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Electrophysiological alterations in early auditory predictive processing as potential markers for autistic symptomatology

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SUMMARY

Autism spectrum disorder (ASD) has been linked to a range of perceptual processing alterations, including hypo- and hyperresponsiveness to auditory stimulation. A recently proposed theory that attempts to account for these symptoms suggests that autistic individuals have a decreased ability to anticipate upcoming sensory stimulation.[1]

Here, we tested this hypothesis with a series of event-related potential (ERP) studies in which we compared the neural correlates[2] of motor-auditory prediction (N1 attenuation), visual-auditory prediction error (omission N1), and deviancy detection (MMN) in auditory, visual and audiovisual speech between older adolescents and young adults with ASD and age-matched individuals with typical development (TD).

The results of our first ERP study[3] showed that, unlike in the TD group, self-initiation of tones through a button press did not attenuate the auditory N1 in the ASD group, indicating that the ability to anticipate the auditory sensory consequences of self-initiated motor actions might be decreased in ASD.

Our second ERP study[4] demonstrated that unexpected omissions of a sound of which the timing and content could be predicted by preceding visual motion elicited an increased early auditory omission response (oN1) in the ASD group, indicating that violations of the prediction model may produce larger prediction errors in individuals with ASD.

Finally, our third ERP study showed that deviancy detection in auditory speech is reduced in ASD, while deviancy detection in audiovisual and visual speech is intact.

Taken together, our findings suggest that **individuals with ASD may experience difficulties in anticipating upcoming auditory stimulation**. Importantly, these difficulties might be due to domain-specific alterations, rather than general impairments in predictive coding. This notion provides potential avenues for future research on electrophysiological markers for ASD.

METHOD & RESULTS

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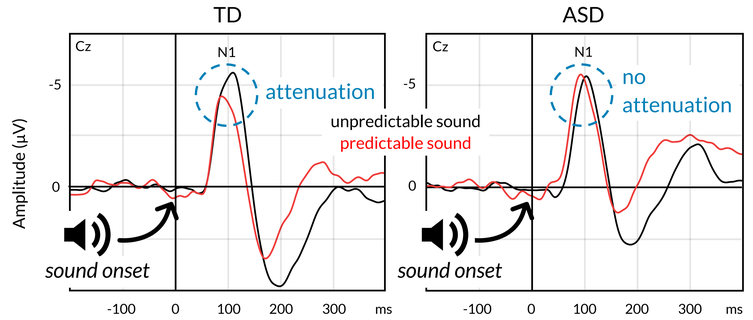
STUDY 1 – MOTOR AUDITORY PREDICTION

Group	N	♂/♀	Age	IQ
ASD	30	22/8	18.55	103.00
TD	30	24/6	18.83	111.97

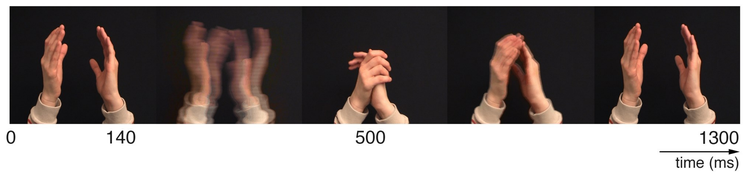
Predictable sound (160 trials)
Subjects pressed a mouse button at a steady pace of ~1200 ms, which generated a 50 ms pure tone of 1000 Hz.

Unpredictable sound (160 trials)
The 1000 Hz pure tones were replayed at the same pace as in the predictable sound condition, but no button press was required



Note: ERPs in the predictable sound condition (red lines) were corrected for motor activity via subtraction of the waveform recorded during a motor-only condition in which subjects pressed the mouse button in the same pace while no tone was presented

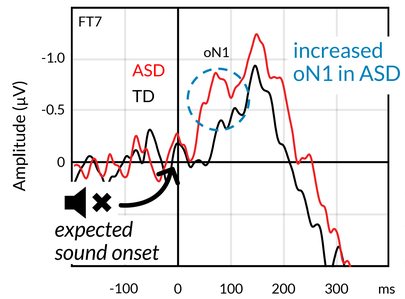
STUDY 2 – VISUAL AUTOVISUAL PREDICTION ERROR



Group	N	♂/♀	Age	IQ
ASD	29	21/8	18.64	103.03
TD	29	23/6	18.93	112.07

ERPs were obtained from **168 unexpected sound omissions** in a sequence of 1400 presentations of an audiovisual recording of a handclap in which the visual motion of the hands reliably predicted the timing and content of the sound.

ERPs evoked by unexpected sound omissions



Note: ERPs were corrected for visual activity via subtraction of the waveform recorded during a visual-only condition in which the video of the handclap was presented without sound

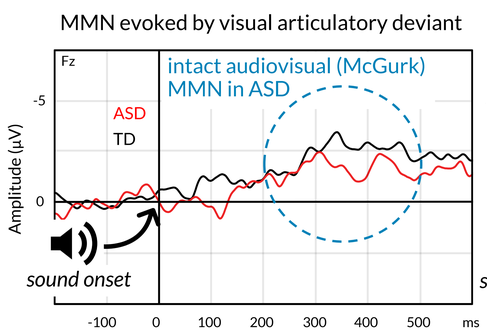
STUDY 3 – DEVIANCY DETECTION IN AUDIOVISUAL AND AUDITORY SPEECH

Group	N	♂/♀	Age	IQ
ASD	20	15/5	18.55	100.45
TD	20	15/5	19.15	114.65

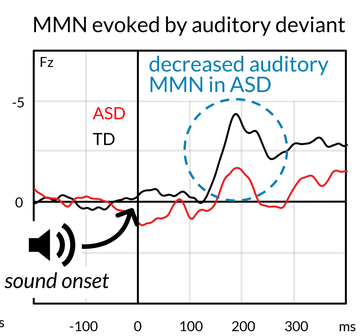
Audiovisual mismatch-negativity (**MMN**) waveforms were recorded using a **McGurk oddball paradigm** in which audiovisual recordings of a male speaker were presented uttering the syllable /bi/. In 15% of all trials (120 out of 800), the **visual articulatory deviant** stimulus /gi/ was dubbed on the auditory stimulus /bi/, leading* to the illusory McGurk percept /di/.

Auditory MMN waveforms were recorded using an oddball paradigm with the syllable /bi/ as the standard auditory stimulus and the syllable /gi/ as the **auditory deviant** stimulus (15% of all trials, 120 out of 800).

MMN evoked by visual articulatory deviant



MMN evoked by auditory deviant



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Note: Audiovisual MMN waveforms were corrected for visual activity via subtraction of the waveforms recorded during a visual-only condition in which the standard and deviant videos were presented without sound.
* Obtainment of the illusory McGurk percept /di/ was confirmed by a behavioral task in both the ASD and TD group.

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