

Implicit learning of perceptual distributions in children with autism spectrum disorder

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Introduction

- Recent theories of autism spectrum disorder (ASD) based on the Predictive Coding framework hypothesize **differences in implicit learning based on the statistical regularities** of the environment in individuals with ASD.
- Previous studies revealed evidence for the ability of children with ASD to **represent sets of low-level stimuli by its mean** (i.e. ensemble perception) when **assessed explicitly**.
- Chetverikov and colleagues (2016) found evidence for **implicit learning of feature distributions' parameters** (mean, variance and shape) in adults assessed by repetition and role-reversal effects in an odd-one-out visual search task.

Objective

- To test whether children with and without ASD are able to **implicitly extract and exploit** the statistical properties (mean, variance, shape) of the distributions of sets of differently oriented lines to improve their visual search performance.

Methods

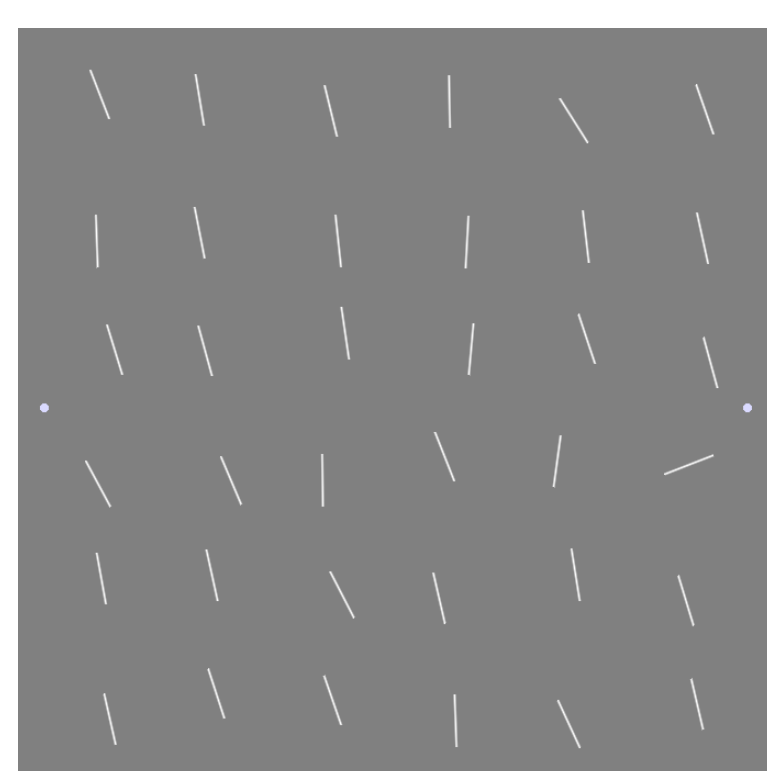
Participants

- 24 children with an official ASD diagnosis (10 – 14y)
- 25 typically developing (TD) children (10 – 14y)
- Group-wise matched for age, gender ratio and intelligence

