Title
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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 35(35)

ISSN
1069-7977

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Publication Date
2013

Peer reviewed

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Abstract

A recent paper by Lev-Ari and Keysar (2010) reported that the processing fluency associated with non-native speech causes non-native speakers to sound less credible. The authors found that the same trivia statements were rated as less truthful when spoken by a non-native speaker of English. The present paper reports the results of three studies that attempted to replicate the findings of Lev-Ari and Keysar (2010) by focusing on processing fluency manipulations other than accent. Although we used virtually the same methodology as Lev-Ari and Keysar (2010), we failed to replicate the key finding that foreign-accented speech is less credible than native-accented speech. The implications of this finding is discussed.

Keywords: fluency, foreign accent, credibility.

Introduction

The U.S. Census Bureau (2010) reported that 38.5 million people (around 12.5% of the nation's population) have as mother tongue a language other than English. The increasing number of non-native speakers of English in the U.S. suggests that a significant amount of daily interactions involve a non-native speaker communicating in English with some sort of foreign accent.

The social psychological literature on language attitudes has documented considerable amount of evidence showing that, compared to their nonstandard, accented counterparts, listeners evaluate standard, non-accented speakers more favorably across different traits, such as competence, status, intelligence, confidence, guilt and success (Ryan & Giles, 1982).

It is not entirely clear which cognitive mechanisms underlie this phenomenon. There is research suggesting that accent serves as a signal for the speakers' social group and that any negative attitude towards non-native speakers is caused by in-group biases and not by the accent itself. Alternatively, there is research showing an individual's actions and attitudes towards others are heavily dependent on how that person processes the information provided by them. The subjective ease with which individuals process incoming information influences them in a variety of cognitive tasks and domains (Gilbert, 1991; Schwarz, 2004; Alter & Oppenheimer, 2009) such as estimates of familiarity (Jacoby & Whitehouse, 1989), clarity (Whittlesea, Jacoby, & Girard, 1990), riskiness (Song & Schwarz, 2009), location and abstractness (Alter & Oppenheimer, 2008), truthfulness (Reber & Schwarz, 1999; Unkelbach, 2007), liking (Winkielman & Cacioppo, 2001) and even confidence (Koriat, 1993). Thus, one plausible hypothesis is that the negative impressions and judgments towards non-native speakers are triggered by the difficulty associated with processing accented speech.

A recent paper by Lev-Ari and Keysar (2010) directly explored this possibility. They asked native speakers of English to listen to a series of trivia statements such as *Ants don't sleep* and then indicate the degree of veracity of each statement. Participants listened to statements spoken by both native and non-native speakers of American English. The accented speech varied in terms of the degree: either mildly or heavily accented. They found that the statements spoken by non-native speakers were reliably rated as less truthful compared to the same statements spoken by native speakers.

The authors argued that their findings could not be explained in terms of stereotypes of prejudice signaled by the accent because participants were told that the non-native speakers were only reciting statements provided by a native speaker, and therefore were not displaying their own knowledge. Based on these findings, Lev-Ari and Keysar (2010) claimed that people misattribute the processing difficulty associated with non-native accented speech with the level of credibility they attribute to the content of the speech.

We began this project with the aim of exploring this issue further. The core idea is that if processing fluency influences people's judgments of the veracity of statements, then other manipulations of the speech signal such as adding background noise would also influence judgments of truth. We hoped to explore this issue both for statements of the kind used by Lev-Ari and Keysar (2010) as well as other kinds of judgments like consumer preference judgments. To presage our results, though, we were unable to replicate the initial findings.

This paper reports results for 3 studies. Study 1 explored the claim that inducing processing difficulty with mechanisms other than foreign accent (i.e., white background noise – Study 1a – and speech babble noise – Study 1b) affects judgments of truth. Studies 2 and 3 are attempts to replicate the findings of Lev-Ari and Keysar (2010). In Study 2, we asked participants to judge the truthfulness of trivia statements spoken by native and non-native speakers of English. In Study 3 we explore whether accent influences participant's perception of the price of a product.

Study 1

Study 1 investigated the claim that inducing processing difficulty with mechanisms other than foreign accent affects judgments of truth.

