Motion Prediction Abilities in Autism Spectrum Disorder

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Introduction

- Individuals with autism spectrum disorder (ASD) often prefer routine and have difficulty in unpredictable situations
- Emerging theories suggest an underlying prediction impairment in ASD (Van de Cruys et al., 2014; Sinha et al., 2014)
- Motion prediction requires estimating future object position based on experienced sensory information
    - Longer time period of prediction → greater prediction demand → cognitive extrapolation required
- Motion prediction abilities in typically developing (TD) individuals improve with age as they increasingly rely on the most relevant information present (Benguigui et al., 2004, 2008)

Study Objective:

- To investigate motion prediction abilities in ASD

Methods

Participants:

	ASD (n=20)			TD (n=20)		
	Mean	SD	Range	Mean	SD	Range
Age	13.76	1.7	10-16	13.61	2.3	9-17
IQ	105.75	15.0	84-133	113.50	14.6	92-148

Task/Measures:

"Press space bar when you think the bird arrives at the white line"

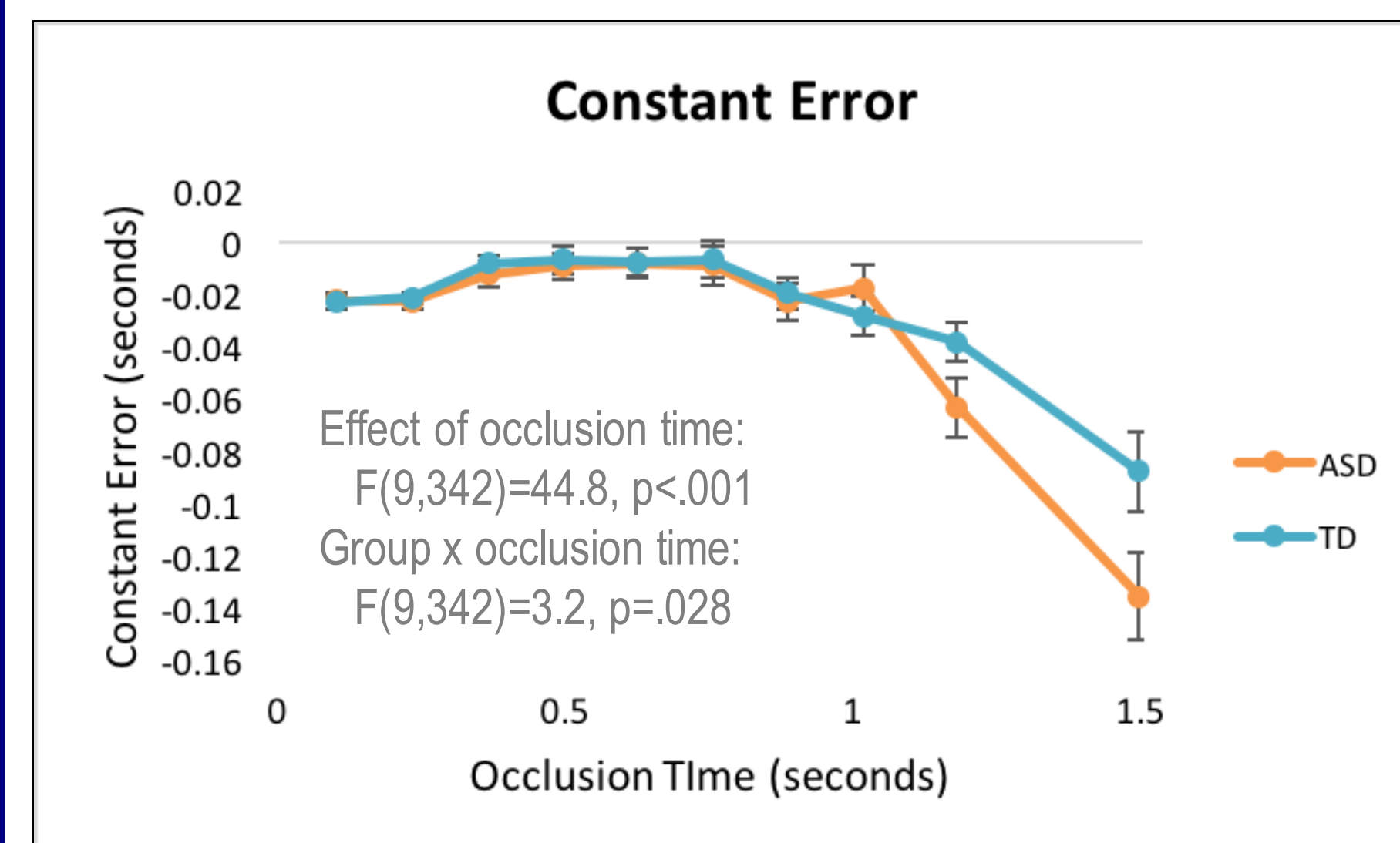Fixation   Moving Object   Occluder   Target

