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Advantage Accented? Listener Differences in Understanding Speech in Noise

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Abstract
Cross dialectal communication results in poorer performance than within-dialect communication in a variety of listening tasks. However, some listeners appear to be less affected than others, and this paper explores the factors behind interlistener variation in a listening in noise task. 63 native speakers of American English transcribed 120 HINT sentences, which were presented mixed with noise at -3dB SNR. The sentences had been recorded by six young males: two speakers of Standard American English (SAE), two speakers of Southern American English (STH), and two non-native, L1-Chinese speakers (NNS). Participants were asked to transcribe what they heard as best they could, and were scored on keywords correct. While everyone did much worse with NNS than SAE and STH, participants who self-reported being accented did significantly significantly better with STH (and trend better with NNS) than those who reported being unaccented. Additionally, participants who reported being in a good mood did significantly better with SAE sentences than speakers who reported being in a bad mood. Finally, there was a main effect of extraversion, such that extraverts did worse overall than introverts. The results suggest that individual differences account for some of the interlistener variation in cross-dialectal listening task, and exploring these metrics further may help us understand the cognitive mechanisms involved in processing unfamiliar dialects.

Advantage Accented? Listener Differences in Understanding Speech in Noise

Abby Walker*

1 Introduction

Cross-dialectal communication has been likened to listening to degraded speech signals (Mattys et al. 2012, Van Engen and Peelle 2014): effective communication is possible, but more difficult and more cognitively taxing than within-dialect communication. However, not all listeners appear to be as equally challenged when processing unfamiliar dialects, and this paper presents a preliminary exploration into reasons behind inter-listener variation.

It is very clear that a listeners' linguistic experience mitigates their performance in a variety of listening tasks, so that more familiar dialects are processed more easily than less familiar dialects (i.e., Clopper and Bradlow 2008, Nygaard et al. 1994, Sumner and Samuel 2009, Walker 2014). What is perhaps more interesting is the way in which dialectal experience may affect linguistic processing more generally, so that varied experience improves performance with all dialects, even unfamiliar ones. Clopper and Pisoni (2006) find that "army brats" are better than "homebodies" at identifying dialects, even if they have not lived in a given dialect region. Baese-Berk et al. (2013) find that listeners who are exposed to L2 English speakers with a variety of L1 backgrounds are more accurate at transcribing an L2 speaker with a novel L1 variety than listeners who had less varied training. In Clopper and Walker (to appear), we find evidence in a phonological priming task that listeners who have lived in multiple dialect regions show weaker facilitation for matching primes and weaker inhibition for competing primes compared to listeners who have not lived in multiple dialect regions. Critically, these effects may be independent of whether listeners are familiar with the dialects in question or not; rather, people who have lived in multiple dialect regions may simply have different listening strategies and/or less robust category boundaries than monodialectal listeners.

Turning to the sociolinguistic literature, we find discussions of a different way in which experience might influence speech processing: namely, that due to having a non-standard dialect, some listeners carry an unfair proportion of the communicative burden, being responsible for both how well they hear, and how well they are heard (i.e., Lippi-Green 1997). An open question is whether this burden fundamentally affects how these listeners process accented speech, or speech in general. There are a few reasons why we might expect to observe such an effect. First, since non-standard speakers are exposed to the standard variety through institutions and media, they could be (at least passively) bidialectal, and their varied linguistic input may have fundamentally shaped their cognitive representations and processing strategies. An alternative reason there could be differences is attentional: since non-standard speakers are responsible for successful communication, their default setting may be to listen more attentively than standard speakers do.

Relatedly, attitudes and mood could also explain interlistener processing differences. Ethnolinguistic expectations/prejudices have been shown to influence not only how accented a speaker is rated, but also how well listeners understand them (Kang and Rubin 2009, Rubin 1992). In the shadowing paradigm, participants' valence towards a speaker can affect the level of convergence they make toward their interlocutor or model (Babel 2010, Bourhis and Giles 1977, Yu et al. 2013). And in a speaker rating task, Campbell-Kibler (2010) finds that participants who self-report being in a bad mood rate speakers more negatively, and other work has found that mood affects syntactic processing (see van Berkum et al. 2013 for a review).

