Autistic traits differences in cue-weighting of focus production and perception

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Background: Prosodic focus is realized along multiple phonetic dimensions including f0 (with the highest relative importance), intensity, and duration among measures of voice quality and spectral tilt [1]. However, studies in the prosodic dimension have shown that the relative importance of each cue (i.e., cue-weighting) varies between individuals [2,3]. The factors that motivate these individual differences remain unanswered. Differences in listeners' prosodic perception and production may be due to individual cognitive processing styles. For example, Stewart et al. [4] found that higher levels of autistic character traits indicated by a higher Autism Spectrum Quotient (AQ) score [5] correlated significantly with the ability to better discriminate *low-level* auditory pitch and duration differences for pure tones, but there was no difference for the parameter intensity. The current study examines whether prosodic cue-weighting in production and perception of *high-level* realistic speech stimuli would differ when comparing (non-clinical) populations with varying levels of autistic traits, as indicated by their AQ score differences (ranging from 50 to 200).

Perception and production tasks: We recorded 42 native Canadian English speakers/listeners. To analyze data from the two ends of our AQ scale, we examined prosodic patterns of 18 participants grouped into a high AQ population (highest quartile, AQ > 124) and contrasted them to a low AQ population (i.e., lowest quartile, AQ < 104). We conducted perceptual tasks with stimuli in sentence context (e.g., "*Lynn* and *Neil* gazed at the *moon*"), with one of three possible nouns manipulated with Praat [6] for one of the three prosodic parameters f0, intensity, or duration. These manipulations either corresponded to natural focus production values (*full* condition) [7,8] or to productions below these values (*half* condition). The listener's task was to identify the noun in focus and thus gave a 33.3% chance probability. Mixed effects logistic regressions[1] showed that high AQ participants differed significantly from low AQ participants by their perception of pitch (p=.019*) and intensity (p=.01**), but not duration (p=.158) (see Fig. 1), and, for intensity, only the high AQ participants were more accurate in the full condition than in the half condition (p=0.03*). The *full* condition was significantly different from the *half* one for all three parameters. For the production task, we used very similar sentence material as for the perception task, generating out-of-focus (background), broad focus, or narrow focus conditions. Linear mixed effects models[2] did not show any significant effect of AQ level across any of the acoustic parameters. Results for f0 range approached the 5% significance level (p = 0.054), suggesting that participants with higher AQ scores produce lower f0 ranges (see Fig. 2), and, thus, less prosodic variability compared to low AQ participants.

Discussion: Our results suggest that differing autistic traits have a greater influence on the perception than on the production of focus. For perception, we show that high-AQ individuals were more sensitive to changes in f0 and intensity to mark focus than low-AQ ones, in line with proposals positing that individuals with higher levels of autistic traits are better able to detect fine-grained differences in low-level, purely acoustic stimuli (as also shown in [9]). While no significant differences between AQ groups are observed at the duration level, we found that overall listeners are more sensitive to duration differences than to the other cues (see Fig.1), suggesting possible ceiling effects. Some results for production (i.e., f0) agree with findings showing that speakers with autistic traits show less variability in their production of prosody [10,11], but otherwise our data fails to provide clear evidence for a perception-production link.

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[1] glmer(correct_response ~ AQ_score*half_full_condition+(1|listener))

[2] lmer(intensity/f0/duration ~ focus_condition * AQ_score +(1|speaker)+(1|target))

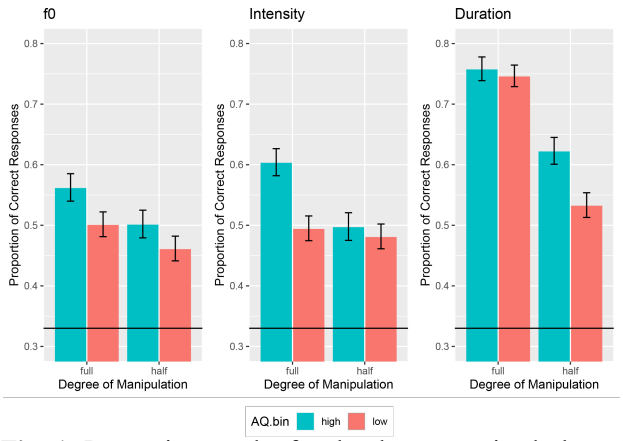

Fig. 1. Perception results for the three examined phonetic parameters f0, intensity and duration differences, either presented in conditions typically found in production data (full condition) or with below threshold values (half condition).

