Individual Differences in Perceptual Compensation and Lexical Effects and Implications for Sound Change

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Introduction.

Studies on sound change have long observed that many changes are conditioned by phonetic factors such as articulatory and perceptual constraints. One theory that incorporates this observation is Ohala's hypocorrection theory (Ohala 1993), which argues that some sound changes occur when listeners fail to perceptually compensate for variation caused by coarticulation and therefore misperceive the intended sound (For *Perception compensation* (PC), see Mann 1980 and the following work). Following Ohala, Yu (2010) used an individual-difference approach to explore how sound change is actually introduced and spread. Assuming that sound change is most likely to occur when some individuals (the innovators) in a community systematically do hypocorrection and meanwhile possess the social resources to spread new variation, these studies set out to seek individual-difference cognitive dimensions that link both systematic under-compensation and differences in individuals' social traits. Yu (2010) found that individuals who are low on the Autism Spectrum Quotient (AQ) compensate minimally for coarticulation, suggesting these people are likely to introduce changes, according to Ohala's theory. Since low AQs are also related to personality traits that contribute to one's active social interactions and well-connected social networks (Yu 2010), they are also ready to spread the new variants. Thus, low AQ people are the most likely innovators of sound change.

However, the assumption in Yu's study (following Ohala) that failure in PC necessarily results in misperception can be challenged. Speech is redundantly cued and higher-level information, such as lexical knowledge, provides listeners with plenty of chances to correct potential misperception. For example, the Ganong effect demonstrated that an ambiguous sound between *k and g* in *_ift* tends to be perceived as embedded in a real word *gift* rather than *kift* (Ganong 1980), suggesting lexical information can shift perceptual boundaries. A study has found a negative correlation between AQ and the degree of lexical effects (LE) (Stewart & Ota 2008). This study and Yu (2010) together suggest that low AQ people have low PC while high LE. If this is the case, chances are that they can use lexical information to restore the intended sound even if they fail to compensate and thus cannot be the innovators. The introduction of a sound requires individuals who are poor at using both acoustic and higher-level (lexical) contextual information to factor out variation. Their social profile decides whether the introduced variants will spread to community to initiate a sound change.

Methodology.

To take a further step in exploring the relation between linguistic behaviors and social profiles, this study investigated how individuals with different AQ differ in their degree of PC and LE. 101 people took a screening test using a questionnaire that tests one's autistic level (Baron-Cohen et al. 2001), from which the top and bottom portions were selected to form a high AQ group (mean AQ=34.47 out of 50, sd=4.0) and a low AQ group (mean AQ=12.87 out of 50, sd=2.8) (15 people in each). PC and LE were tested using two identification tasks. The stimuli in the PC task were *alga-arda,* which were deliberately set to differ from those in Yu (2010). The Ganong effect paradigm was used to measure the degree of LE using the classic *kiss-gift* stimuli. In addition, since Yu (2010) found a correlation between the ability to switch attention and PC, a Stroop task was used to evaluate the ability to control attention and suppress interference (Stroop 1935). The research questions are: 1) whether the relation between AQ and PC can be generalized to other linguistic contexts; 2) whether people with different AQ also differ in LE; 3) how individuals' PC relates to LE. The findings help to answer whether individuals with certain social traits tend to misperceive and thus introduce and spread new variants.

Results.

For both identification tasks, individual's identification functions were obtained by calculating the percentage of /ga/ or /gi/ responses at each step. Two participants were excluded from analyses involving LE since their correction rates were below 50% at endpoints for both continua. The identification functions of PC and LE of the two groups are given in Figure 1 and

Figure 2, respectively. For each panel in Figure 1 and 2, the difference between the two identification functions in the two conditions indicates the degree of PC or LE. The two figures show that the high AQ group has higher degree of both PC and LE. To examine the statistical reliability of these observations, data of PC were subject to 2 (contexts) x 9 (steps) x 2 (groups) mixed ANOVA using the group average /ga/ responses as the dependent factor. An interaction between GROUP and CONTEXT ($F(1, 28)=8.84$, $p=0.006$) was found, suggesting that the differences of /ga/ responses in the two contexts—an indication of the degree of PC—differed significantly between the two groups. This result is consistent with Yu's (2010) finding of a positive correlation between AQ and PC. A similar mixed ANOVA analysis was done on LE and interaction between GROUP and CONTEXT is found to be not significant ($F(1, 26)=3.525$, $p=0.072$). Yet, since the p-value only slightly exceeds 0.05, a significant difference may be obtained when including more participants. This may be left to future studies.