A final consideration is the role that *individual differences* may play, a term that has become a catch-all for the non-demographic factors, usually cognitive and personality-based, that can influence behavior. Looking at neurotypicality, recent work suggests that there are differences in per-

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ceptual acuity based on a listener's Autism Quotient scores (i.e., Mottron et al. 2006, Yu 2010), which impacts convergence in a shadowing task (Yu et al. 2013). In terms of personality type, Yu et al. (2013) find that the higher a person scores on the Big Five personality type *openness* (Goldberg 1990), the more that they will accommodate in a shadowing task; Boland and Queen (2016) find that *agreeableness and extraversion* mediate how harshly readers judge prescriptive errors; and Denis (2015) has argued that gregariousness may be a factor in whether a speaker uses innovative variants in a change in progress.

1.1 Listening in Noise

In listening in noise experimental paradigms, participants are played speech that is mixed with noise, and are scored on the number of keywords they correctly transcribe. Recognizing words in noise is obviously more difficult than recognizing words in the clear, and it gets harder as the SNR decreases (i.e., Clopper and Bradlow 2008) and if the competing noise is more similar to the signal, so that competing speech is a more effective mask than white noise (Danhauer and Leppler 1979, Parikh and Loizou 2005), and competing speech in the same language is more difficult than competing speech in a different language (Freyman et al. 1999, Van Engen and Bradlow 2007). This latter phenomenon highlights the fact that noise can interfere with signal processing not simply because of energetic masking, where parts of the frequency spectrum are masked (also called *peripheral masking*), but also because of informational masking, where the listener has trouble separating the signal and the noise and/or not paying attention to the noise (also called *central masking*).

While comprehension of any speech type is negatively impacted by noise, researchers have found a larger effect of noise on the intelligibility of unfamiliar, and/or non-native dialects (Munro 1998, Nygaard et al. 1994, Walker 2014), and further, that increased experience with a dialect improves performance within an experimental session (Bradlow and Bent 2008), and across a lifetime (Walker 2014; though see Evans and Iverson 2007).

However, recent research has suggested that other factors, beyond familiarity, influence how well a given dialect is understood in noise. First, the prestige of the dialect may impact the size of the noise penalty. Clopper and Bradlow (2008) compare listeners' performance in noise with 4 American dialects of English: General American, Southern, Northern, and Mid-Atlantic, with listeners finding them relatively easier to harder in that order. Critically, this is despite the fact that the study was run in the Northern cities dialect region, and is independent of the dialect background of the speaker (Northern students did not do better with Northern voices). In Walker 2014, I find that while British English listeners have a clear own-dialect advantage when listening to English and American speakers in noise, American listeners do not (that is, they do equally well with English and American speakers). Some of this effect may be due to the stimuli used in the study, but patterns in the data and comments from my participants led me to argue that the relative prestige of British and American English was at least partly responsible for this asymmetry.

Second, expectations about the listener and/or dialect have been shown to effect performance in noise: both McGowan 2015 and Babel and Russell 2015 find that leading participants to believe a speaker was Asian or Caucasian affected how well they processed their speech in noise. In the former study, the masked English was read by a non-native, L1-Chinese speaker, and telling participants the speaker was Asian helped them in noise compared to telling them the speaker was Caucasian. In the latter study, the masked English was read by native speakers of Canadian English, and telling participants the speaker was Asian instead of Caucasian made them worse. While this latter effect has been interpreted as a drop in effort when participants believe they are listening to a non-native speaker (Kang and Rubin 2009, Rubin 1992), the fact that Babel and Russell find that listeners with Asian networks are more negatively impacted by being told the speaker is Asian leads them to argue that their effects appear to be about ethnolinguistic expectations.

In the current study, I investigate whether there are listener differences, beyond familiarity, that predict performance in a listening in noise task, with a particular interest in the way that such differences might interact with the dialect of the speaker. Specifically, participants were played speech from speakers of Standard American English, Southern American English, and L1-Mandarin L2-English, and the accuracy of their transcriptions was modeled as a function of speaker dialect and personal attributes gathered from a post-task questionnaire.

2 Methodology

2.1 Stimuli

Six males recorded the stimuli for this study. Two were speakers of Standard American English (SAE), two were speakers of Southern American English (STH, from Southern Virginia), and two were non-native, L1-Mandarin speakers of English (NNS). Each speaker recorded 120 sentences from the list of HINT sentences (Nilsson et al. 1993). Sample sentences are below in (1-3). Recordings were rms equalized and mixed with speech-shaped noise at -3dB SNR. For each file, the noise began 500 ms before the sentence began and continued 500 ms after it ended.