- 4 blocks of 100 trials each
- Eye tracking measured throughout

- Across trials, object speed and occluder length varied
    - Object speed: 10-20 degrees/second
    - Occluder length: 0.5-20 degrees

- Occlusion Time (seconds) = $\dfrac{\text{occluder length}}{\text{object speed}}$

Analysis & Results

### Analysis 1. Effects of group and occlusion time on prediction

Two measures of prediction ability calculated for each participant:
- Constant Error = Estimated – Actual Occlusion Time
- Variable Error = Standard deviation of constant error

Constant Error

Effect of occlusion time: $F_{(9,342)}=44.8$, $p<.001$
Group x occlusion time: $F_{(9,342)}=3.2$, $p=.028$

Variable Error

Effect of occlusion time: $F_{(9,342)}=196.8$, $p<.001$

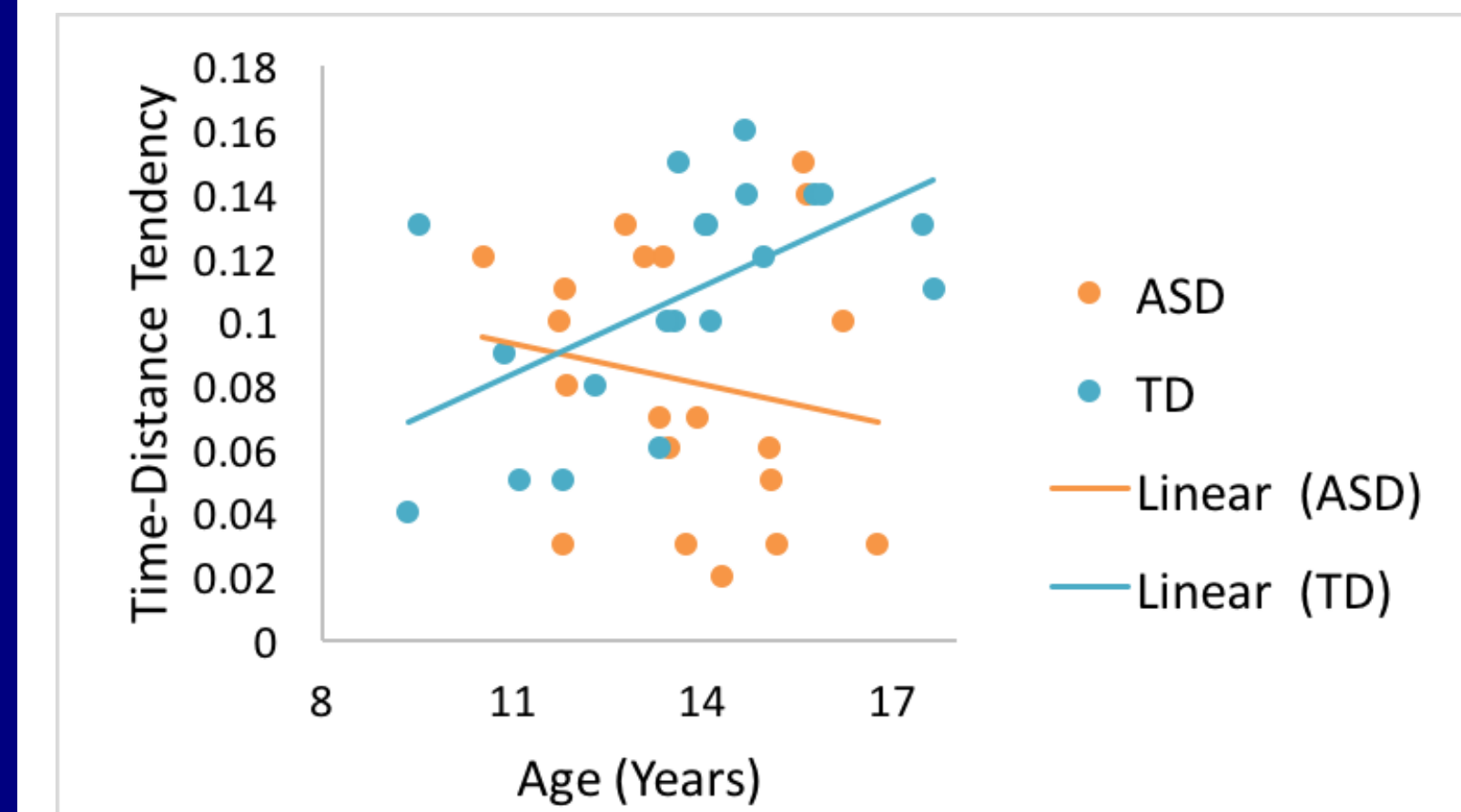As occlusion time increased, both groups underestimated the object's arrival to the target

