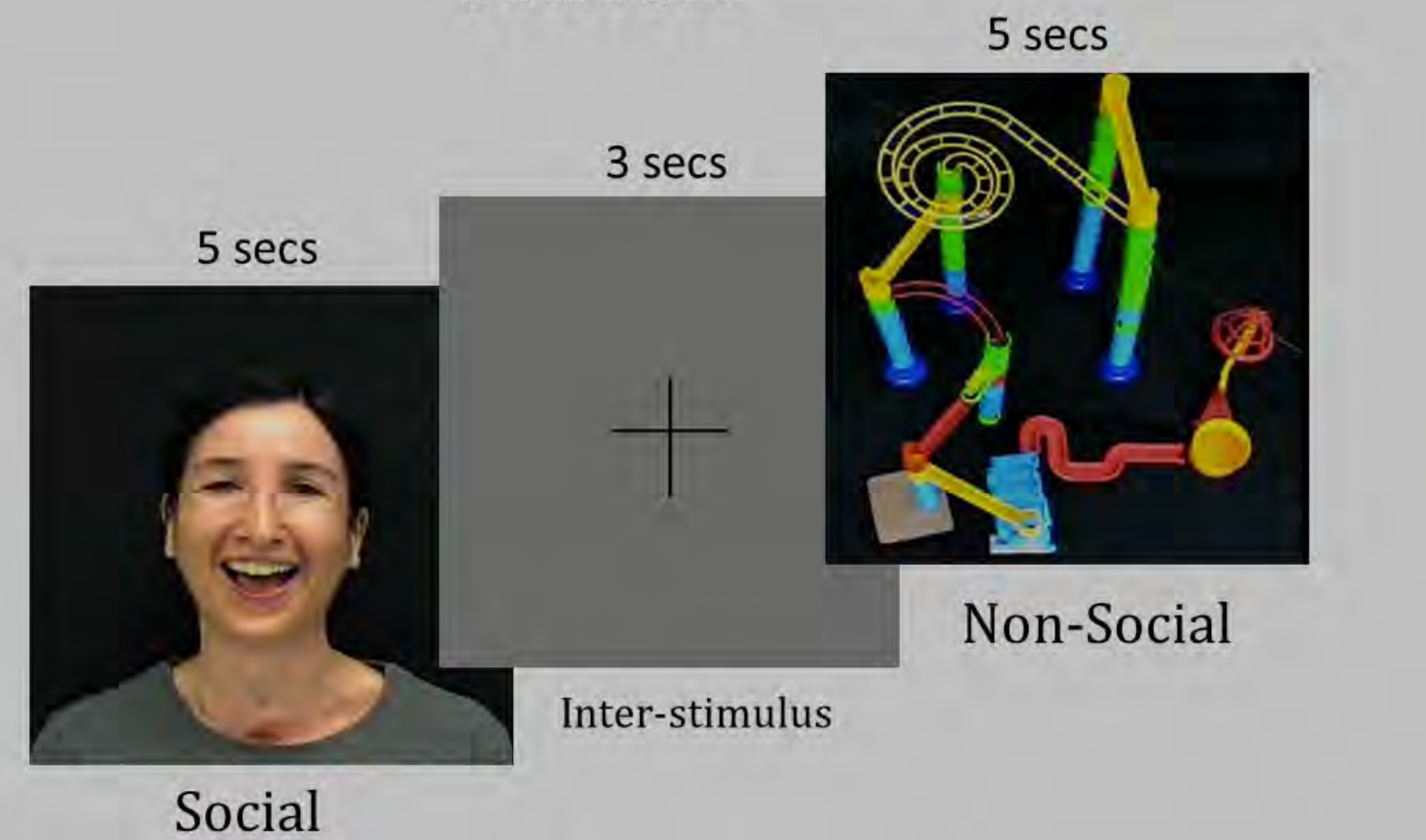
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METHODS

STIMULI



Social – Linguistic (SL): Woman telling a story
Social Non-Linguistic (SNL): Woman making non-speech sounds (e.g., popping)
Social – Emotional (SE): Woman laughing or crying

Non – Social (NS): Mousetrap game; ball going through a series of ramps, tunnels, and slides (Milton Bradley)