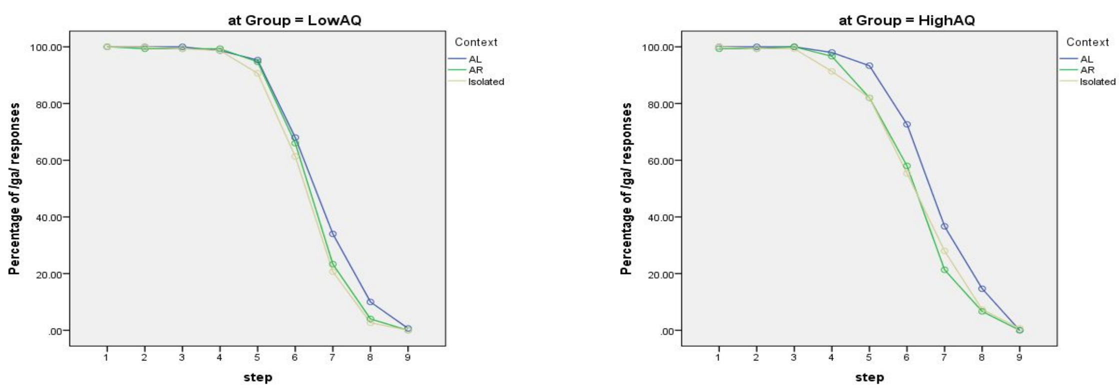

Figure 1. Identification functions of PC in the two groups

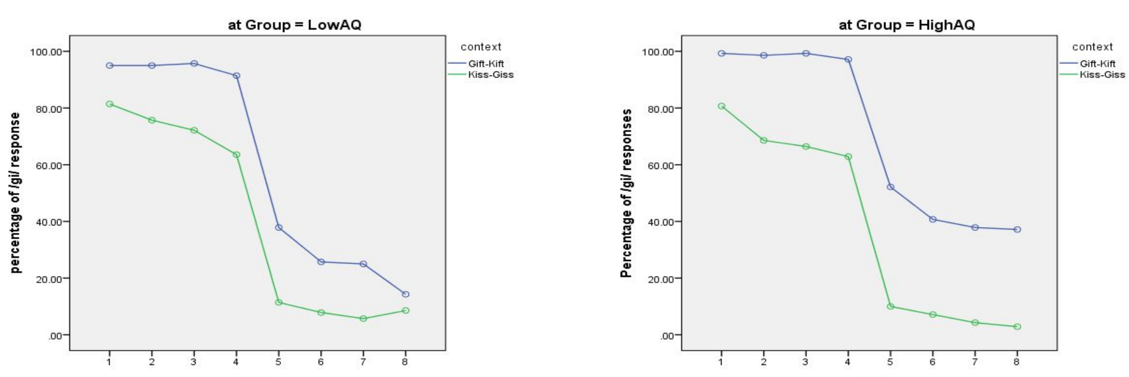

Figure 2. Identification functions of LE in the two groups

Given a similar pattern of PC and LE across the two groups, a Pearson correlation was conducted between the two tasks, using the difference between the two identification functions as indicators of degree of PC/LE (termed as identification shift (IS)). A moderate positive correlation was obtained between the two factors (r=0.455, p=0.015, n=28), confirming that individuals compensating less were also less subject to the lexical influence. To further identify the individuals who have both low PC/LE, the averages of IS in PC/LE were calculated and those whose PC/LE were below the averages were categorized as having low PC/LE– the group of most likely innovators. As can be seen from the left bottom of Figure 3, out of the 14 people in each group, 8 from the low AQ group (two overlap) and 2 from the high AQ group fall into this category, suggesting that people who show low PC and LE are more likely to have low AQ.