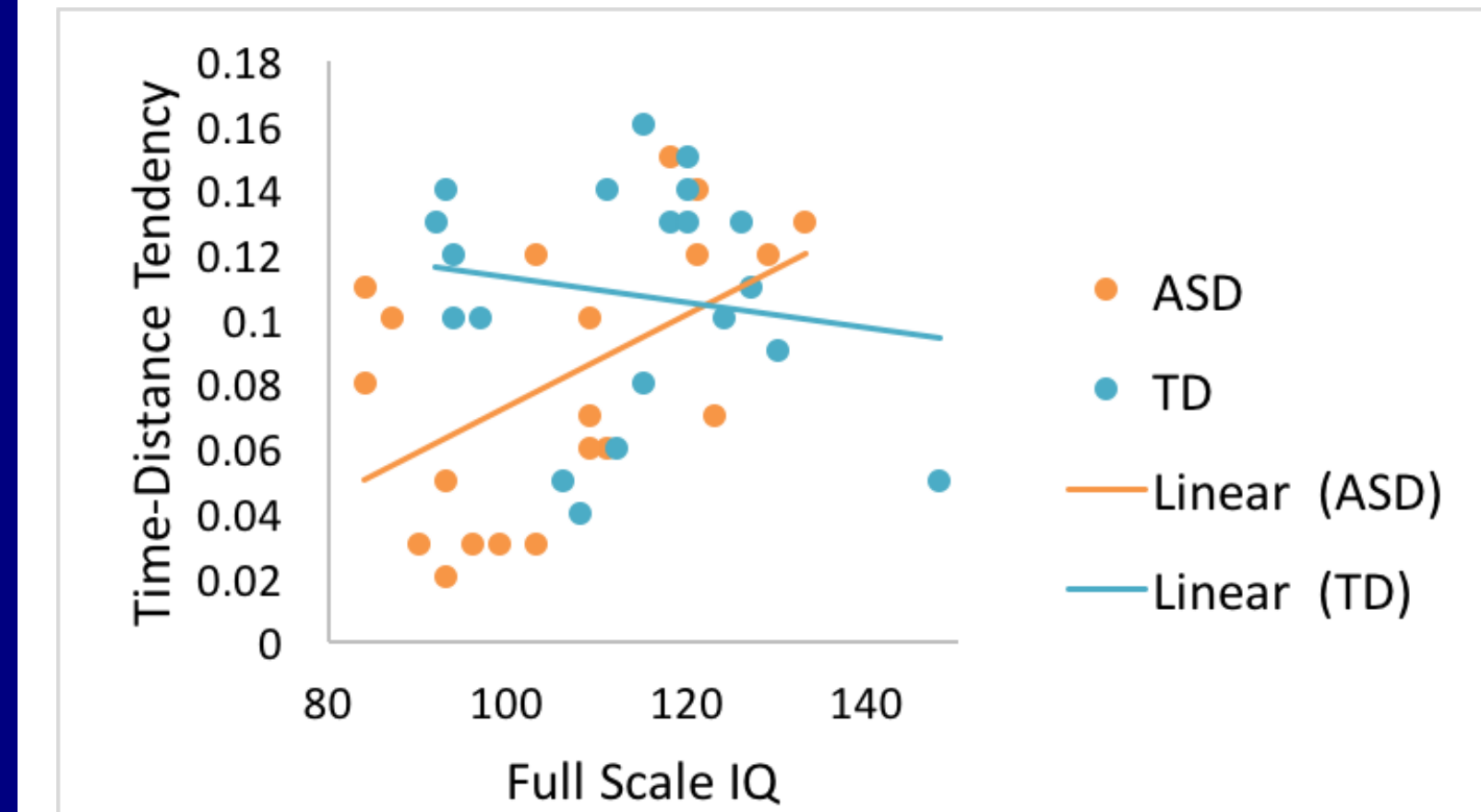The ASD group underestimated more than the TD group at the longest occlusion time
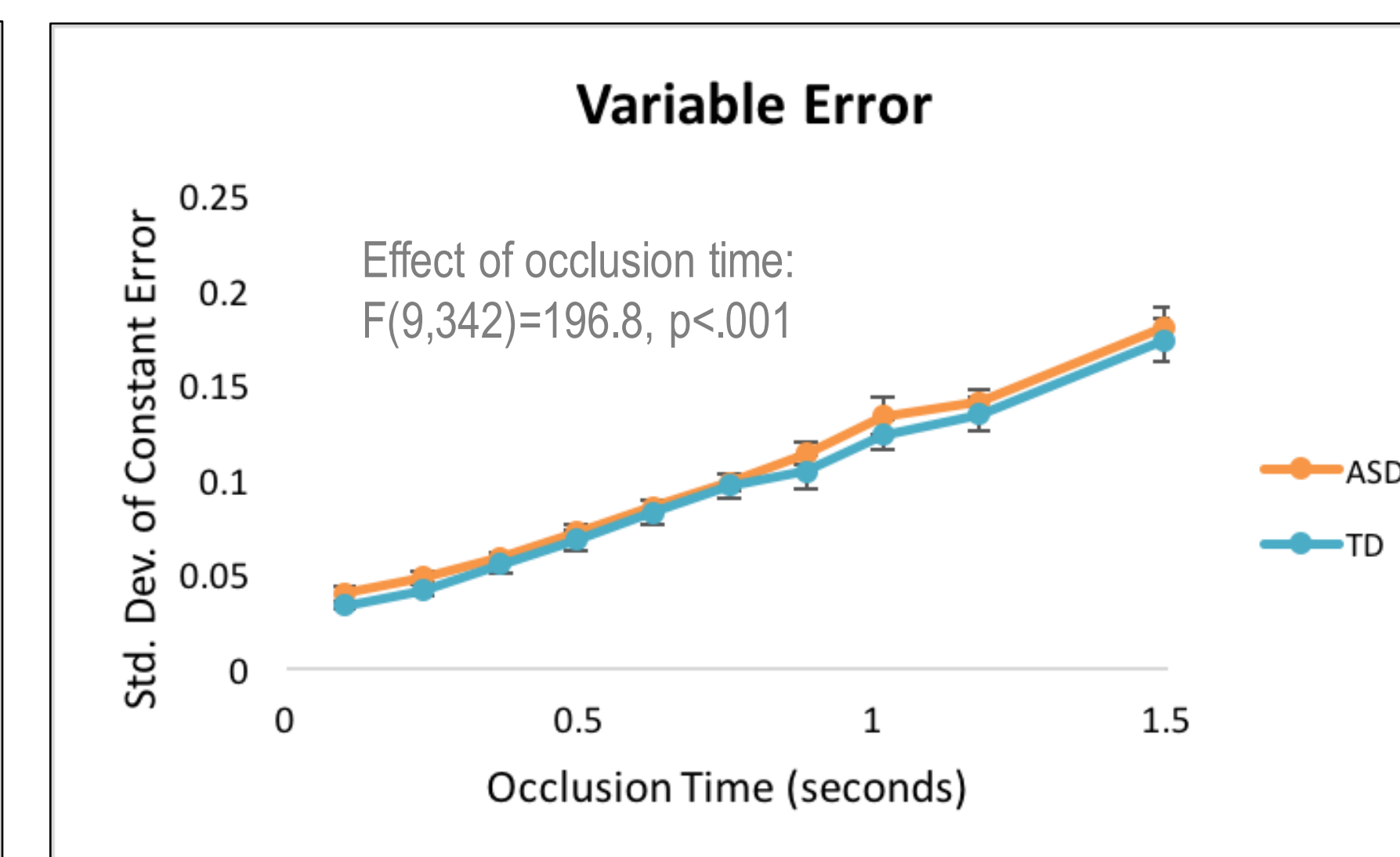
As occlusion time increased, both groups responded in a more variable way.

