Auditory attention switching difficulty in young adults with autism spectrum disorder

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Background

- Sensory processing difficulties, particularly in the auditory domain, are commonly reported by individuals with autism spectrum disorder (ASD).
- Deficits include difficulty listening under noisy conditions and impaired cross-modal attention switching [1, 2].
- Auditory attention deployment in ASD is not well understood.

Questions

1. Can adults with ASD use voice and location cues to selectively direct auditory attention?
2. How does auditory attention differ in adults with ASD compared to control subjects?

Methods

Participants

- 24 adults (21-22 years old; $n = 12$ ASD; $n = 12$ control).
- Subjects with ASD recruited from larger longitudinal study at UW Autism Center.
- Initial research diagnosis of ASD (according to DSM-IV criteria [3]) established at age 3 (1998-2000) using: 1) ADI-R [4], 2) ADOS-G [5], 3) medical and family history, 4) cognitive test scores, and 5) clinical observation and judgement.
- Control subjects were newly recruited.
- ADOS-2 [6] and WASI-II [7] administered to all subjects for the current study (2016-2019).
- To ensure clinically normal hearing thresholds, all enrolled subjects passed audiometric (octave frequencies between 250 and 8000 Hz), distortion product otoacoustic emission, and auditory brainstem response screening.

Task

- Attend to one of two simultaneous auditory streams, repeat back two words.
- 2 attention conditions (maintain, switch); 3 cue types (voice, location, both).

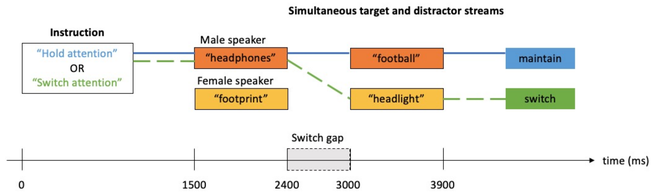

Fig 1. Trial timing. Each trial began with an instruction spoken by the target speaker. After the instruction, two simultaneous auditory streams began. In the depicted maintain trial (solid line), subjects would hear "hold attention" in a male voice, attend to the male voice throughout the trial and repeat back: "headphones, football." In the depicted switch trial (dashed line), subjects would hear "switch attention" in a male voice, attend to the male voice for the first word, switch attention to the female voice for the second word and repeat back: "headphones, headlight." Each trial had either a voice/location cue, or both cues.

Results

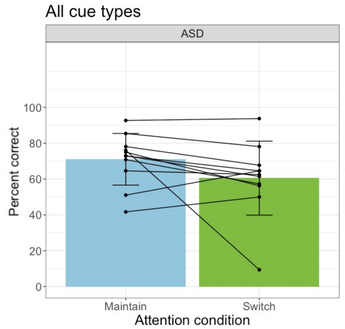

Fig 2. Task performance by attention condition for the ASD group ($n = 11$; mean ± 1 SD). No difference in performance on maintain-attention compared to switch-attention trials (paired samples t-test; $t(10) = 1.665, p = .127$).

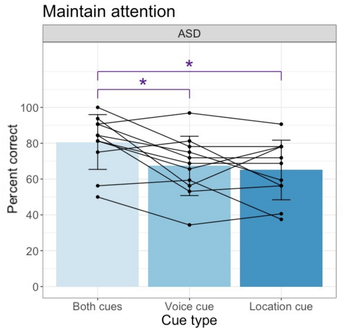

Fig 3. Task performance on maintain-attention trials by cue type for the ASD group ($n = 11$; mean ± 1 SD). Main effect of Cue Type (ANOVA; $F(2,20) = 9.703, p = .001$). Better performance on trials with both cues than trials with a voice cue ($p = .035$) or a location cue ($p < .001$).

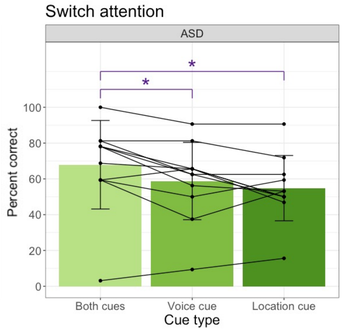

Fig 4. Task performance on switch-attention trials by cue type for the ASD group ($n = 11$; mean ± 1 SD). Main effect of Cue Type (ANOVA; $F(2,20) = 7.420, p = .004$). Better performance on trials with both cues than trials with a voice cue ($p = .046$) or a location cue ($p = .021$).

