The Effect of Cognitive Processing Style on the Perceptual Compensation of Stop Voicing for Place of Articulation

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Introduction

Perceptual Compensation in Speech Perception

- Speech perception requires correctly extracting individual segments and words from the acoustic stream
- This occurs in spite of phonetic variation from, for example, lexical and phonetic variants, as well as speaker gender and dialect[5,6,7]
- Accommodating for phonetic variation is known as perceptual compensation

Variation in Speech Perception

- In spite of perceptual compensation, there are differences in speech perception[5]
- Some of this can be accounted for by the listener's native language or dialect[5,6]
- However, individual differences also exist within dialect groups[6,7]
- Question: What underlies within-dialect differences?

Can **Cognitive Processing Style** Account for Individual Differences?

- The Autism Quotient (AQ)[1] has been used to correlate cognitive processing style with individual differences in perceptual compensation
  - AQ measures traits associated with autism; however it is not diagnostic
  - **Individuals with high AQ scores tend to be detail oriented while those with low scores tend to look at the larger picture**
- Hypothesis[12]: If the cognitive processing captured by AQ is associated with language processing:
  - **High AQ** individuals should pay more attention to lower level phonetic details
  - **Low AQ** individuals should pay more attention to higher level information and the overall message
- Previous studies show the expected correlations between AQ and perceptual compensation for co-articulation[10] and lexical effects[12]

Current Study

- Question: Does the correlation between AQ and perceptual compensation extend to the effect of place of articulation on stop voicing perception?
  - Production[8]
    - **Voicing**: Voice onset time (VOT) is longer for voiced stops (/b d g/) than voiceless stops (/p t k/)
    - **Place of Articulation**: VOT is longer for velar stops (/k g/) than alveolar (/t d/) and labial (/p b/) stops
  - Perceptual Compensation in Perception[8]: Listeners perceive /g/ at higher VOTs than /d/ and /b/
- Hypothesis: If AQ is correlated with perceptual compensation for place of articulation in stop voicing perception, high AQ listeners should perceive /g/ at higher VOTs than low AQ listeners
- Methodology: Forced-choice word identification task with VOT continua for each place of articulation

Methods

- Participants: 41 native speakers of English
- Stimuli: Three 10-step VOT continua (one per place of articulation) = 30 stimuli
  - Synthesized in Praat[3] from natural recordings of a male native speaker of American English
  - Script by Yoonjung Kang, based on Toscano & McMurray (2015)'s method

AQ \ Sex	*F*	*M*	Total
High AQ (>64.1)	8	11	**19**
Low AQ (<64.1)	17	5	**22**
Total	**25**	**16**	**41**

VOT (ms)	1	10	19	27	36	45	52	64	71	80
	Voiced									Voiceless
Labial	bot									pot
Alveolar	dot									tot
Velar	got									cot

- Procedure: Listeners heard each stimulus item and had to rate whether they thought it was male or female on a 6 point scale (Figure 1)
  - **Task 1**: Demographic and language background questionnaire
  - **Task 2**: Forced-choice word identification task
    - 5 block, each containing all 30 stimuli randomized
    - 1st block was for training, the remaining 4 were analyzed
  - **Task 3**: AQ Questionnaire[1] (4 point Likert-type scale response)
- AQ Questionnaire Scoring: 4-point scale ranging from 0 (non-autistic trait response) to 3 (Autistic trait response) for each item, for a total range of 0-150
  - For graphs, AQ is divided into high and low groups based on mean AQ (64.1)

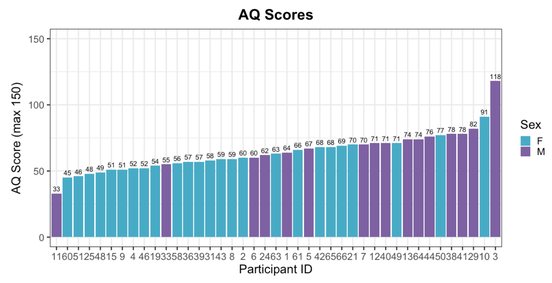
Results

Regression Model

- A mixed effects logistic regression model was built in R[9] using the glmer()[2] function
  - **Response variable**: voicing identification (voiced or voiceless)
  - **Predictor variables**: place of articulation (Helmert coding; labial vs alveloar, velar vs others), VOT, AQ, sex (F: -0.5, M: 0.5), and their interactions
  - **Random intercepts**: participant, item
- Significant effects: place of articulation (velar vs others), VOT, VOT*sex, place of articulation (velar vs others)*VOT*AQ, place of articulation (velar vs others)*VOT*AQ*sex, place of articulation (labial vs alveolar)*VOT*AQ*sex

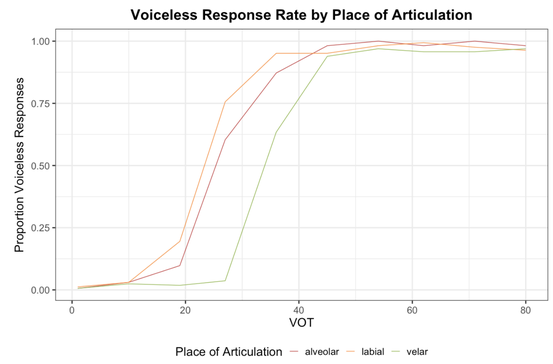
Gender & AQ are Correlated

- Males tend to have higher AQ scores than females
- Consistent with previous findings[10,12]
- Significant in a simple linear regression