Analysis 2. Effects of strategy: Are individuals using the most relevant information (time) more than other information (distance)?

Linear regressions to evaluate how time and distance information explain participants' occlusion time estimates

Calculate R^2 for:
- Actual occlusion time on each participant's estimated occlusion time
- Actual occluded distance on each participant's estimated occlusion time

Data from a representative participant

Time as Information — $R^2 = 0.88541$

Distance as Information — $R^2 = 0.7694$
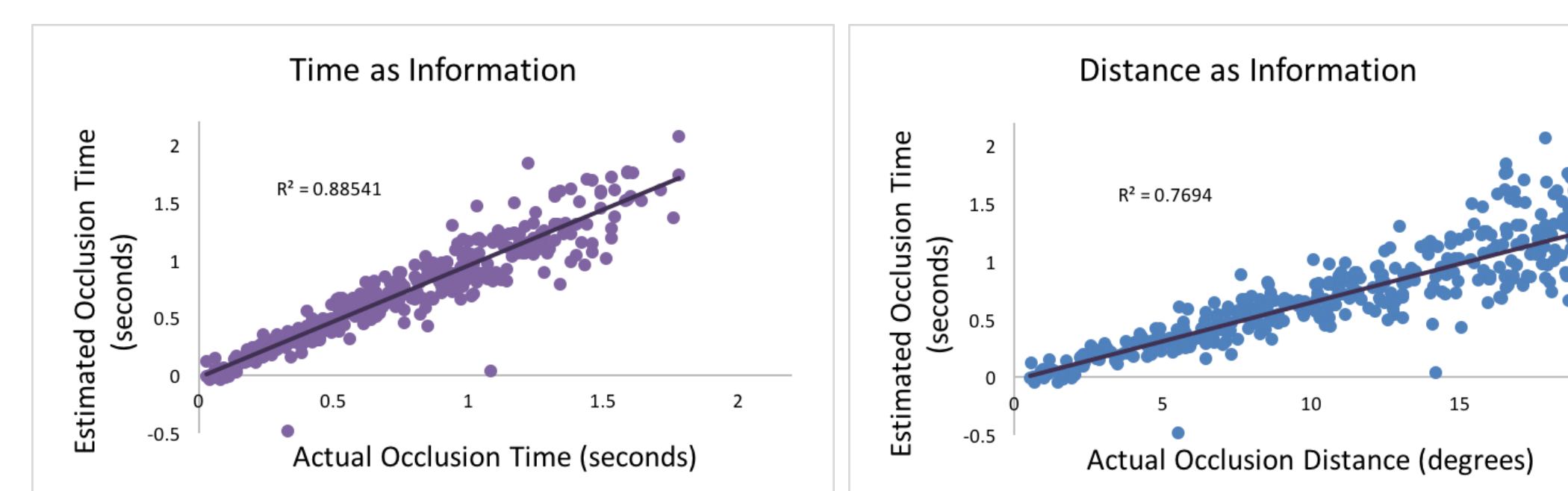
Time-Distance Tendency = R^2 for time as information – R^2 for distance as information

Predictors of Estimated Occlusion Time
- Distance as information
- Time as information