(1) The boy{boys} fell from the window{windows}.
(2) The puppy{puppies} played{play, plays, playing} with the ball{balls}.
(3) The janitor{janitors} swept the floor{floors}.

Three to four content words in each sentence were identified as keywords. Keywords are underlined in the sample sentences above. An *a priori* list of acceptable variants was created, so that if listeners answered with a homophone, or an inflected form of the keyword, that would count as a correct answer. These are bracketed in examples (1–3) above. Scoring was automated using an R. script, and as part of this process spelling errors were identified and corrected, so that they would not count against participants' accuracy.

2.2 Experiment Design

Six lists were created in E-Prime, so that a given participant would hear all 120 HINT sentences only once (20 from each speaker), but that across participants, each sentence would be heard from all six speakers. Participants were asked to transcribe what they heard as best they could by typing their answers onto a keyboard. After completing the listening in noise part of the experiment, participants were played a sentence in the clear twice from each speaker, and were asked to 1) transcribe the sentence, and 2) to rate the speaker in terms of how educated, friendly, and accented they sounded.

Following these listening tasks, participants answered demographic questions. They then completed a survey consisting of 89 Likert scale randomized questions that included ten questions for each of the Big Five personality traits: *openness, neuroticism, conscientiousness, agreeableness* and *extraversion.* These questions were taken from the IPIP representation of the Goldberg (1992) markers for the Big-Five factor structure.[1] The remaining 39 questions are listed below, and covered topics such as participants' experiences as being (un)accented (4–26), their linguistic prescriptivism (27–33), their attitudes to Southern accents (34–35) and Asian immigrants (36–37), and their current mood (38–42).

(4) I have an accent.
(5) People always comment on my accent.
(6) People tell me they like the way I speak.
(7) People tease me about my accent.
(8) Other Americans sometimes have trouble understanding me.
(9) People often misunderstand me.
(10) I often have to ask people to repeat themselves.
(11) I have trouble understanding people with unfamiliar accents.
(12) I have trouble understanding people with accents.
(13) People often ask me to repeat myself.
(14) I consciously changed my accent since starting college.
(15) I make a conscious effort to make my speech intelligible.
(16) I make a conscious effort to make sure people don't make fun of me for my accent.
(17) I switch how I speak depending on who I'm talking to.

[1] See http://ipip.ori.org.

(18) I switch how I speak depending on the context.
(19) I grew up speaking Standard American English.
(20) People in my hometown have strong accents.
(21) People in my family have strong accents.
(22) I don't like the accent I grew up speaking.
(23) I like my accent.
(24) I have close American friends with strong accents.
(25) I have close friends who are not native-speakers of English.
(26) People can tell my ethnicity based on how I talk.
(27) There are right and wrong ways to speak.
(28) I hate it when people make grammatical errors.
(29) I correct people when they make grammatical errors.
(30) Schools should do a better job of teaching people proper English.
(31) People who immigrate to America should learn English.
(32) People who immigrate to America should only speak in English in public spaces.
(33) I like foreign accents.
(34) I like Southern accents.
(35) People with Southern accents sound stupid.
(36) There are too many immigrants from Asia in America.
(37) There are too many students from Asia at Virginia Tech.
(38) I was in a good mood before starting this experiment.
(39) I am in a good mood right now.
(40) Today is going well.
(41) I'm having a bad day
(42) I am in a bad mood right now.

2.3 Participants

The experiment was run at Virginia Tech, Blacksburg, VA. The data from 63 native speakers of American English (13 male, 50 female), aged 18–34 (median 21), with no reported hearing problems, are included in the analysis below. Based on where they had lived prior to age 18, using dialect boundaries in Labov et al. 2006, participants were categorized as coming from one of four regional backgrounds: 25 had only lived in the South, 2 in the North, 7 in the Mid-Atlantic, and 29 were mobile (they had lived in 2+ dialect regions, including overseas).

Participants were given a mean score on each of the Big Five personality types. For the other 39 Likert questions they answered (i.e., 4–42), I performed factor analysis to find the latent variables, following the guidelines in Weatherholtz et al. 2014. This analysis suggested there were six latent variables: *mood* (loading >0.5 or <-0.5 on questions 39, 40, 41, 42), *accentedness* (4, 5), *accent shame* (22, 23), *intelligibility* (9, 13), *pro-English bigotry* (27, 31, 32, 36), and *Southern accent attitudes* (34, 35).

