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Electrophysiological Correlates of

Impaired Motor-Auditory Prediction in Autism Spectrum Disorder

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Introduction

The amplitude of the auditory N1 in the event-related potential (ERP) is typically attenuated when sounds are self-generated compared to externally generated sounds.[1] This effect has been ascribed to internal forward modals predicting the sensory consequences of one's own motor actions.

A recently proposed theory posits that - unlike individuals with typical development (TD) - individuals with Autism Spectrum Disorder (ASD) have no strong predictive internal forward model of the world around them.[2] This lack of 'prior' knowledge makes it difficult to predict upcoming events and may severely compromise interactions with the environment.

Here, we tested the hypothesis of impaired predictive coding in ASD by examining the neural underpinnings of sensory consequences of motor-auditory predictions in individuals with ASD.

We hypothesized that - due to a lack of robust internal representations - individuals with ASD rely more on bottom-up incoming sensory signals, as if every stimulus is being experienced afresh.

Following this reasoning, we expected smaller attenuation effects for self-generated sounds in subjects in the ASD group, compared to their neurotypical age and gender matched counterparts in the TD group.

Method

Participants

ASD: N = 26, 6 female, mean age 18.04, mean TIQ 111.50

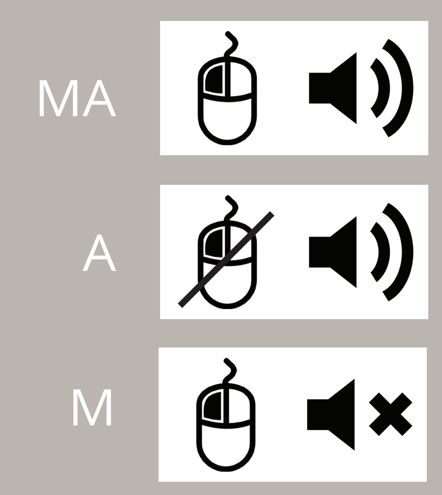
TD: N = 26, 6 female, mean age 18.77, mean TIQ 101.78

Experimental conditions

1. Motor-Auditory (MA)
Subjects pressed a mouse button at a steady pace of ~1200 ms, which generated a 50 ms pure tone of 1000 Hz.