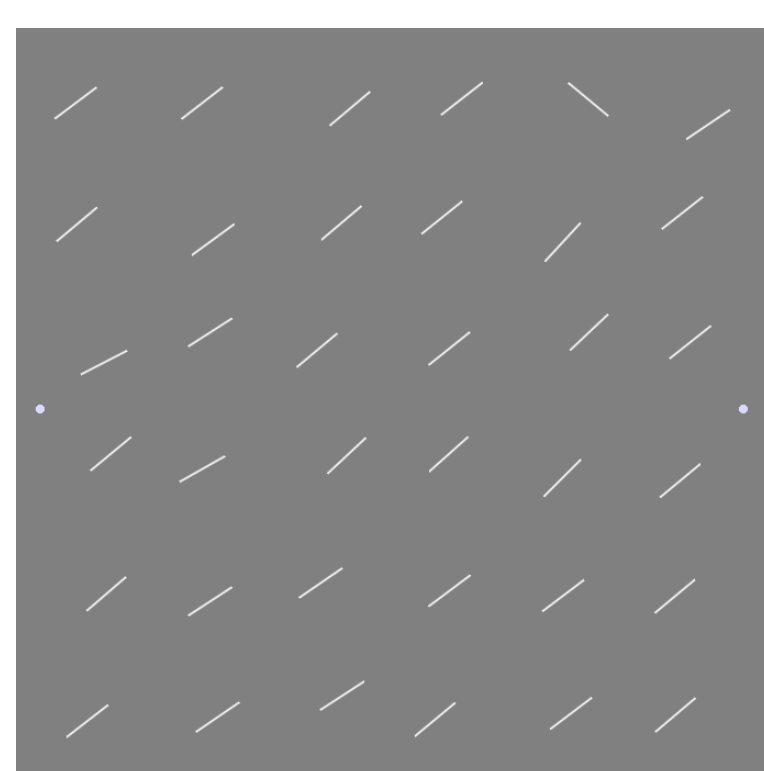
Stimuli and Procedure

- Odd-one-out visual search task
- Array of 36 differently oriented lines
 - “Upwards arrow key” when target is in upper part
 - “Downwards arrow key” when target is in lower part
- Orientation of distractor lines sampled from Gaussian distribution
- Target orientation 60° to 120° different from distractor distribution mean

Prime trial, DSD = 10°



Test trial, DSD = 5°

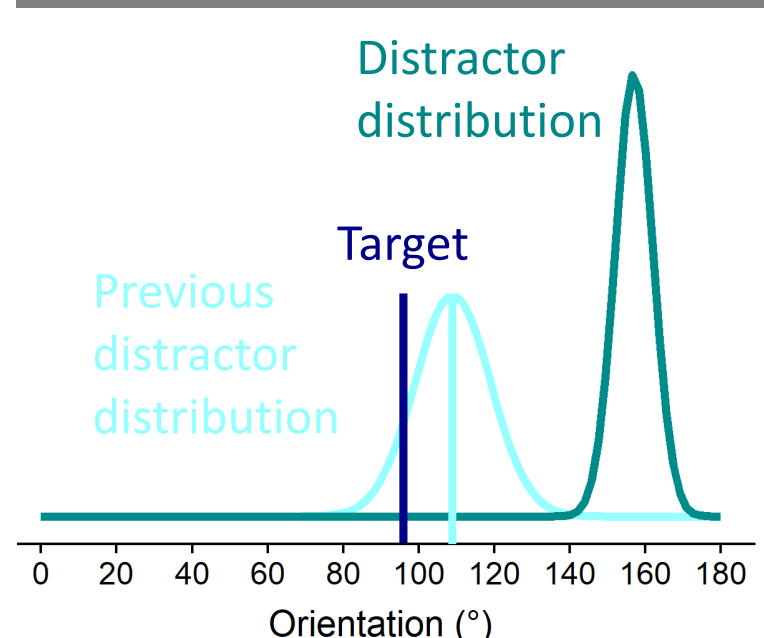
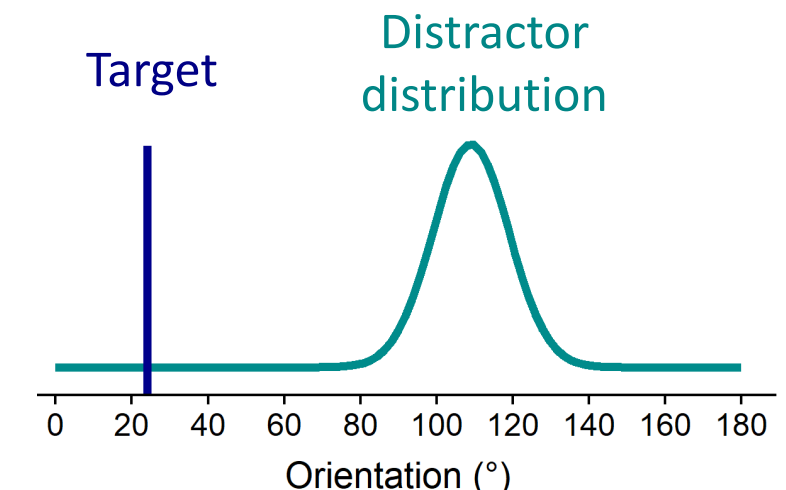


Prime streaks

- 5 – 6 prime trials
- Within each streak:
 - Distractors sampled from same distribution
 - Target orientation & location randomly changes