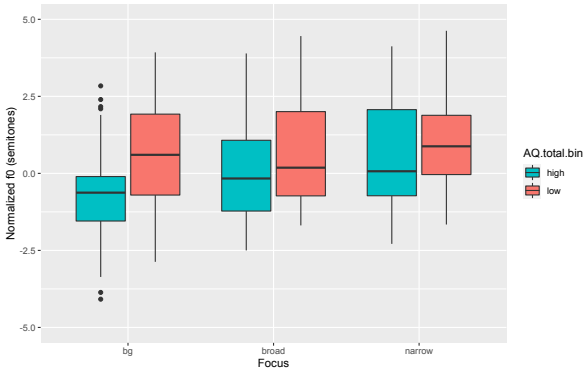

Fig. 2. Production results for the normalized f0 range differences (in semitones) within the focus word, split by focus condition (background = bg, narrow and broad focus), and high versus low AQ bin of the recorded participants.

References

[1] S. Roessig, B. Winter, and D. Mücke, "Tracing the Phonetic Space of Prosodic Focus Marking," *Front Artif Intell*, vol. 5, May 2022, doi: 10.3389/frai.2022.842546.

[2] A. C. L. Yu, "Perceptual Cue Weighting Is Influenced by the Listener's Gender and Subjective Evaluations of the Speaker: The Case of English Stop Voicing," *Front Psychol*, vol. 13, Apr. 2022, doi: 10.3389/fpsyg.2022.840291.

[3] R. Patel, C. Niziolek, K. Reilly, and F. H. Guenther, "Prosodic adaptations to pitch perturbation in running speech," *Journal of Speech, Language, and Hearing Research*, vol. 54, no. 4, 2011, doi: 10.1044/1092-4388(2010/10-0162).

[4] M. E. Stewart, T. D. Griffiths, and M. Grube, "Autistic Traits and Enhanced Perceptual Representation of Pitch and Time," *J Autism Dev Disord*, vol. 48, no. 4, 2018, doi: 10.1007/s10803-015-2517-3.

[5] S. Baron-Cohen, S. Wheelwright, R. Skinner, J. Martin, and E. Clubley, "The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Males and Females, Scientists and Mathematicians," 2001.

[6] P. Boersma and D. Weenink, "Praat: doing phonetics by computer." [Online]. Available: www.praat.org

[7] M. Breen and C. Clifton, "Stress matters: Effects of anticipated lexical stress on silent reading," *J Mem Lang*, 2011, doi: 10.1016/j.jml.2010.11.001.

[8] J. Kim and A. Arnhold, "Prosodic focus marking in Canadian English," in *Proceedings of the International Conference on Speech Prosody*, International Speech Communication Association, 2022, pp. 97–100. doi: 10.21437/SpeechProsody.2022-20.

[9] L. Mottron, M. Dawson, I. Soulières, B. Hubert, and J. Burack, "Enhanced perceptual functioning in autism: An update, and eight principles of autistic perception," *Journal of Autism and Developmental Disorders*, vol. 36, no. 1. 2006. doi: 10.1007/s10803-005-0040-7.

[10] C. A. M. Baltaxe and J. Q. Simmons, "Prosodic Development in Normal and Autistic Children," in *Communication Problems in Autism*, 1985. doi: 10.1007/978-1-4757-4806-2_7.

[11] C. Lord, M. Rutter, A. Le Couteur, and R. Free Hospital, "Autism Diagnostic Interview-Revised: A Revised Version of a Diagnostic Interview for Caregivers of Individuals with Possible Pervasive Developmental Disorders 1," 1994.