Study 1a

Participants Twenty-six native speakers of English participated in Study 1a. Participants were undergraduate students at The University of Texas at Austin and participated for course credit.

Materials A female native English speaker recorded 70 trivia statements such as *A rat can last longer without water than a camel* in a sound-attenuated booth. To obtain equivalent overall amplitude level for all statements, the sound files were equated for RMS amplitude. Each sound file was mixed with white noise at a four different Sound-to-Noise Ratios (SNR): *level 0* corresponded to +17dB SNR (68dB of speech and 51dB of noise), *level 1* corresponded to +12dB SNR, *level 2* to +6dB SNR and *level 3* to 0dB SNR. In the SNR notation used in this paper, the smaller the dB SNR, the louder the background noise. The mixed files were presented to participants using *E-prime 2.0*.

Procedure Study 1a used a within-subject design. Each participant heard all 70 trivia statements (48 experimental ones and 22 fillers) randomly mixed with one of three levels of noise (*level 0*, *level 1* and *level 2*). Participants sat in front of a computer screen with headphones and were asked to indicate the truthfulness of each statement, using a scale between 0 (definitely false) and 10 (definitely true). Participants were also asked to rate whether they knew for a fact that the statement was true.

Manipulation Check To ensure that the noise manipulation made the trivia statements more difficult to process, a different group of 24 participants were asked to listen and rate the degree of difficulty to understand the statements. Each participant heard 25 randomly selected statements (five for each level of noise: *no noise*, *level 0*, *level 1*, *level 2* and *level 3*).

Manipulation Check Results A one-way repeated measures ANOVA, with the difficulty level as dependent variable and noise level as independent variable, revealed a statistically reliable main effect of noise, $F(4,80) = 60.59$, $p < .0001$, $\eta^2 = .75$, suggesting that the overall distribution of the mean perceived difficulty across the five different noise levels significantly differed from each other. Post-hoc Bonferroni-corrected *t*-tests showed that, except for the *level 0* vs. *level 1* comparison, all other pairwise comparisons reliably differed from each other, $p's < 0.05$.

Truthfulness Ratings Results and Discussion Because we wanted to avoid participants suspicion about the noise manipulation, we decided to present participants only with statements mixed with some level of noise, excluding therefore the sentences with no noise. Also, because the difficulty ratings for *level 3* noise was extremely high ($M = 8.30$, $SD = 1.89$), we decided to exclude this level, to avoid the possibility that participants would simply be unable to hear the statements completely.

To verify whether white noise affected the truthfulness ratings of the trivia statements, we ran a one-way repeated-measures ANOVA, with the truthfulness ratings as the dependent variable and the noise levels as the independent variable. Contrary to what we expected, the mean truthfulness ratings were very similar across all three different levels of white noise. The ANOVA showed that the means did not differ reliably from each other, $F(2,50) = .81$, $p = .45$.

The pattern of results suggests that the presence of white noise in speech does not affect judgments about the content of the speech. These findings go against the robust literature that shows that processing fluency affects cognitive judgments. On the other hand, because the overall truthfulness ratings across all levels of noise was $M = 4.80$ ($SD = 2.85$), one might claim that participants were just not engaging properly in the task, given that, in general, people are not used to hearing speech against this particular type of noise. In fact, Kozou et al. (2005) shows that speech competitors have a different effects on speech recognition and performance compared to non-speech competitors, such as white noise. Study 1b addresses this point by presenting the statements against a speech competitor (i.e., babble speech) which is more common in people's environments and is found to affect speech differently than white noise (Kozou et al., 2005).

Study 1b

Participants Twelve native speakers of English participated in Study 1b. Again, participants were undergraduate students of Psychology enrolled in a The University of Texas at Austin and participated for course credit. None of the participants from Study 1a participated in Study 1b.

Materials The materials were the same as in Study 1b, however, each sound file was mixed with speech babble noise at the same four different SNR's (+17dB, +12dB, +6dB and 0dB). Similarly to Study 1a, the mixed files were presented to participants using *E-prime 2.0*. The procedure was identical to Study 1a.