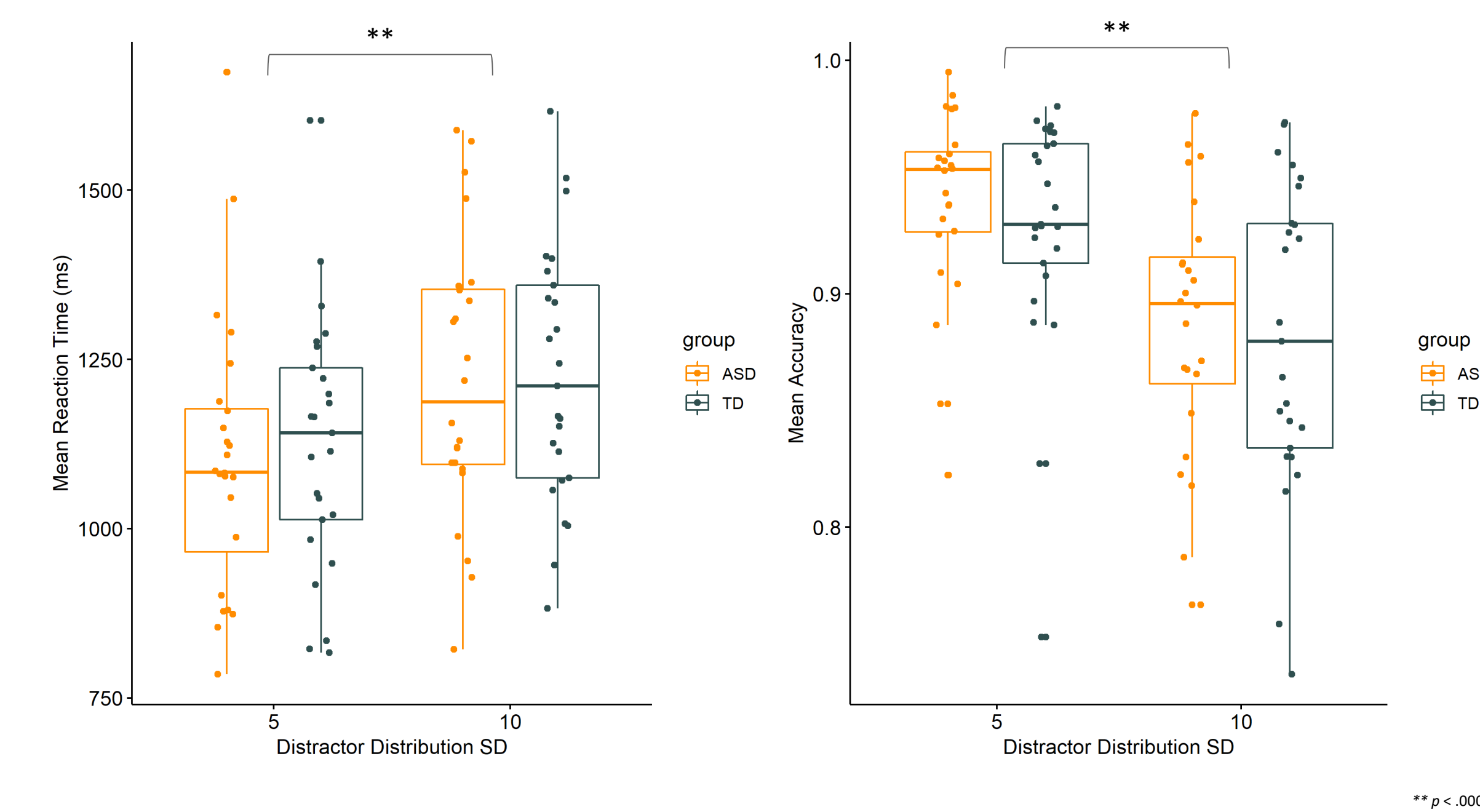
Test streaks

- 1 – 2 test trials
- Difference between Current Target orientation and Previous Distribution mean (CT-PD) ranges from -90° to +90°