2. Auditory (A)
The pure tones were replayed at the same pace as in the MA condition, but no button-press was required.

3. Motor (M)
Subjects pressed a mouse button at the same pace as in the MA condition, but no pure tones were presented.



160 trials / condition

Results

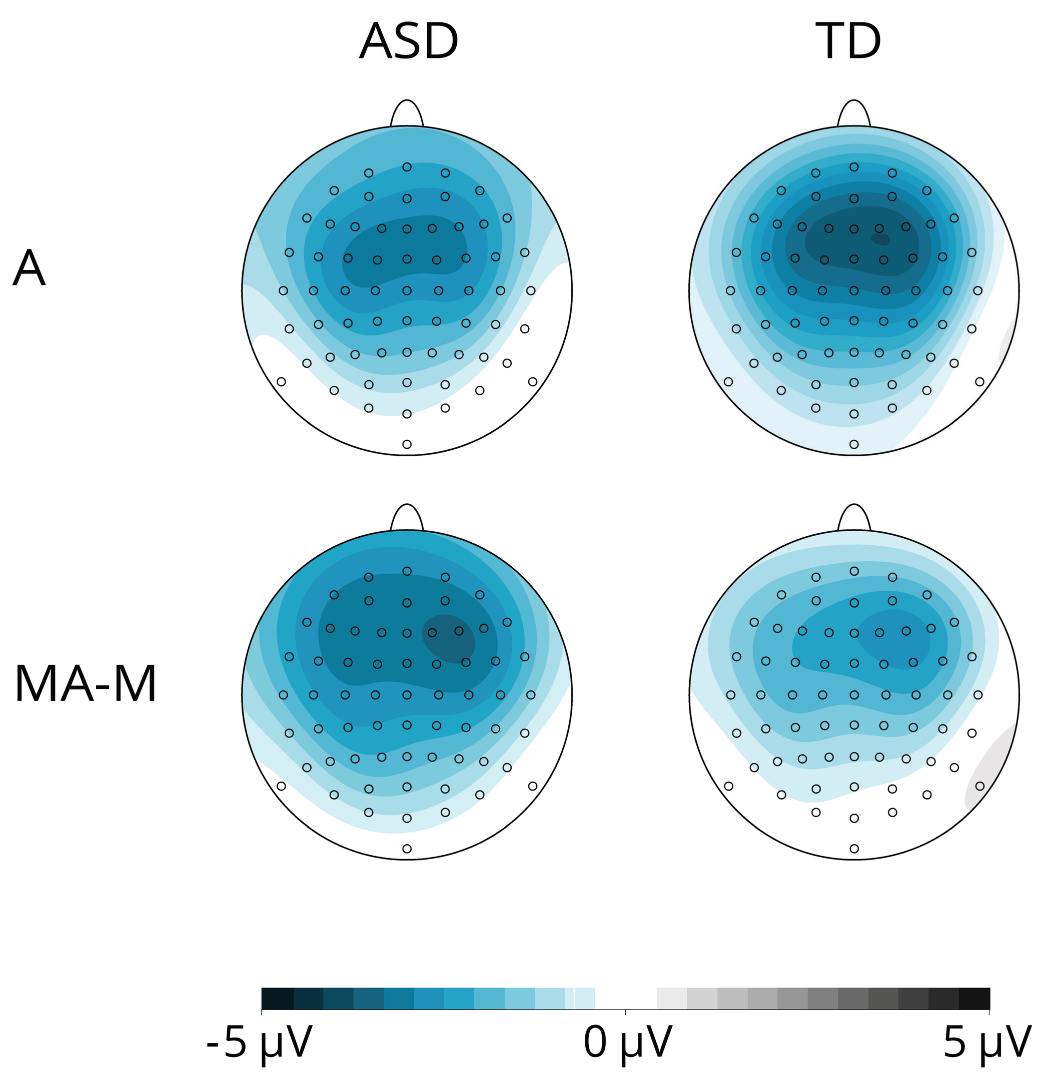


Figure 1. Scalp potential maps of the grand average EEG responses recorded in the N1 time window (50-150 ms).

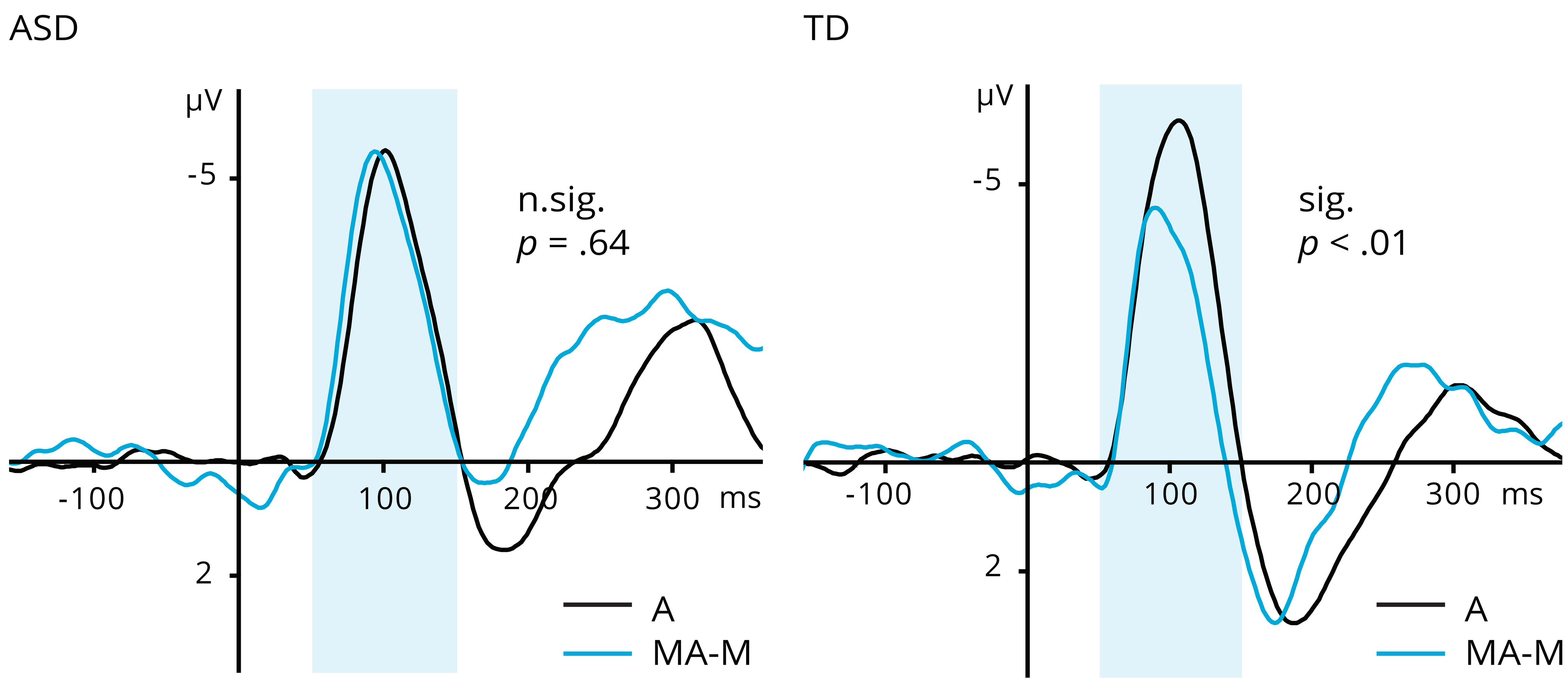


Figure 2. Direct comparison of the grand average ERPs for each group and condition recorded at nine electrodes showing maximal activity in the N1 time window (50-150 ms): Cz, C1, C2, FCz, FC1, FC2, Fz, F1, F2. Motor-auditory ERPs (blue line) were corrected for motor activity via subtraction of the motor waveform (recorded in the M condition) and averaged over electrodes.

Conclusions

For the TD group, the amplitude of the auditory N1 was attenuated in the motor-auditory condition compared to the auditory condition, indicating that the motor action predicted the sound and dampened the sensation.

In the ASD group, there was no auditory N1 attenuation in the motor-auditory condition compared to the auditory condition, indicating that they relied more strongly on bottom-up auditory cues - instead of top-down predictions based on prior knowledge.

These results show that individuals with ASD make less use of internal forward models to interpret the sensory environment and support the notion of impaired predictive coding abilities as the underlying cause of atypical multisensory processing in ASD.

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