Manipulation Check As we did for Study 1a, a different group of 21 participants listened and rated the degree of difficulty to understand the statements. The procedure for the manipulation check was identical to Study 1a.

Manipulation Check Results A one-way repeated measures ANOVA showed a statistically significant main effect of noise, $F(4,80) = 41.14$, $p < .0001$, $\eta^2 = .67$. Slightly different from what was found for Study 1a, post-hoc Bonferroni-corrected *t*-tests revealed that, *level 3* significantly differed from all other levels ($p's < 0.009$). However, *level 0*, *level 1* and *level 2* did not differ significantly from each other.

Truthfulness Ratings Results and Discussion Similarly to the findings from Study 1a, the mean truthfulness ratings did not differ significantly across all three different babble noise levels, $F(2,22) = .14$, $p = .86$. Although, the results for Study 1a and Study 1b suggest that noise (both white and speech babble) does not influence judgments of truth, one might claim that the failure to show differences in truthfulness ratings in Study 1b is easily explained by the fact that the various levels of noise were not perceived as different in terms of difficulty. To address this point, we re-ran Study 1b, but this time with different levels of SNR's. This time, *level 0* corresponded to +8dB SNR, *level 1* corresponded to +2dB SNR, *level 2* to 0dB SNR and *level 3* to -2dB SNR (negative SNR means that noise signal is louder than the speech signal). Using the same manipulation check procedure as before, 17 participants were asked to rate the degree of difficulty associated with listening the statements. A one-way repeated measures ANOVA showed a significant main effect of noise, $F(4,64) = 45.21$, $p < .0001$, $\eta^2 = .74$. Post-hoc Bonferroni-corrected *t*-tests revealed that, except for the pairs *level 1* vs. *level 2* and *level 2* vs. *level 3*, all other levels reliably differed from each other, $p's < 0.05$.

For the truthfulness ratings of this novel noise level manipulation, a group of 13 native speakers of English were asked to rate the degree of truthfulness of the statements (procedure identical as before). Once again, the speech babble noise did not influence the judgments of truth, $F(2,24) = 0.43$, $p = ns$. More importantly, the pairwise combinations that did differ in terms of difficulty level (i.e., *level 0* vs. *level 1*, *level 0* vs. *level 3* and *level 1* vs. *level 3*) did not show any reliable difference in terms of truthfulness ratings.

The results of Study 1a and 1b combined suggest that neither white noise nor speech babble noise seem to influence judgments of truth. More broadly, processing fluency associated with these auditory stimuli does not affect judgments about the content of the sentences. These findings go directly against Lev-Ari and Keysar (2010)'s claim that processing fluency associated with understanding foreign-accented speech directly influences judgments of truth. Study 2 and Study 3 are direct attempts to replicate Lev-Ari and Keysar (2010)'s findings with foreign-accented speech.

Study 2

Participants Sixty-five native speakers of English participated in Study 2. Participants were undergraduate students at The University of Texas at Austin and participated for course credit. None of the participants from the previous studies participated in this one.

Materials A female native English speaker, two female native speakers of Brazilian-Portuguese and two female native speakers of Korean recorded the same 70 trivia statements used in the previous studies. As before, all sound files were equated for RMS amplitude. To ensure that the speech was perceived as accented, a separate pool of 28 participants rated the degree of foreign-accentedness of the statements (both the native and non-native speech). A repeated-measures ANOVA showed a main effect of language, that is, both the Brazilian-Portuguese and the Korean speech were perceived as significantly more accented than the native speech, $F(2,54) = 307.6$, $p < 0.001$, $\eta^2 = .91$. Brazilian-Portuguese and Korean did not differ from each other, although the Brazilian speakers were perceived as slightly more accented.

Procedures To test for the effect of accent on credibility judgments, participants sat in front of a computer and listened to 48 trivia statements in English. Sixteen of these statements were spoken by a native speaker of Brazilian-Portuguese, 16 by a native speaker of Korean and 16 by the native English speaker. All statements were recited in English. After listening to each statement, participants were asked to indicate how truthful they thought the statements were. For this, they used a *Likert* scale ranging from 1 (definitely false) to 10 (definitely true). Each participant heard additional 20 fillers statements read by two additional native speakers of English.