3 Results

The mean proportion of keywords correct for each sentence was 53% (N = 7560). Figure 1 shows how the dialect of the speaker affected performance; there is a dramatic difference in the number of keywords correct for the SAE speakers (mean=61%) and the STH speakers (60%) compared to the NNS speakers (35%).

For statistical testing, the keywords correct were empirical logit transformed for analysis. I built a mixed linear effects model with transformed proportion correct as the dependent variable, participant and sentence as the random effects (with slopes for speaker), and I tested the fixed effects of trial number, and speaker dialect in interactions with participant dialect, the big five personality types, *accentedness, pro-English bigotry, mood, intelligibility*, *accent shame*, and *Southern accent attitudes.* The model was fit in a step-down process using model comparison.

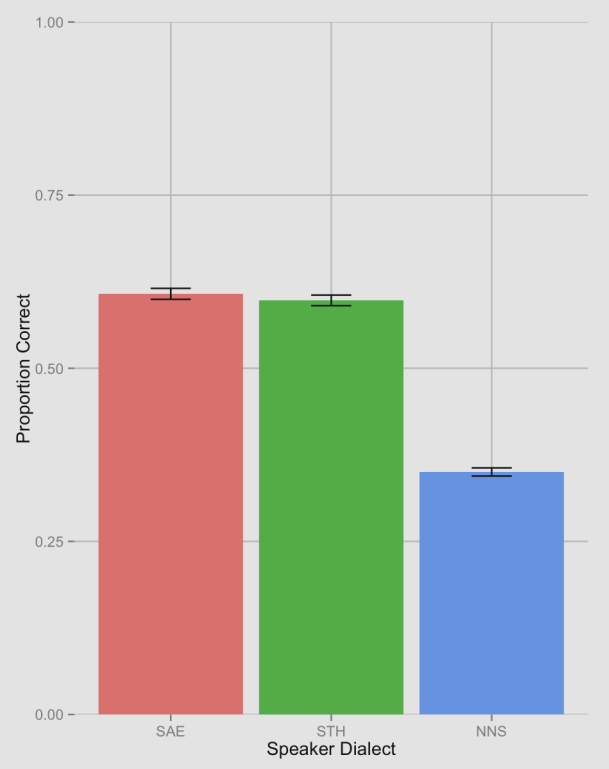

Figure 1. Proportion of keywords correct, by speaker dialect.

	Estimate	Std.Error	t value	p value
(Intercept)	0.1440	0.1373	1.049	0.2942
Mood	0.1317	0.0682	1.93	0.0536
Speaker = NNS	-0.9842	0.1147	-8.578	<0.001
Speaker = STH	0.1644	0.1143	1.438	0.1505
Extrovert	-0.0879	0.0390	-2.257	0.0240
Accentedness	-0.0199	0.0395	-0.504	0.6143
Trial	0.0065	0.0009	7.008	<0.001
Mood:Speaker = NNS	-0.1532	0.0689	-2.223	0.0262
Mood:Speaker = STH	-0.1351	0.0686	-1.969	0.0490
Accentedness:Speaker = NNS	0.0613	0.0411	1.493	0.1355
Accentedness:Speaker = STH	0.0897	0.0408	2.198	0.0280

Table 1. Summary of fixed effects in best-fit lmer model.

The best-fit model (Table 1) revealed a main effect of trial number (participants improve over time), and *extroversion* (more extroverted, less accurate). Speaker dialect was significant in two independent interactions: first, in an interaction with participants' mood, and second, in an interaction with participants' self-reported *accentedness*. For the *accentedness* interaction, while everyone did much worse with NNS than SAE and STH, participants who self-reported being accented did significantly better with STH than those who reported being unaccented. They also trend at being better with NNS, but it is not significant (Figure 2, left panel). The *mood* interaction tells us that participants in a good mood do marginally better with SAE voices than listeners in a bad

mood, but critically, do comparatively worse with NNS and STH voices than listeners in a bad mood (Figure 2, right panel).