Time-Distance Tendency
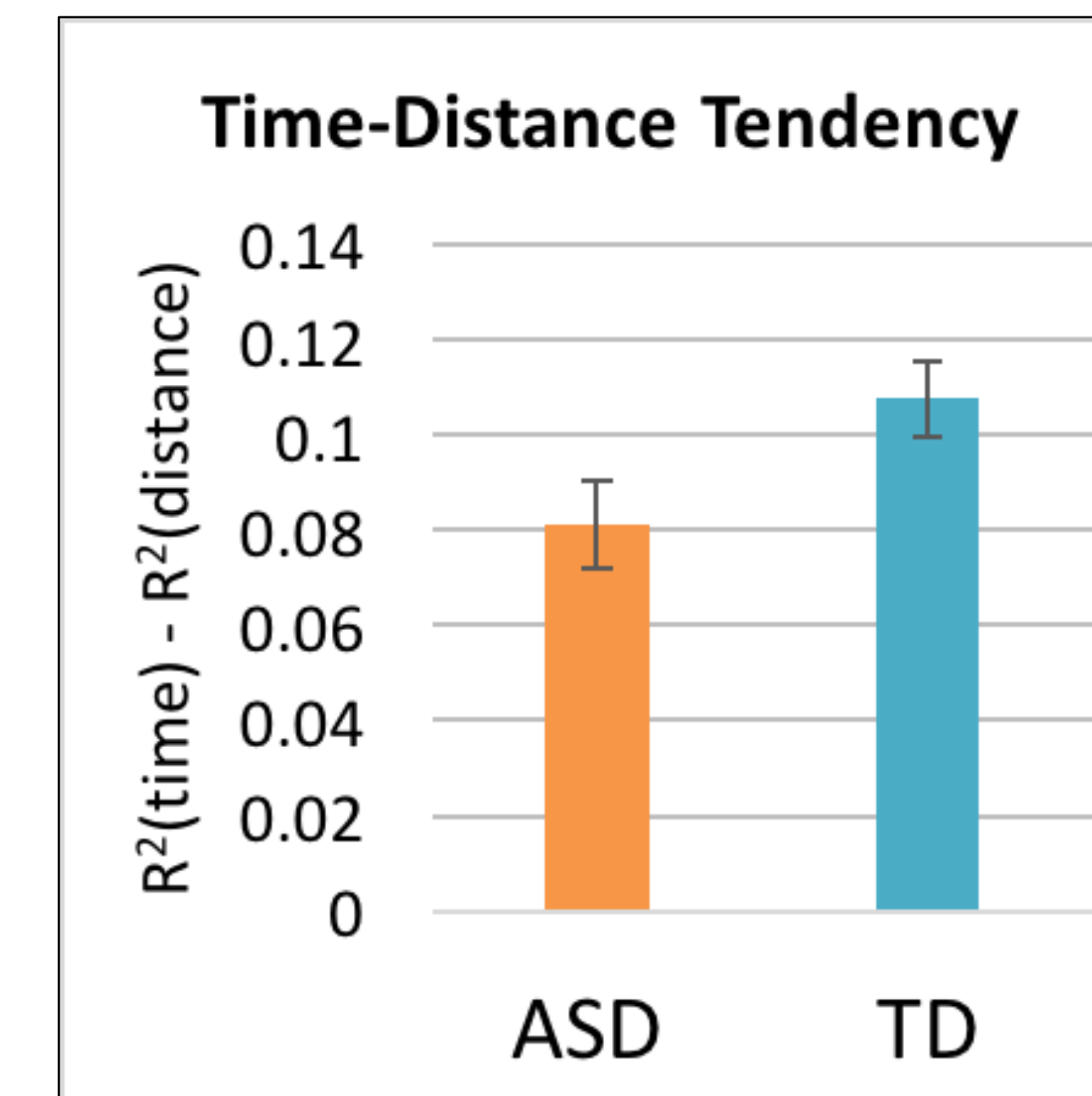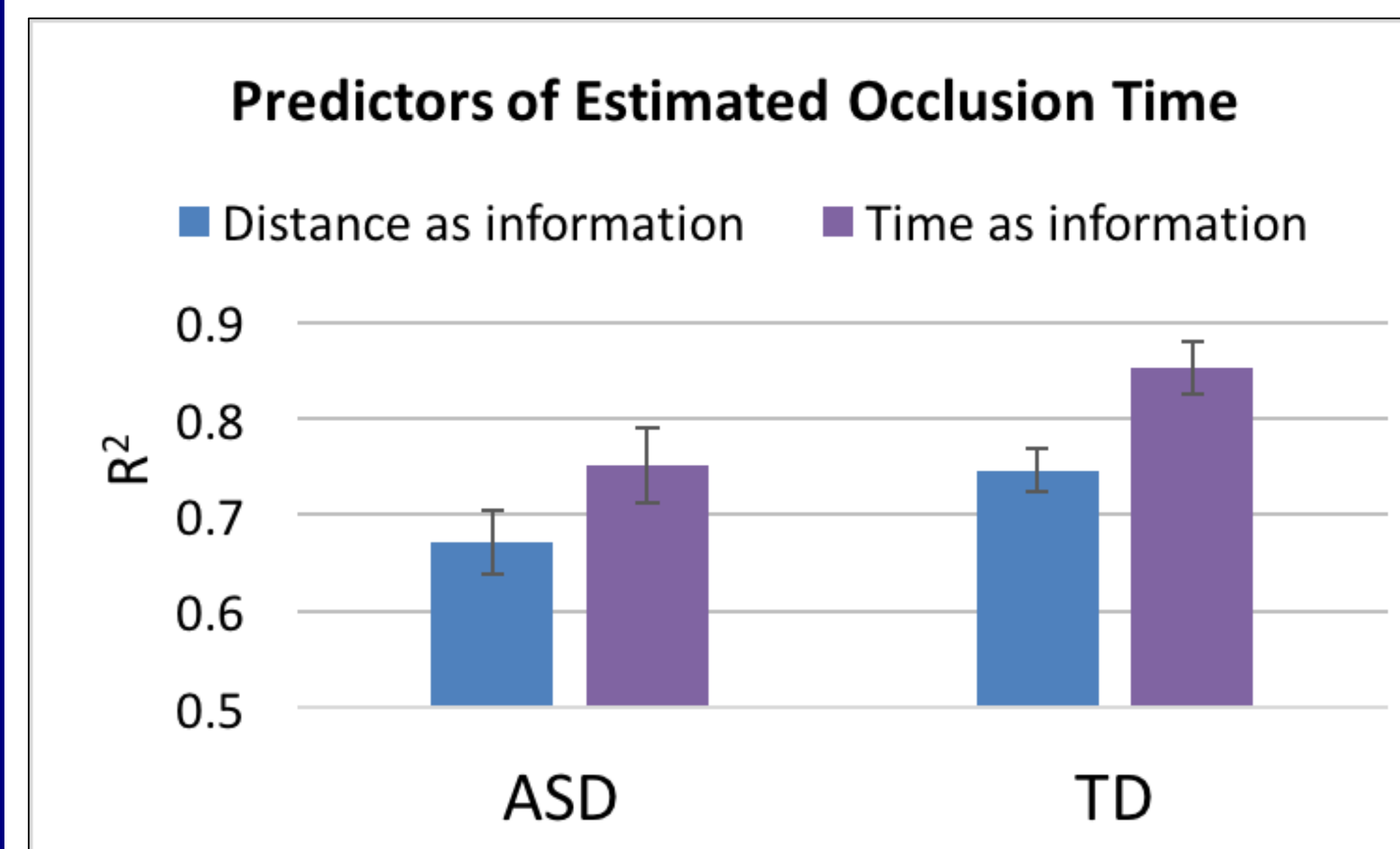
- ASD uses less time and distance information compared to TD, $F_{(1,38)}=4.12$, $p=.049$
- Both groups use time information over distance information, $F_{(1,38)}=237.2$, $p<.001$
- ASD shows less of a reliance on time over distance information, $F_{(1,38)}=4.69$, $p=.037$