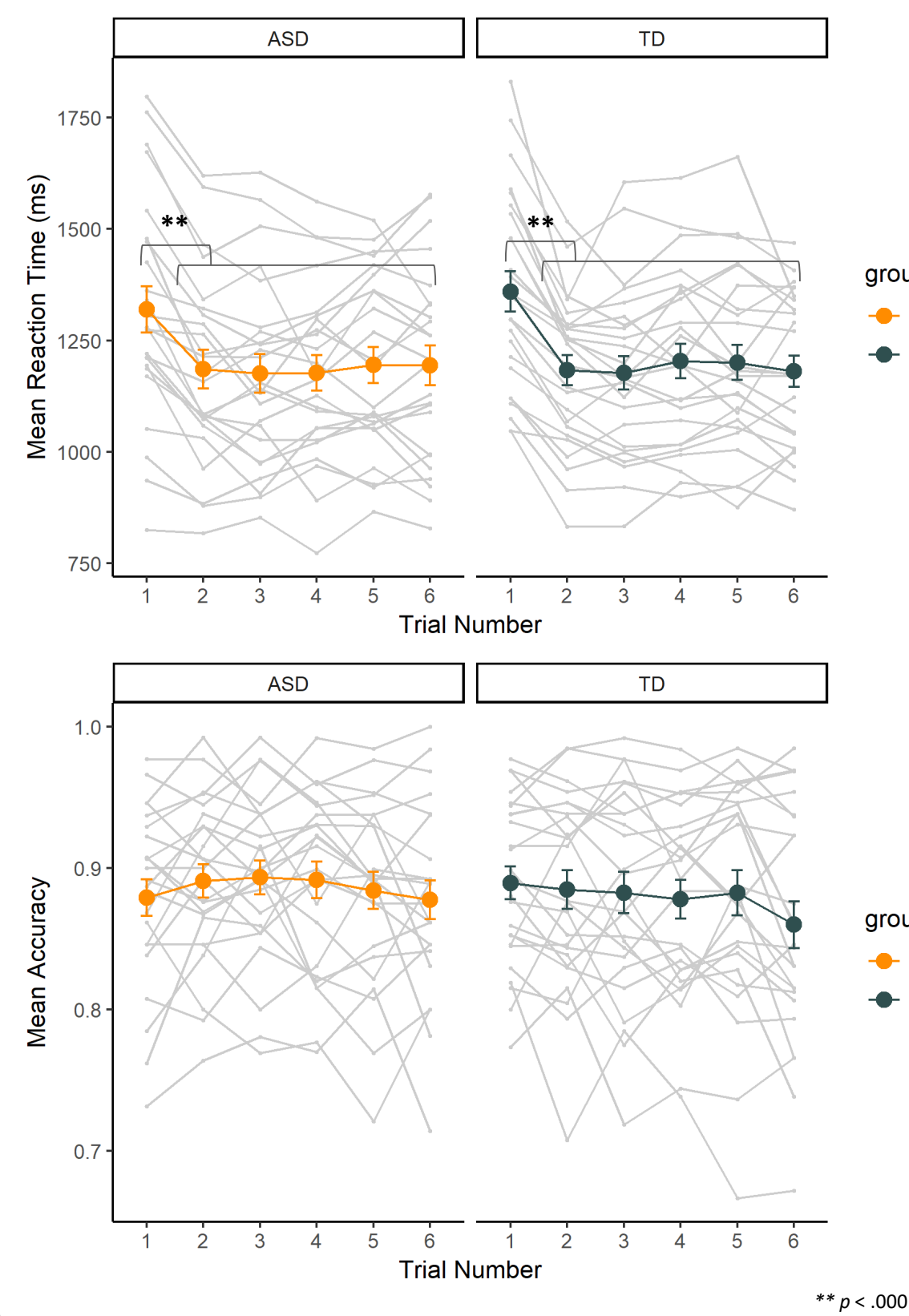


Results