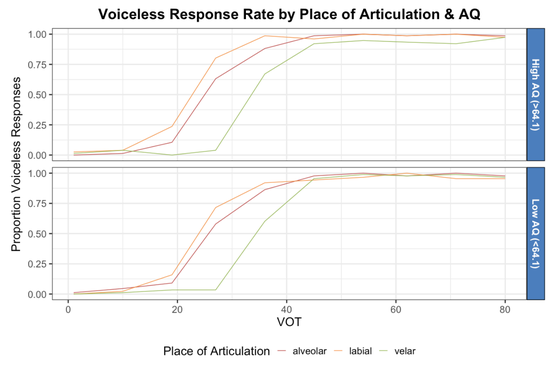
Responses by **VOT & Place of Articulation**

- Participants perceive voiced stops at higher VOTs for velar stops than for alveolar stops
- i.e. Participants perceive /g/ at higher VOTs than they perceive /b/ & /d/
- Expected based on previous results[8]



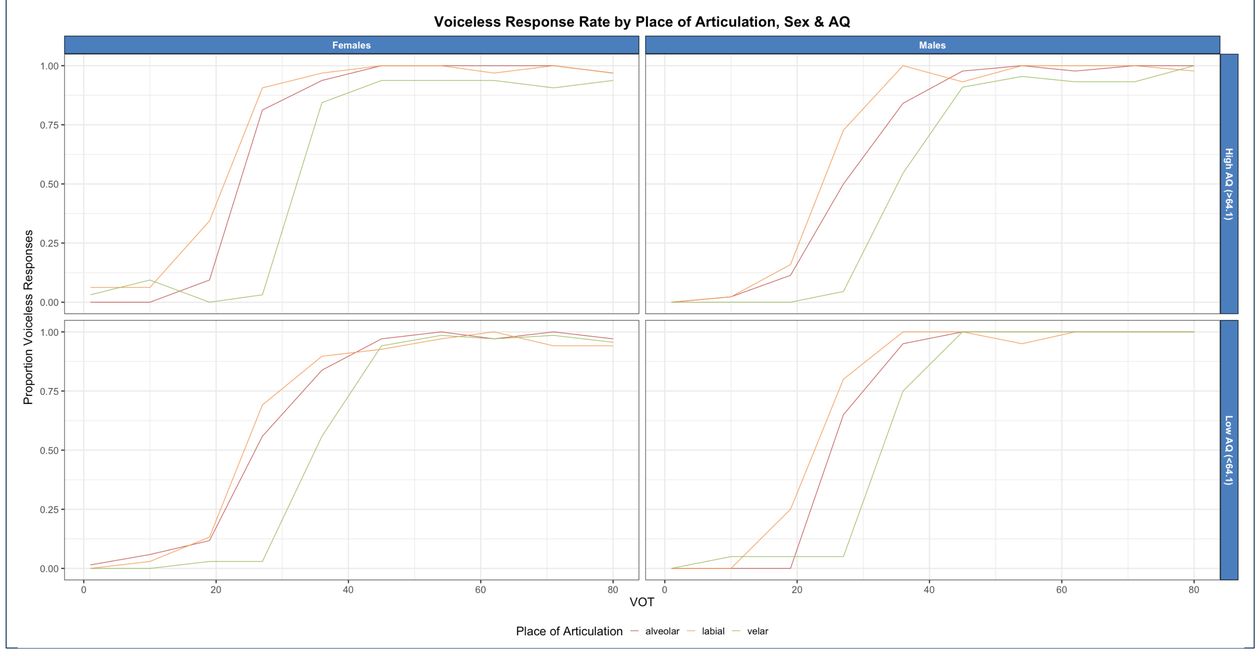
Responses by **VOT, Place of Articulation & AQ**

- High AQ participants perceive voiced stops more often across the continuum than low AQ participants
- Consistent with the idea that they pay more attention to phonetic detail[10,12]



Responses by **VOT, Place of Articulation, AQ & Sex**

- High AQ females appear to transition faster from voiced perception to voiceless perception than the low AQ females and males
- They are more categorical, jumping directly from voiced to voiceless categorization around the 30ms VOT mark, whereas other groups are less categorical at this VOT
- This is also true of the alveolar continuum, but less so of the labial continuum



Conclusion

- All listeners show perceptual compensation for stop place of articulation
- However, high AQ listeners display more compensation across the continuum than low AQ listeners, suggesting they pay more attention to low level phonetic details
  - Consistent with the findings of Stewart and Ota (2008) and Yu (2010)
  - Supports the hypothesis that high AQ listeners will perceive /g/ at higher VOTs than low AQ listeners
- Furthermore, high AQ females are more categorical than other listeners in their categorization of stops with more ambiguous VOTs
  - It's not clear why. One possibility is that it is an interaction of females' linguistic ability[4] and high AQ individuals' attention to phonetic detail

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