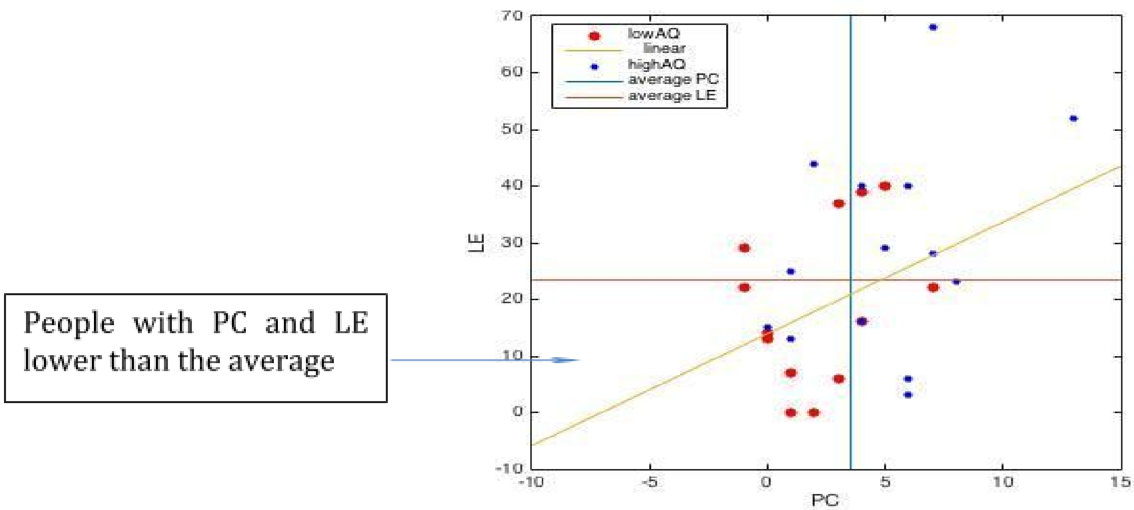

Figure 3. Correlation between PC and LE and categorization using LE/PC information.

Finally, the relationship between Stroop task and PC/LE is examined with Pearson correlation. The Stroop scores were found to correlate with LE (r=0.345, p=0.036, n=28) and marginally with PC (r=0.298, p=0.055, n=30). Since lower score indicates better ability to control attention, the positive correlation suggests that people with better such ability are less influenced by contextual information. To exclude the influence of this ability on the group difference in PC, the group difference was further analyzed by conducting an ANCOVA with the PC as the dependent variable and the Stroop scores as the covariate. The p-value remains the same ($p=0.006$) and no main effect of the Stroop scores was found ($F=2.94$, $p>0.05$). This suggests the attention control ability does not explain the group difference in PC.

Discussion.

Taken together, the results show that low AQ people indeed compensate less than the high AQs, although not all of them necessarily tend to misperceive since some are good at making use of lexical information. Nevertheless, people who do worse in both types of normalization, that is, tend to take the face value of a coarticulated sound despite of the phonetic and lexical contexts, are likely to score low on the autistic spectrum. On the one hand, these people may introduce new variants through constant misperception of speakers' speech; on the other hand, most of these people are in a good position to spread new variants since low AQ is associated with such social traits. They seem to be the best candidates as innovators of sound change.

However, precaution needs to be taken in reaching this conclusion for several reasons. First, the result of the relationship between AQ and LE is different from the previous studies (Stewart & Ota 2008). This may be due to several differences between the two studies, such as the composition of the participants, criterion for valid data, and so forth. Further study with more participants is needed to test which results can be replicated. Second, the correlation between the Stroop task and LE points to the possibility of task-specific artifacts: the identification task requires the listeners to focus their attention on the phone level and may involve suppression of contextual influence; this may explain why people with better ability to control attention are better at identifying the exact signals. Although this factor cannot explain the group difference in PC, it draws attention to the discrepancy between lab experiments and daily communication. It will be interesting to see if the same patterns will hold when distraction tasks are present simultaneously with the perception tasks. Third, it is assumed here that variation is factored out as noise and the stored representations are categorical. Yet, literature on exemplar models demonstrated that listeners have access to and store more detailed phonetic information in memory, including the previously assumed "noise" (Pierrehumbert 2001). The exact nature of the stored representations, however, is not clear. For both PC and LE, the stored representation can either be the perception resulting from normalization, that is, after noise already being factored out, or contain richer information that include the coarticulated variation. If the latter case is true, individual differences in PC and LE may not matter to sound change, since no matter how much one factors out the variation in categorization, the stored information and production will be the same. Further studies are called for to examine the actual production of people with different AQs. This study, although not answering all these questions, provides a great chance to raise challenges to the previously held assumptions and work out ways to address these problems, therefore makes contribution to the next step in this line of study.

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