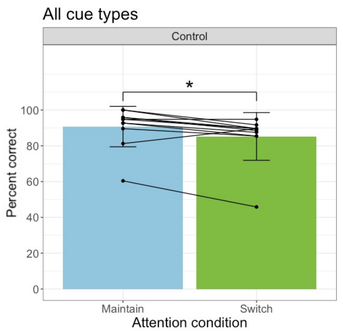

Fig 5. Task performance by attention condition for the control group ($n = 11$; mean ± 1 SD). Better performance on maintain-attention compared to switch-attention trials (paired samples t-test; $t(10) = 3.100, p = .011$).

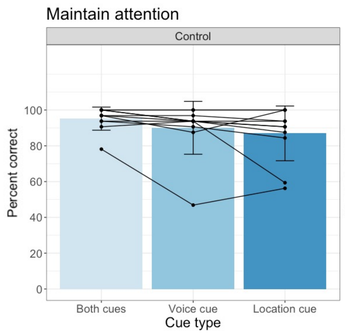

Fig 6. Task performance on maintain-attention trials by cue type for the control group ($n = 11$; mean ± 1 SD). No main effect of Cue Type (ANOVA; $F(2,20) = 3.408, p = .053$).

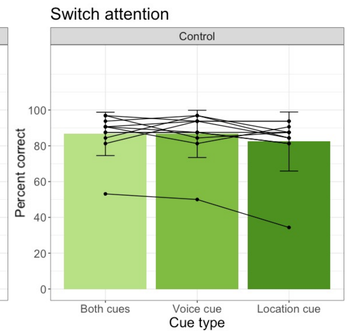

Fig 7. Task performance on switch-attention trials by cue type for the control group ($n = 11$; mean ± 1 SD). No main effect of Cue Type (ANOVA; $F(2,20) = 2.234, p = .133$).

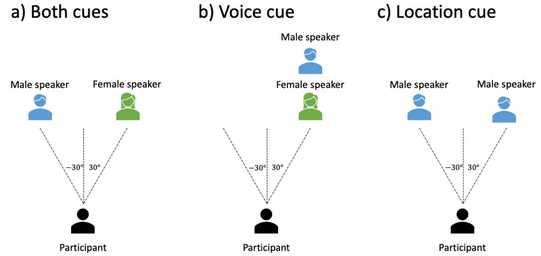

Fig 8. Cue types. a) both cues (male/female voices on the left/right), b) voice cue (male/female voices on the right), c) location cue (same male voice on the left/right).

Conclusion

ASD Group

- No difference in performance on maintain-attention compared to switch-attention trials.
- Better performance on trials with both cues compared to trials with just one cue.

Control Group

- Better performance on maintain-attention compared to switch-attention trials.
- No difference in performance on trials with both cues compared to trials with just one cue.

Discussion

- Communication in everyday life depends on the ability to dynamically shift attention between competing auditory streams.
- In this study, we show that young adults with ASD can use voice and location cues to selectively direct auditory attention, though not as accurately as control participants.
- Compared with control participants, young adults with autism show difficulty maintaining attention on one of two competing speakers.
- Individuals with autism may need more cues to direct auditory attention.
- Our study highlights the importance of understanding auditory attention deployment in ASD and how deficits in auditory attention may contribute to daily life communication challenges.

References

1. Dunlop, W. A., Enticott, P. G., & Rajan, R. (2016). Speech Discrimination Difficulties in High-Functioning Autism Spectrum Disorder Are Likely Independent of Auditory Hypersensitivity. *Frontiers in human neuroscience*, *10*, 401.
2. Reed, P., & McCarthy, J. (2012). Cross-modal attention-switching is impaired in autism spectrum disorders. *Journal of autism and developmental disorders*, *42*(6), 947–953.
3. American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
4. Lord, C., Rutter, M. L., & LeCouteur, A. (1994). Autism Diagnostic Interview—Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24,* 659–685.
5. Lord, C., Rutter, M. L., Goode, S., & Heemsbergen, J. (1989). Autism Diagnostic Observation Schedule: A standardized observation of communicative and social behavior. *Journal of Autism and Developmental Disorders, 19,* 185–212.
6. Lord, C., Rutter, M., DiLavore, P., Risi, S., Gotham, K., & Bishop, S. (2012). Autism diagnostic observation schedule–2nd edition (ADOS-2). *Los Angeles, CA: Western Psychological Corporation*.
7. Wechsler, D. (2011). Wechsler Abbreviated Scale of Intelligence–Second Edition. *San Antonio, TX: NCS Pearson*.