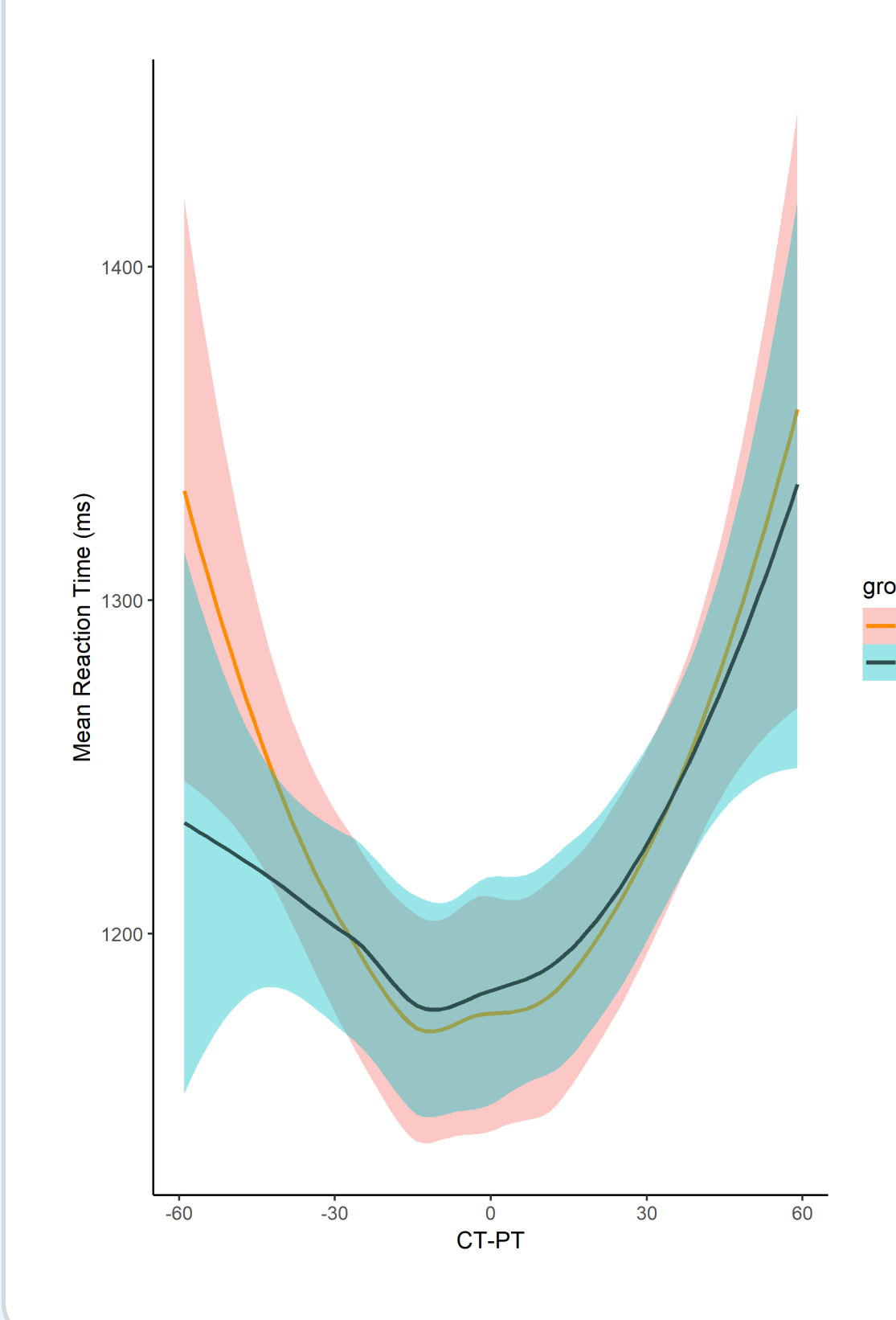
Overall performance per condition for each group