Results (cont.)

Effects of age and IQ on strategy

In the TD group only, Increased age is associated with greater reliance on time over distance information, $r_{(20)}=.57$, $p=.008$.

In the ASD group only, Increased IQ is associated with greater reliance on time over distance information, $r_{(20)}=.52$, $p=.02$.

Discussion/Conclusion

- Some evidence for a deficit in motion prediction abilities in ASD when prediction demands are greatest (occlusion times greater than 1 second)

- Individuals with ASD may rely less on the most relevant information when making predictions

- Children with ASD do not appear to show the expected age-related shift to optimal prediction strategies

Future directions
- Examine effects of object speed and amount of visible time (before occluded)
- Analyze eye tracking data
- Examine prediction abilities in ASD over longer durations and in other sensory modalities and multisensory conditions

References

Van de Cruys, S. et al (2014). Precise minds in uncertain worlds: predictive coding in autism. Psych Rev, 121(4), 649.
Sinha, P., et al (2014). Autism as a disorder of prediction. PNAS, 111(42), 15220-15225.
Benguigui et al. (2004). Age differences in estimating arrival time. Neurosci Let, 369, 191-196
Benguigui, et al. (2008). Motion prediction and the velocity effect in children. Brit J Dev Psychol, 26(3), 389-407.

Acknowledgements & Contact

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