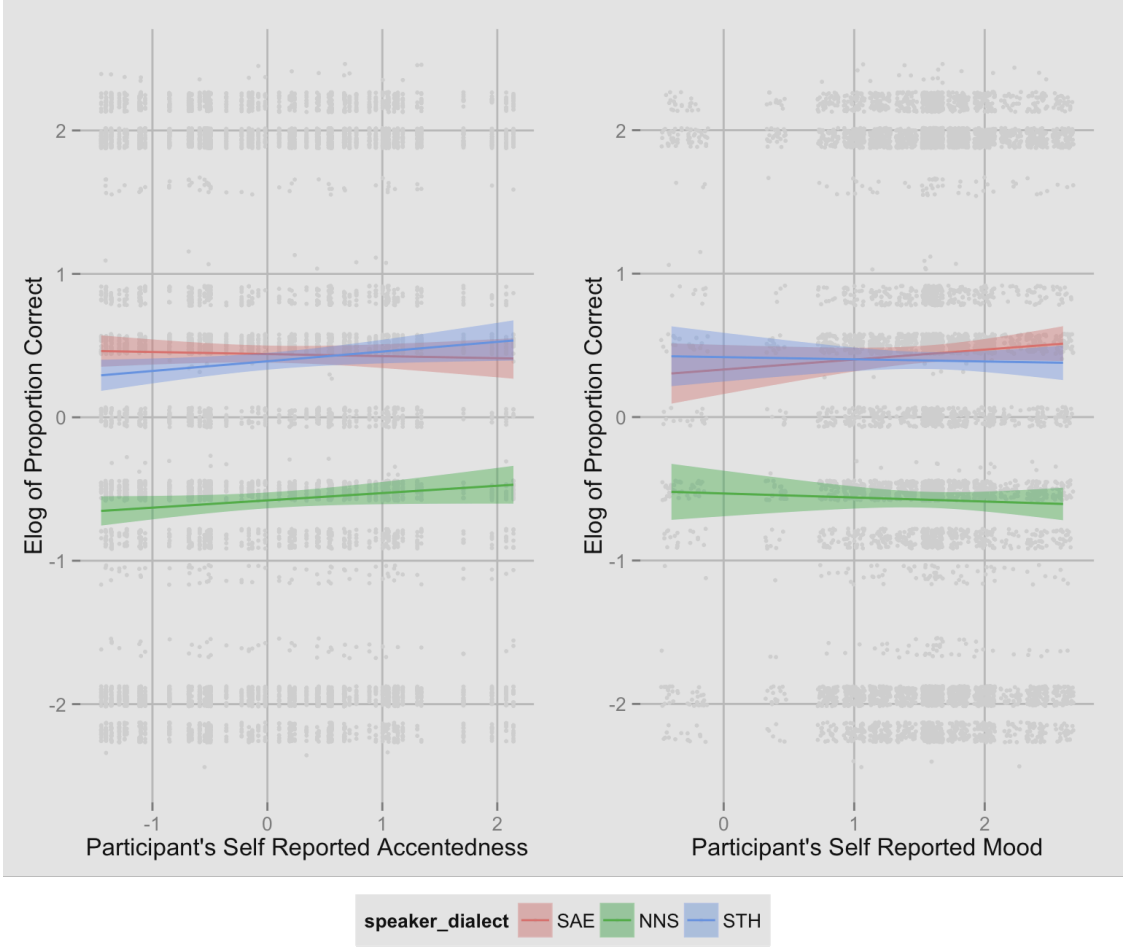

Figure 2. Transformed proportion correct as a function of speaker dialect and listener's self-reported *accentedness* (left panel), and their self-reported *mood* (right panel).

4 Discussion and Conclusion

The fact that listeners performed worse with non-native speech replicates previous findings (i.e., Munro 1998), though the fact that the listeners in this study do equally well with Southern and General American accents contrasts the findings of Clopper and Bradlow (2008), since their listeners performed worse with Southern accented speech at both -2dB and -6dB SNL. That study was conducted in the North (with Northwestern students) and did not include listeners who grew up exclusively in the South, while this study was conducted in the South (with Virginia Tech students), and a third of listeners grew up exclusively in the South; in short, this difference is likely to be the result of different levels of familiarity with Southern accents in the two populations. However, Clopper and Bradlow also found an advantage for General American dialects over Northern dialects (in fact, the Northern dialect penalty was larger than the Southern one), despite their study being run in the North, with a third of their participants having grown up exclusively in the North. That is, they found that their listeners did better with the standard dialect than the local dialect, and we find no such difference.

The main finding from this study, and its namesake, is that participants who self-report being accented are more accurate at transcribing Southern speech than unaccented participants are. Since this study was conducted at a university in Southwest Virginia, one question is whether this is a

familiarity effect: if participants who report being accented have Southern accents, then it would not be unsurprising based on previous literature if they did better with their own accent in noise than unfamiliar participants. Methodologically, this could suggest that rather than assigning dialectal experience based on where participants had lived, we might better evaluate it by looking at their speech (self-reported, or independently measured through acoustic or perceptual means) (cf. Evans and Iverson 2007).