ANALYSIS

- Pupillary responses were recorded at a rate of 60 Hz, using a Tobii X60 eye-tracker.
- All trials were standardized for peak and average auditory volume, and visual luminance.
- Pupillary data were inspected for artifacts (i.e., blinks, loss of tracking, head movements) and corrected using linear interpolation. Useable data consisted of pupil traces at least 500ms in length in which artifacts did not make-up more than 20% of the pupil trace⁵.
- Average pupil diameter (across left and right pupil) was calculated for instances in which pupil data was captured in the area of interest.
- Mean pupil size was calculated for each stimulus condition and subtracted from mean pupil size of the preceding 1s of the inter-stimulus interval, which served as a baseline for each trial.

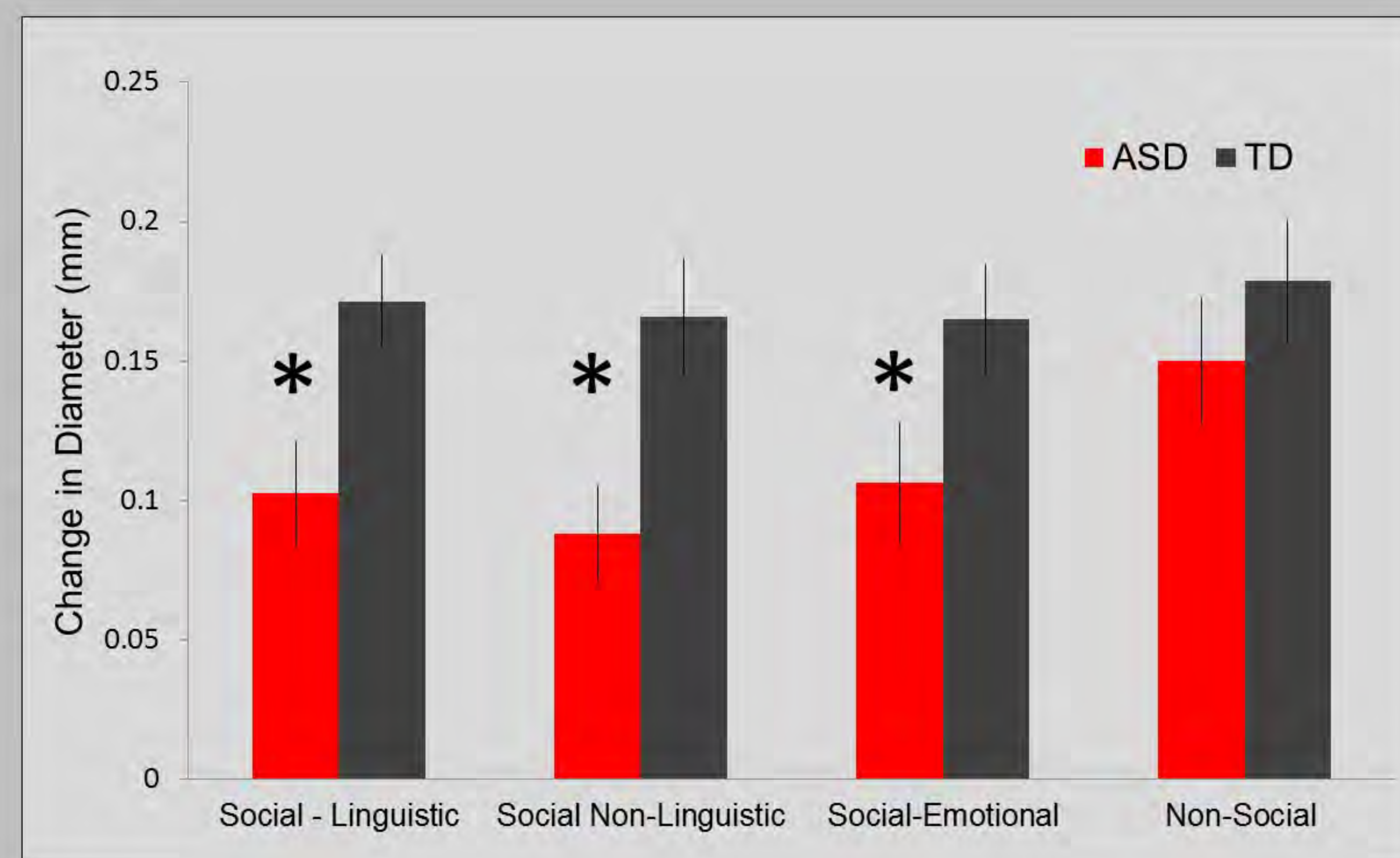
PARTICIPANTS

	Total N = 71	ASD (N = 39)	TD (N = 32)
Sex		M = 30 (76.9%)	M = 9 (28.1%)
Chronological Age		12.3 (3.2) yrs range = 6.8 – 20.0 yrs	12.4 (3.0) yrs range = 6.4 – 18.7 yrs
IQ		94.0 (22.2) range = 45 – 145	102.8 (10.6) range = 86 – 121
Mental Age		11.5 (4.2) yrs range = 4.9 – 20.3	12.7 (3.2) yrs range = 5.5 – 19.6

- * Diagnostic Measure: Autism Diagnostic Observation Schedule – 2nd Edition (ADOS-2)
- * Intelligence Measure: Wechsler Abbreviated Scale of Intelligence – 2nd Edition (WASI-2)

RESULTS

RESEARCH OBJECTIVE #1: Characterize pupillary responses to social and non-social information in typical development and ASD



- A Stimuli by Group two-way interaction was not statistically significant ($p = 0.16$, η^2 partial = .026).
- TD children had larger dilations than ASD children for Social-Linguistic ($p = 0.009$, $d = 0.65$), Social Non-Linguistic ($p = .005$, $d = 0.68$), and Social-Emotional ($p = 0.046$, $d = 0.490$) stimuli with no difference for the Non-Social Non-Linguistic condition ($p = 0.38$, $d = 0.21$).

Individuals with ASD had significantly **smaller** pupillary responses to **social conditions**, but were comparable to TD individuals in the non-social condition.