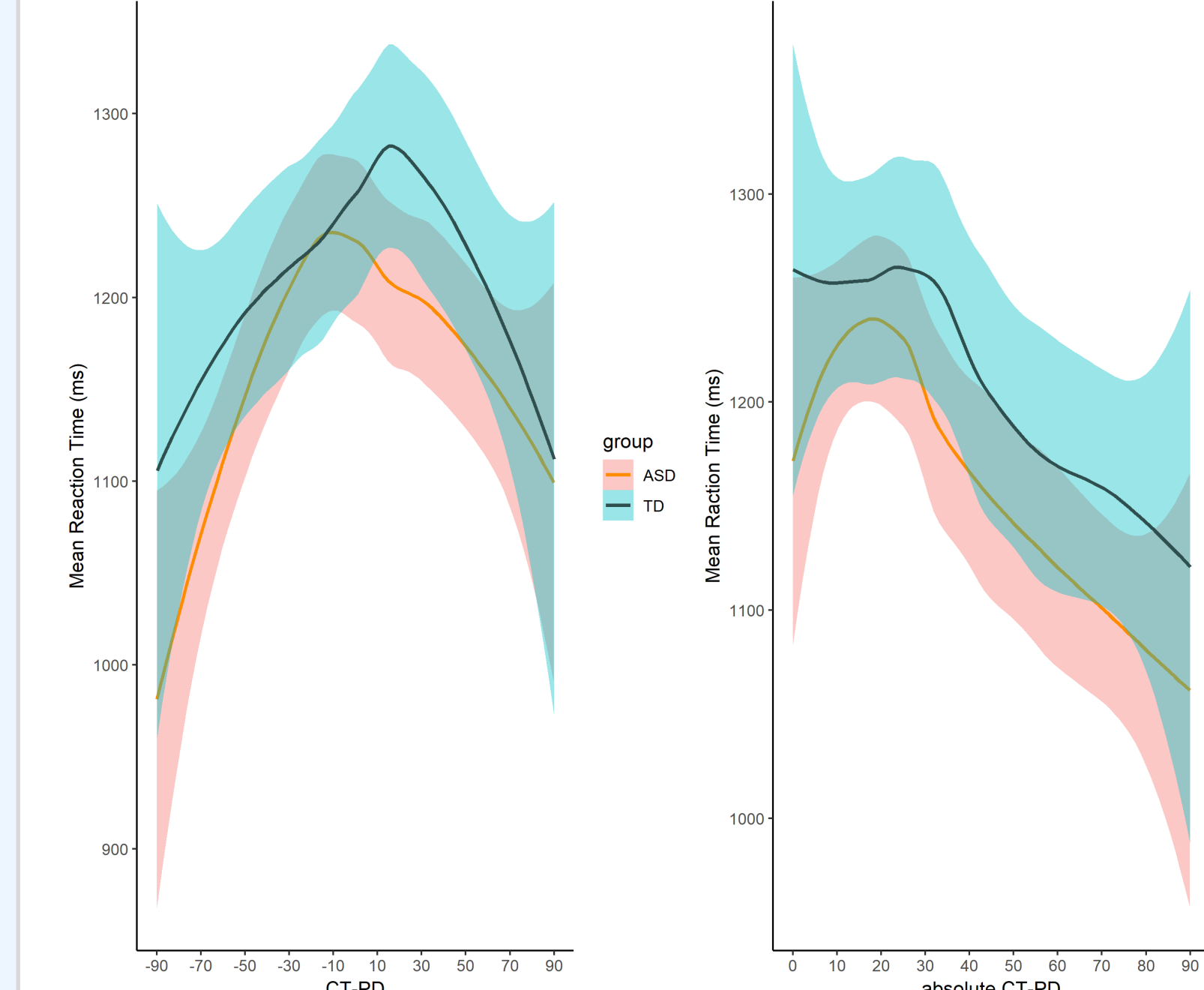
Repetition effect in prime streaks



Priming by target in prime streaks

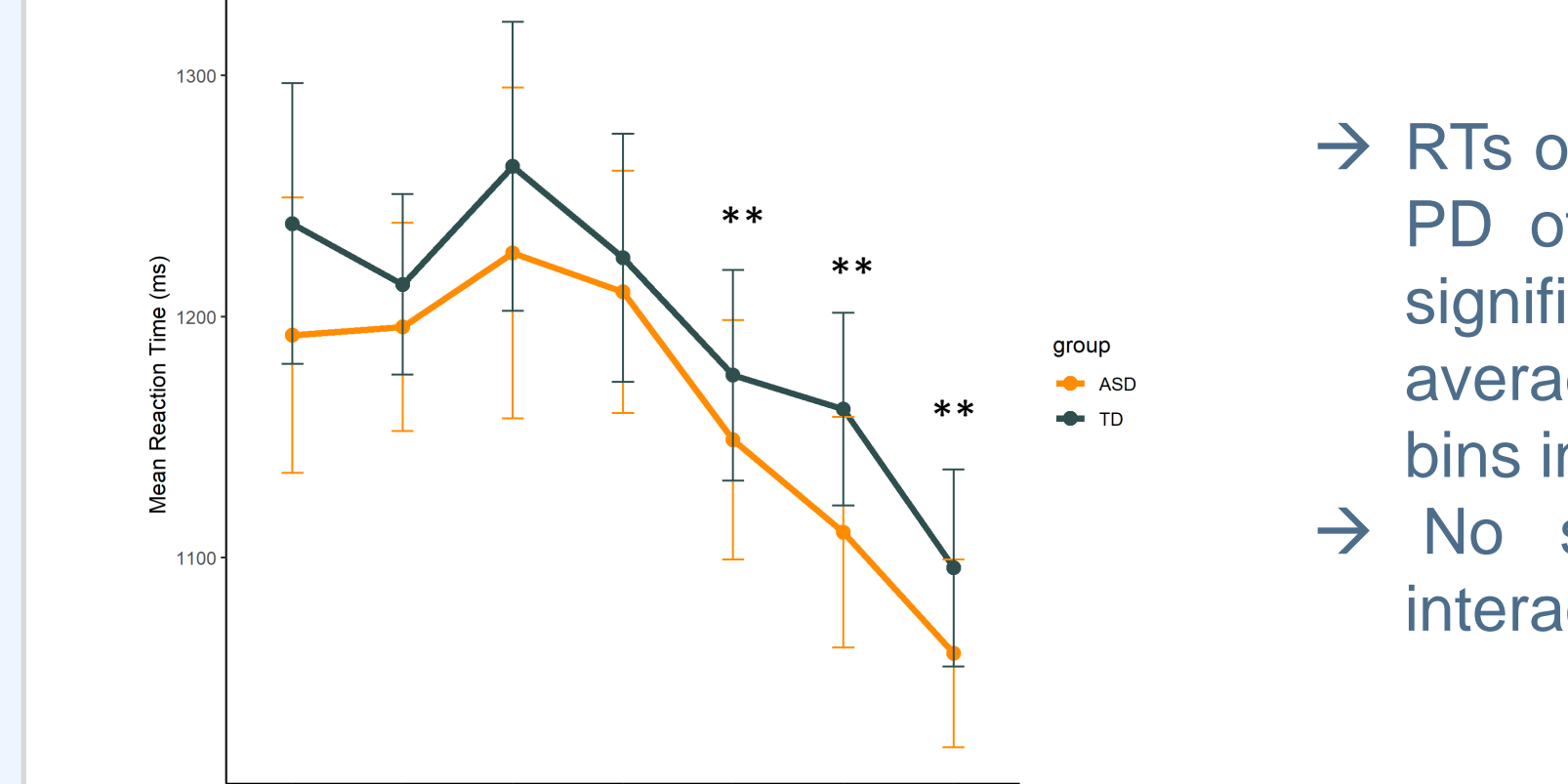


Role-reversal effects in test streaks: RTs over CT-PD

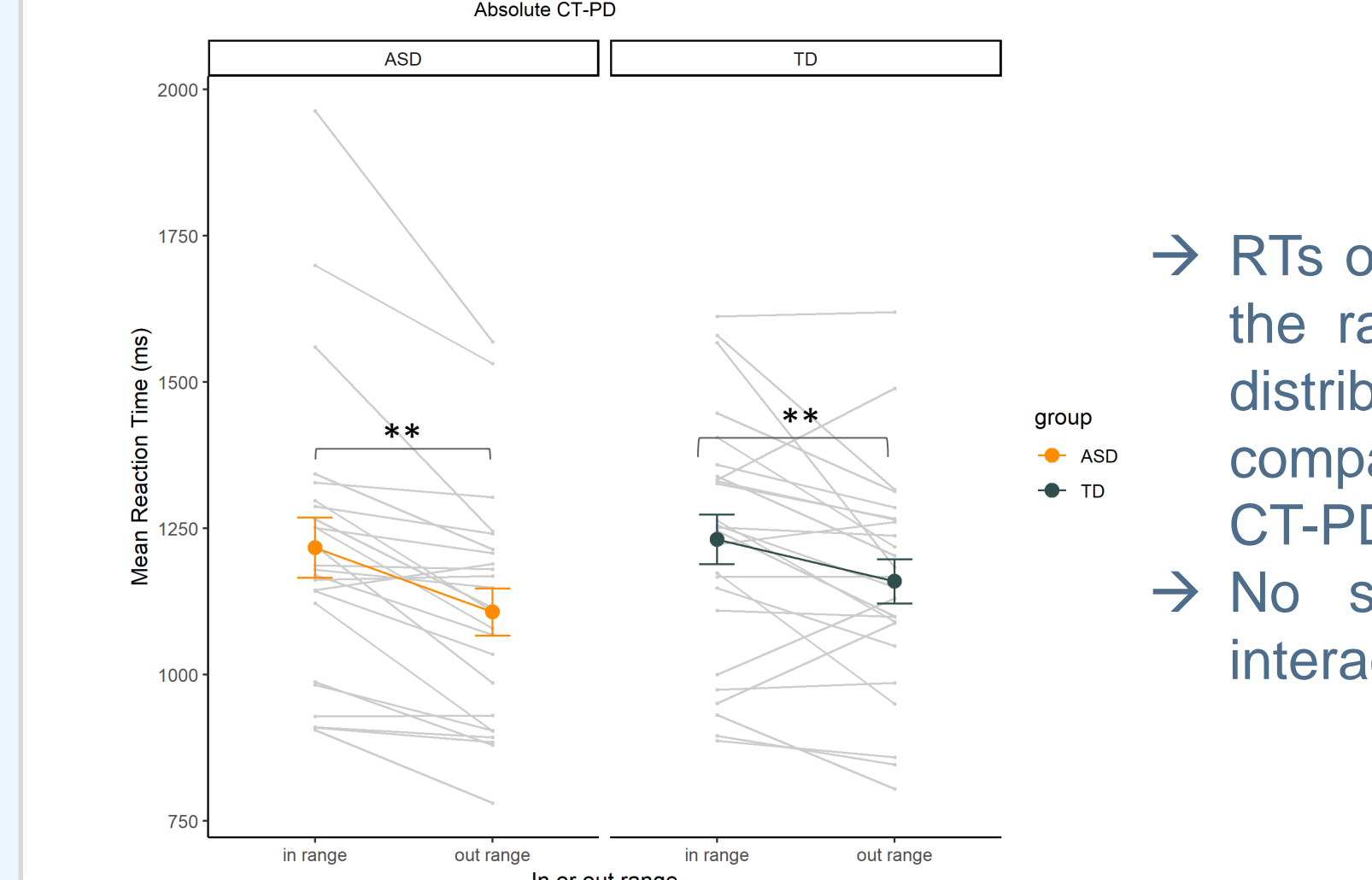


Linear mixed model with absolute CT-PD, group and group x absolute CT-PD as predictors of RT:

- Significant negative slope for absolute CT-PD ($B = -.05 (.01)$, $t = -5.47$, $p < .0001$).
- No significant effect of group or interaction effect.



- RTs on test trials with an absolute CT-PD of 35°-50°, 50°-70° and 70°-90° significantly lower compared to average RTs on all smaller CT-PD bins in both groups.
- No significant effect of group or interaction effect.



- RTs on test trials with CT-PD outside the range of the previous distractor distribution significantly lower compared to RTs on test trials with CT-PD inside the range.
- No significant effect of group or interaction effect.

Discussion

- No difference in overall performance between children with and without ASD, in line with predictions based on High and Inflexible Precision of Prediction Errors in individuals with ASD (HIPPEA; Van de Cruys et al., 2014).
- Both groups implicitly extract the statistical properties of the distractor distributions to improve their search performance to the same extent.
- Search times on test trials linearly decrease when CT-PD increases, without a significant breakpoint in both groups. Children with and without ASD seem to represent the distributions in a less precise way compared to adults.

References

- Chetverikov, A., Campana, G., & Kristjánsson, Á. (2016). Building ensemble representations: How the shape of preceding distractor distributions affects visual search. *Cognition*, 153, 196–210. <https://doi.org/10.1016/j.cognition.2016.04.018>
- Van de Cruys, S., Evers, K., Van der Hallen, R., Van Eylen, L., Boets, B., de-Wit, L., & Wagemans, J. (2014). Precise minds in uncertain worlds: Predictive coding in autism. *Psychological Review*, 121(4), 649–675. <https://doi.org/10.1037/a0037665>