The interpretation of the *accentedness* effect as being about familiarity cannot be ruled out at this stage, but there is evidence that it is not the entire explanation. First, the top-third most *accented* speakers in the study did not all grow up exclusively in the South; while 9 were Southern (36% of Southern participants), 7 were Mobile (24% of Mobile participants), 4 were Mid-Atlantic (57% of Mid-Atlantic participants), and 1 was Northern (50% of Northern participants). Second, while self-reported *accentedness* only significantly affects performance with the Southern voices in this study, as Figure 2 shows the trend is that *accentedness* also affects performance with the non-native voices as well, which is harder to explain as a familiarity effect. Combined, this suggests that instead of just being about familiarity, participants' self reported *accentedness* may be influencing performance for other reasons, because they do not decrease their effort for non-standard speakers (i.e., Kang and Rubin 2009), or because they have more flexible linguistic systems (see Clopper and Walker, to appear). At the very least, a more thorough examination of the relationship between accentedness and linguistic processing is warranted.

The second factor that interacts with speaker dialect is listener mood: participants who report being in a better mood did better with the Standard English voices, but worse with the Southern and Non-native voices. Work investigating the effect of mood on cognitive processing generally finds narrower attention and more conservative behavior from participants in bad moods relative to good moods (i.e., Zadra and Clore 2011), and a growing body of work has suggested that such cognitive reconfigurations can impact basic linguistic processing (see van Berkum et al. 2013). We might expect that narrow attention would aid in a difficult listening task; that is, that a bad mood might predict better behavior because listeners are carefully and attentively attending to the signal. However, this specific task was transcribing high-predictability sentences, and so participants might do better who were not just attending to the signal, but who were considering more broadly the words in the context of a meaningful sentence and taking guesses at words they couldn't hear; that is, listeners in good moods might do better. What is interesting about the current data is that it suggests that conservative vs. exploratory listening strategies (resulting from bad and good moods respectively) could be relatively more/less effective depending on the dialect you were listening to. Specifically, making guesses and being exploratory might help when you are listening to a standard dialect, but hurts you when listening to non-standard dialects because you need to be more carefully attending to the signal. Looking at patterns in the errors participants made in the future may be illuminating in interpreting the processes behind these results.

Regardless of the interpretation of this result, it is worth noting that even though SAE and STH voices look very similar in terms of overall rates of accuracy, mood impacts performance with them differently. This highlights the fact that even though listeners might ultimately perform similarly with different dialects, the mechanisms underlying those performances (i.e., how they got the right answer in each case) might be different.

We also find a main effect of the personality type *extroversion*: overall, the more introverted a participant was, the more accurate they were in the task, independent of which dialect they were transcribing. Extraversion is associated with sociability, assertiveness, activity, and talkativeness; whereas introverts are reserved and even-paced. Extraversion has been found to correlate positively with performance in jobs with social interaction (e.g., Barrick and Mount 1991, Vinchur et al. 1998), though (by secondary school) introverts show higher academic achievement than extraverts (e.g., Furnham et al. 2003). In a study of linguistic attitudes and sensitivity towards prescriptive errors, Boland and Queen (2016) find that extroverts were more generous in their social ratings of writers who made errors than introverts. An attempt at explaining why we see the effect of extraversion in this study would be purely speculative at this stage, and it would be worth replicating the general effect. Regardless, the significant effect of extroversion suggest that individual differences are indeed a promising avenue for exploring linguistic behaviors.

It is critical in all of these discussions to emphasize that apart from the gross difference between SAE/STH and NNS speakers, the effect sizes observed otherwise are very small. That is,

the comparative penalty for non-native speech is still substantial even for the least introverted, most accented listeners. The results from this study certainly suggest that further research into the interaction between speaker dialect and listener attributes is warranted, but they also remind us that difficulties with unfamiliar and/or non-natives accents in noise is probably mostly attributable to the difficulties of reconciling linguistic differences between varieties in an already taxing task. Of course, it is possible that listener factors could have significantly more impact in less-difficult listening tasks where researchers have also found effects of dialect (Rubin 1992, Sumner and Kataoka 2013, Sumner and Samuel 2009).

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