Results and Discussion To investigate the effect of foreign accent on the judgments of truth, we ran a repeated-measures one-way ANOVA, with language (accented vs. native) as independent variable and the truthfulness rating as the dependent variable. Our results failed to replicate the findings reported by Lev-Ari and Keysar (2010). There was no reliable main effect of language on the truthfulness ratings, $F(2,128) = .18$, $p = .83$ (Figure 1). Contrary to what Lev-Ari and Keysar (2010) claimed, although the foreign speech is perceived as accented relative to the native speech, the accent did not change people's perceptions of truthfulness. However, the main claim of Lev-Ari and Keysar (2010) is that the difficulty associated with foreign-accented speech, and not necessarily the accent itself, is what drives the misattribution effect. It is reasonable to assume that although the foreign speech is accented, it might not necessarily be difficult to understand. On top of that, it might be that given that the content of the trivia statements are too opaque, participants in our study just did not engage in the task properly.

To further explore these points, we ran Study 3 using a more engaging decision-making task. We also assessed the level of difficulty on top of the level of accentedness for the non-native speakers. Study 3 used a design similar to (Shah & Oppenheimer, 2007) who showed that people weigh fluent information more heavily than they weigh disfluent information. Using a similar design, we hypothesized that if accented speech is indeeed more difficult to process (i.e., dis-

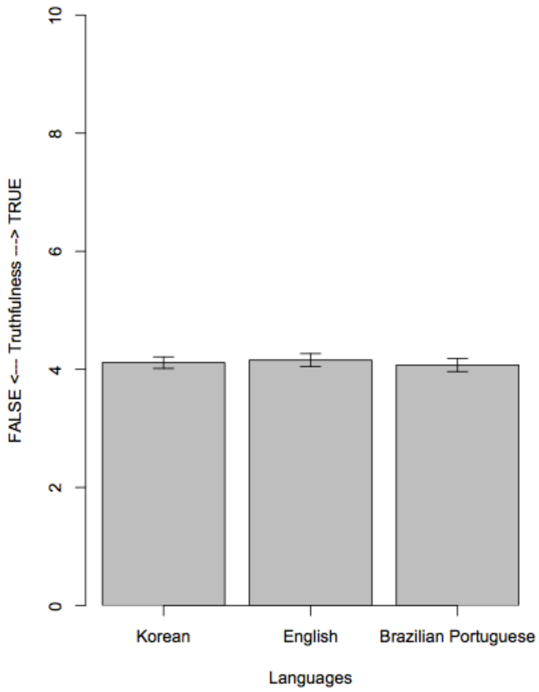

Figure 1: Credibility ratings as a function of accent.

fluent) compared to native speech, participants would weight consumer reviews provided by non-native speakers less heavily than the same review provided by a native speaker.

Study 3

Participants Sixty native speakers of English participated in Study 3. Participants were undergraduate students of psychology at The University of Texas at Austin and participated in exchange for course credit. None of the participants in Study 3 participated in the previous studies.

Materials Three female native speakers of English and three female non-native speakers of English (a Brazilian-Portuguese speaker, an Iranian speaker and a Korean speaker) recorded both positive and negative reviews for six different products. To obtain equivalent overall amplitude levels for all recordings across the two speakers, the sound files were equated for RMS amplitude.

Difficulty and Accentedness Manipulation Check To ensure that the non-native speech was indeed perceived as more difficult to understand, a different group of 24 participants rated the degree of difficulty of the reviews. Each participant randomly heard a review for each of the six products. Three of these reviews were positive and three were negative. Three were from a native speaker and three were from a non-native speaker (one for each non-native language). Participants rated the level of difficulty using a *Likert* scale ranging from 1 (easy) to 7 (difficult).