RESEARCH OBJECTIVE #2: Determine whether pupillary responses can accurately distinguish ASD from typical development

Step 1: $p = .37$ OR = .015	NSNL $p = .37$
Step 2: $p = .012$ OR = .156	NSNL $p = .37$
Step 3: $p = .023$ OR = .168	SNL $p = .008$
Step 4: $p = .045$ OR = .172	NSNL $p = .28$
	SNL $p = .17$
	SL $p = .40$
	SE $p = .61$
	NSNL $p = .38$
	SNL $p = .15$
	SL $p = .33$
	SE $p = .61$

A hierarchical logistic regression was used to predict group membership. The non-social condition was not predictive of group, whereas the social variables were, regardless of order of entry. The final model was significantly predictive of group ($\chi^2_{(4)} = 9.76$, $p = 0.045$).

	ASD	TD	% Correct
Step 1: NSNL			
ASD	32	7	82.1
TD	26	6	18.8
Overall			53.5
Step 4: NSNL, SNL, SL, SE			
ASD	32	7	82.1
TD	15	17	53.1
Overall			69.0

Pupillary responses to **social** stimuli were **significantly predictive of group membership**. The whole model categorized individuals into groups with 69% accuracy rate.

DISCUSSION

- A host of behavioral and perceptual studies that have shown individuals with ASD have reduced engagement with social stimuli⁶ and a preference for non-social stimuli.⁷
- The current study was unique in demonstrating this lack of social engagement in ASD at an early, pre-conscious level of physiological processing.
- The **Social Motivation Theory**⁸ suggests that humans are biased to *orient* towards social stimuli, be *rewarded* by engagement in social interactions, and strive to *maintain* social bonds.
- By not orienting towards and engaging with social stimuli, individuals with ASD may miss out on rich social learning opportunities and rewards associated with social interactions; this may be implicated in the social communication impairments observed in ASD.
- Future research with infants will determine whether pupillary responses can be used as a screening tool for diagnosis.
- Other clinical implications include using pupil responses as a pre/post intervention measurement tool, or as a possible biofeedback mechanism^{9,10}.