Title: A Multidimensional Investigation of Sensory Processing in Autism: Neurophysiological, Psychophysical, Self-Report, and Parent-Report Measures

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Introduction: Atypical sensory processing in Autism Spectrum Development (ASD) emerges early and predicts later autistic social behaviours (Baranek et al., 2018; Damiano-Goodwin et al., 2018) and is also a correlate (Lin & Huang, 2019) or aspect (McConachie et al., 2019) of quality of life in ASD. Discrepancies between types of sensory measures are a challenge in this field, and assessments using multiple measures are recommended (Uljarević et al., 2017). The present study assesses sensory processing in 11- to 14-year-old ASD and TD participants using self- and parent-report questionnaires, auditory and tactile detection thresholds, tactile spatial resolution thresholds, and auditory and somatosensory event-related potentials (ERPs).

Method: 46 autistic (41 male, mean age = 12.73 yrs) and 21 typically-developing (14 male, mean age = 13.04 yrs) participants provided usable data. ADOS and ADI-R were used to verify ASD diagnoses. The self-report Adolescent/Adult Sensory Profile (AASP) and the caregiver-report Sensory Experiences Questionnaire-Version 3.0 (SEQ-3.0) and Sensory Profile (SP) were collected. Subscores were compared across groups using ANCOVA, covarying for WISC PRI scores.

Auditory detection thresholds for pure tones of 125, 250, 500, 1000, 2000, 4000, and 8000 Hz were measured in each ear using a clinical audiometer; initial intensity was 40 dB HL and levels were increased or decreased in steps of 5 dB and 10 dB respectively. Permutation tests based on the maximum statistic from any ear and frequency (adapted from Gondan & Minakata, 2016) were used to compare thresholds across groups. Tactile detection thresholds were estimated by applying Von Frey monofilaments to the index finger, which was concealed by a screen and curtain; thresholds were averaged across four presentation blocks. Tactile spatial resolution thresholds were estimated using hemispherical plastic JVP domes with gratings of varying bar and groove widths (0.35 – 3.00 mm). Domes of declining groove widths were each applied to the index finger in random orientations for 10-trial blocks, with participants being instructed to report the orientation. 75% (i.e., chance) thresholds were interpolated.

ERPs were collected in a multisensory paradigm with auditory (A), somatosensory (S), visual (V), AS, AV, SV, and ASV stimuli; participants were instructed to respond to all events. Only A (65 dB SPL 20 ms broadband noise bursts with speech-shaped spectra) and S (8 ms single, static mechanical taps) stimuli are reported here. High-density EEG (125 channels) was digitized at 1000 Hz, average-referenced, processed using SOBI ICA with SMARTer output (Saggar et al., 2012). Auditory Tb (or N1c) mean amplitudes were measured at temporal sites in a window ±30 ms around the peak of the grand average across both groups (135 – 195 ms) and somatosensory P60 mean amplitudes were measured at contralateral centro-parietal sites in a window ±20 ms around the peak of the grand average across groups (38 – 78 ms).

Results: ASD participants showed more intense/atypical sensory behaviour on all questionnaire subscales except AASP Sensation Seeking (p = .99; all other corrected $p \leq .02$). A trend towards differences in hearing thresholds was observed, permutation p = .09, driven by trending lower left ear PTA thresholds in ASD, p = .11. Von Frey hair and JVP dome thresholds did not differ across groups, $p \geq .19$. In ASD, there were no correlations between questionnaire scores and thresholds after correcting for multiple comparisons. Auditory Tb amplitudes did not differ between groups after covarying for WISC PRI scores and auditory thresholds, but somatosensory P60 amplitudes were attenuated in ASD, p = .02, and this was strongly trending after covarying for PRI and Von Frey thresholds, p = .07. Interestingly, autistic participants with greater (more negative) auditory Tb amplitudes had higher overall PTA hearing thresholds, $r(29) = -.43$, p = .01. There were no associations between P60 amplitudes and tactile thresholds.

Discussion: Overall, the different types of measures (neurophysiological, psychophysical, questionnaire) appeared largely independent of one another. For the most part, questionnaires easily captured autistic participants' sensory challenges. The null result from the AASP Sensation Seeking scale likely reflected items designed for the general population rather than ASD; interestingly, the largest questionnaire effects were observed on the SEQ-3.0, an autism-specific measure. In marked contrast to questionnaires, no significant group differences in psychophysical thresholds were observed. A trend towards sharper hearing acuity in ASD from the left ear may have reflected other factors besides sensory processing itself; the left ear was always tested first and autistic participants could (for example) have shown more attention to task early on. Consistent with prior research, we found attenuated somatosensory P60 ERP amplitudes in ASD. Contrary to our predictions – we expected no association – we found that autistic participants with larger auditory Tb ERPs had higher hearing thresholds. This finding could potentially suggest a role for loudness recruitment in neural hyper-responsiveness to sounds even in autistic participants with hearing in the normal range, but further research using ERPs to stimuli of multiple intensities is required to replicate and extend this association.

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