A repeated-measures two-way ANOVA, with language

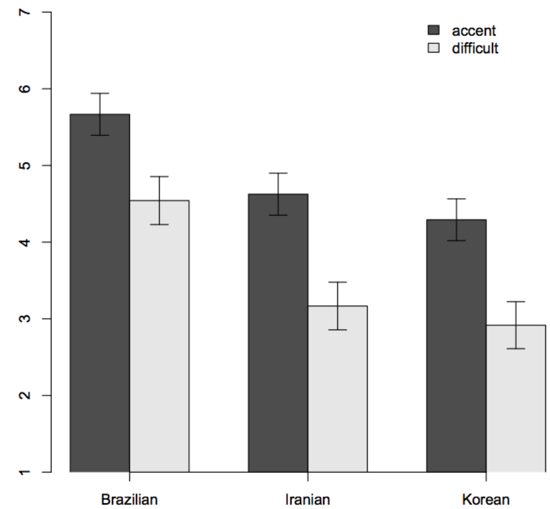

Figure 2: Accentedness and Difficulty

(native vs. non-native) and valence (positive vs. negative) as independent variable and the difficulty ratings as dependent variables, revealed a reliable main effect of language, $F(1,22) = 91.51$, $p < 0.001$, $\eta^2 = .98$, but no statistically significant main effect of valence or language x valence interaction. Notably, the main effect of language suggests that the non-native speech was perceived as reliably more difficult ($M = 3.54$, $SD = 1.66$) than the native counterpart ($M = 1.05$, $SD = 0.23$).

The same participants were also asked to rate how accented they perceived the reviews to be. Similarly to the results for the difficulty ratings, a repeated-measures two-way ANOVA, with language (native vs. non-native) and valence (positive vs. negative) as independent variable and the accent ratings as dependent variables, showed only a statistically significant main effect of language, $F(1,22) = 260.5$, $p < 0.001$, $\eta^2 = .92$, suggesting that the non-native speech was perceived as significantly more accented ($M = 4.86$, $SD = 1.44$) than the native counterpart ($M = 1.04$, $SD = 0.2$). Overall, the pattern shows that the more accented, the more difficult to understand (see Figure 2).

Procedures Study 3 used a 2 (valence: positive vs. negative) X 2 (language: native vs. foreign) fully within-subject design. Each participant completed a total of 12 trials (six fillers and six experimental trials) that were presented to them in random order. Three of the trials were negative reviews and three were positive reviews. Language was also balanced per participant: three native speakers and three non-native speakers.

In each trial, participants were presented with a series of specifications about a product (e.g., *this camera has 14.0 megapixels of resolution*). The specifications were presented in the written format and were the same across conditions. After reading a product specifications they listened to a consumer review about the product. After listening to each review, participants were asked to estimate how much they

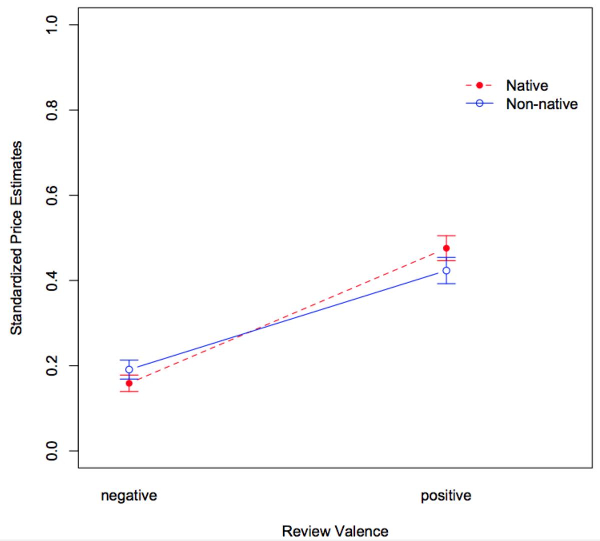

Figure 3: Price Estimates as a function of Accent and Valence

think the product should cost. For each product, participants were given a range or prices to estimate from.

Results and Discussion As the price intervals were different for each product, we standardized the estimates to be amounts between 0 and 1. To investigate whether valence and language affected the prices estimates, we ran a repeated-measures two-way ANOVA with valence and language as independent variables and the standardized price estimate as dependent variable. We found a reliable main effect of valence, $F(1,58) = 22.64$, $p < .001$, $\eta^2 = .28$, suggesting that participants were indeed attentive to the content of the reviews, providing higher price estimates for the positive reviews (M = .44, SD = .28) than for the negative reviews (M = .17, SD = .20). However, no reliable main effect of language or interaction of language and valence were found (see Figure 3). Again, this pattern of results suggests that processing fluency associated with processing foreign accented speech does not affect cognitive judgments such as price estimation, $F(1,58)$ = .14, $p = .71$.

General Discussion

In the present paper, we ran three studies to further explore the idea that the difficulty associated with foreign-accented speech affects cognitive judgments Lev-Ari and Keysar (2010). In both Studies 1a and 1b, the presence of noise made the statements significantly harder to understand than the statements spoken in quiet. This finding is consonant with several studies showing that processing speech in adverse conditions imposes an extra cognitive burden on listeners (Lane, 1962; Munro, 1998). Yet, this manipulation did not affect participants' judgments of truth.

For Study 2, even though the non-native speech was perceived as accented, they did not affect judgments of truth. This result is consonant with other research showing no relationship between degree of accent and credibility (De Meo, Vitale, Pettorino, & Martin, 2011).

In Study 3, although the reviews spoken by non-native speakers were perceived as accented and difficult, they did not influence participants' price estimations. Taken together, these findings fail to support the claim that the processing difficulty associated with understanding non-native accented speech influences cognitive judgments.

The lack of effect of accent on cognitive judgment can be explained in terms of the kinds of masking (*energetic* versus *informational*) that accent and background noise causes to the speech signal. Energetic masking (also known as perceptual masking) occurs when there is a degradation of the acoustic signal in shared spectro-temporal regions. Because the energy of a speech signal is concentrated in a few spectro-temporal regions of high informational value, if masking takes place in other regions, little impact on speech processing will be observed (Cooke, 2006). On the other hand, informational masking (also known as conceptual masking) occurs when there is a reduction of speech intelligibility even after any energetic masking has been accounted for (Cooke, 2006). Generally, informational masking refers to distractions that directly competes with the listener's attentional resources when processing the speech (e.g., the presence of an unrelated task.)

Studies on speech processing and speech segmentation (Mattys, White, & Melhorn, 2005; Mattys, Carroll, Li, & Chan, 2010) have demonstrated that depending on the type of masking (energetic or informational), people will attend to different cues to process and segment the speech. Energetic masking (e.g. white noise) tends to favor the listener's reliance on lexical-semantic information whereas informational masking tends to favor the listener's reliance on sub-lexical, acoustic information. Related to our current findings, it might be that the presence of white noise (i.e., energetic masking) made our participants focus closely on the conceptual aspect of the message other than the acoustic features. Therefore, instead of producing a metacognitive feeling of disfluency, the presence of the white noise made it easier for people to focus on the declarative information of the speech.

Another alternative is linked to the evidence that listeners normalize accented speech before engaging in any sort of conceptual processing with the content of the speech (Lahiri & Marslen-Wilson, 1991; Floccia, Goslin, Girard, & Konopczynski, 2006). According to this view, the acoustic signal is cleaned of all distortions and deviant information and a "clean" signal is processed instead. This normalization process happens after short periods of exposure to accented speech. In fact, there is evidence that after sufficient information on the accent is gathered, comprehension strategies return to baseline levels (Floccia et al., 2006), making people less tuned to the acoustic properties of the signal. It is possible that the participants in our study normalized the accented speech after a short period of exposure and then neglected to attend to sub-lexical acoustic features of the speech.

Conclusion

Our findings suggest that (Lev-Ari & Keysar, 2010) findings might have been a case of a *false positive*. Although scientists always aim at publishing accurate and replicable effects, errors are inevitable (Simmons, Nelson, & Simonsohn, 2011). In fact, the standard alpha level widely adopted in science (i.e., 5%) means that about 5% of the time, when scientists look for an effect that is *not* there, they will find a statistically significant difference. The only way to spot such *Type I Errors* is by reducing the *publication bias* (Pashler & Wagenmakers, 2012), that is, by giving more space in the literature for publications attempting to replicate previous findings. In that sense, replications and failures to replicate effects play an important role in the scientific arena (Makel, Plucker, & Hegarty, 2012). The present paper contributes to the growing body of research interested in unvailing and understanding more systematically psychological phenomena.

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