

FINAL DEVOICING IN BULGARIAN: INCOMPLETE NEUTRALIZATION AND L2 EXPERIENCE

Jason Bishop^{1,2}, Sejin Oh^{2,3}, Chen Zhou²

¹The College of Staten Island, CUNY; ²The Graduate Center, CUNY; ³Haskins Laboratories
jason.bishop@gc.cuny.edu, soh@gradcenter.cuny.edu, czhou1@gradcenter.cuny.edu,

ABSTRACT

The present study examined the phonetic realization of word-final devoicing in Bulgarian. First, we asked whether final devoicing in Bulgarian was phonetically incomplete. Second, we asked whether the degree of any incompleteness was associated with greater L2 experience in a language without final devoicing (English), as such apparent L1 attrition has been reported previously for Russian. Production results from 34 native Bulgarian speakers indicated final devoicing to be (1) phonetically incomplete, at the group level, on two acoustic measures, and (2) more severe in speakers with more L2 English experience on two (other) acoustic measures. However, the magnitude of the differences was very small, in line with previous findings on incomplete devoicing in other languages, and likely suggests variation in subtle subphonemic patterns rather than genuine attrition of a grammatical process.

Keywords: incomplete neutralization; final devoicing; L1-L2 interaction; bilingualism

1. INTRODUCTION

The present study investigated the phonetic realization of voicing contrasts in word-final position in Bulgarian. A generalization in Bulgarian, as in many languages, is that both underlyingly voiced and underlyingly voiceless obstruents surface as voiceless when word-final, rendering words such as /ʃɛf/ ('boss') and /ʃɛv/ ('seam') to be pronounced as apparent homophones, [ʃɛf]. However, in studies of various languages over the years, such phonological neutralization has been shown incomplete, in that small phonetic differences surface in the direction expected for the underlying form. For example, in the majority of work done on German, minimal pairs like /ʁa:d/ ('wheel') and /ʁa:t/ ('council') are both realized as [ʁa:t], but underlying /ʁa:d/ will tend to have shorter duration for the final stop closure, a shorter release burst, a longer preceding vowel, and/or more extensive voicing into closure. The differences are usually found to be statistically significant, but very small in magnitude, on the order of 10–20 milliseconds at most. It remains a matter of debate which of these acoustic parameters is the strongest or most reliable correlate of the underlying contrast,

with some authors reporting preceding vowel duration to be primary (e.g., [8] for German), while others have reported release burst duration to be the strongest correlate (e.g., [6] for German; [4] for Dutch). However, this picture is complicated by the known presence of individual differences ([1],[2],[8]), which, though they clearly exist, remain poorly understood. In the present study, we aimed to investigate in Bulgarian one possible source of individual differences that has been pointed out, experience with a second language (L2) that allows word-final voicing contrasts.

While it has long been acknowledged that L2 experience might have an effect on incomplete neutralization ([5],[6],[10]), we are aware of only one study that has tested this systematically, namely an experiment reported in [2]. [2] explored final devoicing in minimal pairs produced by native Russian speakers who either lived in the US and were bilingual in English (N=7), or were recorded in Russia and were mostly monolingual (N=4). The two important findings from that study for us were as follows. First, there was incomplete neutralization overall among Russian speakers; regardless of L2 experience, the group as a whole exhibited incomplete neutralization effects of the typical magnitude, and on all four of the acoustic measures mentioned above. Second, while they found no significant interactions based on L2 experience in this group of 11 speakers, they found this to be because of variation in L2 experience among the bilinguals; when excluding bilinguals with limited L2 experience from the comparison, a significant effect of L2 experience emerged (and on all four acoustic measures). Indeed, individual differences in L2 English experience among the 11 bilinguals (estimated by years spent studying English and years spent living in an English-speaking country) accounted for almost half the variance in incomplete neutralization in terms of preceding vowel duration.

Thus, evidence from at least one study suggests that incomplete neutralization effects can be sensitive to experience with a non-devoicing language. The goal of the present study was to extend this discussion to Bulgarian, which to our knowledge has not been investigated in the incomplete neutralization literature previously. In particular, we asked the following basic questions about word-final devoicing in Bulgarian:

1. Is final devoicing in Bulgarian phonetically incomplete?
2. Is there an effect of L2 experience on the (in)completeness of final devoicing?
3. What, if any, acoustic measures are most relevant?

We explored these questions in a production study in Bulgarian, with American English being the non-devoicing L2 in question. We strongly predicted the answer to question (1) to be in the affirmative; incomplete neutralization effects of some kind have been reported for the vast majority of final devoicing languages studied previously, and we did not have a reason to expect Bulgarian to be different. The answers to the other questions, however, were rather more exploratory. With respect to (2), we predicted that any effect of L2 English, a language with final voicing contrasts, would be in the direction of less phonetically complete devoicing in L1 Bulgarian, but only one previous study has confirmed this, and it was for Russian (and contained relatively few speakers). With respect to (3), previous work provides even less basis for strong predictions regarding the relative importance of specific cues, for some of the reasons (i.e., sample size, individual differences) mentioned above. However, we note that some authors have claimed preceding vowel duration to be most reliably targeted by incomplete neutralization ([8]), and in fact [2], as mentioned above, found incompleteness in terms of preceding vowel duration to be the most strongly related to L2 English experience in Russian.

2. EXPERIMENT

2.1. Methods

2.1.1. Materials

The data analysed and presented here were part of a larger study of the phonetic realization of neutralizing patterns in Bulgarian, which included minimal pairs related to both final devoicing and vowel reduction. Relevant to our purposes here were the 13 minimal and near-minimal pairs for word-final voicing contrasts, which included 8 pairs with final stops (e.g., /kub/ 'cube', /kup/ 'bundle'; /rɔŋ/ 'horn', /rɔk/ 'rock'; /pɔd/ 'beneath'; /pɔt/ 'sweat') and 5 with final fricatives (e.g., /ʃɛv/ 'seam', /ʃɛf/ 'boss'; /kɔz/ 'trump card' /kɔs/ 'blackbird'; /prav/ 'straight', /graf/ 'count/earl'), all of which corresponded to some morphologically related form in the language that revealed the underlying voicing. These final-devoicing target words were part of a list that also included 20 minimal pairs for reduction of unstressed vowels (e.g., /bɔ'di/ 'stitch', /bu'di/ 'wake up') and 71 filler items that did not involve either neutralizing process and were semantically related to target words

to mask the purpose of the experiment (see also [2]). Words were arranged in one of two pseudorandomized lists that placed members of any minimal pair at least 6 items apart, with a semantically-related filler word following each target word. PowerPoint slides were created that contained (in Bulgarian Cyrillic orthography) each test and filler item first in isolation and then again in a simple carrier sentence ("Моля кажете ___ още веднъж", 'Please say ___ again'), although the analyses here are limited to isolated productions.

2.1.2. Participants

Participants analysed were 34 native speakers of Bulgarian, all of whom had some degree of English language proficiency. We operationalized L2 English experience as a speaker's country of residence. Half of the speakers were recruited in the US and had lived there for one year or more; the other half were recruited in Bulgaria and had not lived in an English-speaking country. We refer to the groups as English-ambient vs Bulgarian-ambient, respectively. English-ambient speakers consisted of 11 males/6 females ages 19-66 (mean= 34.9) who had been living from 1 to 19 years in the US (mean=8.4). Bulgarian-ambient speakers consisted of 9m/8f ages 18-22 (mean=19.5).

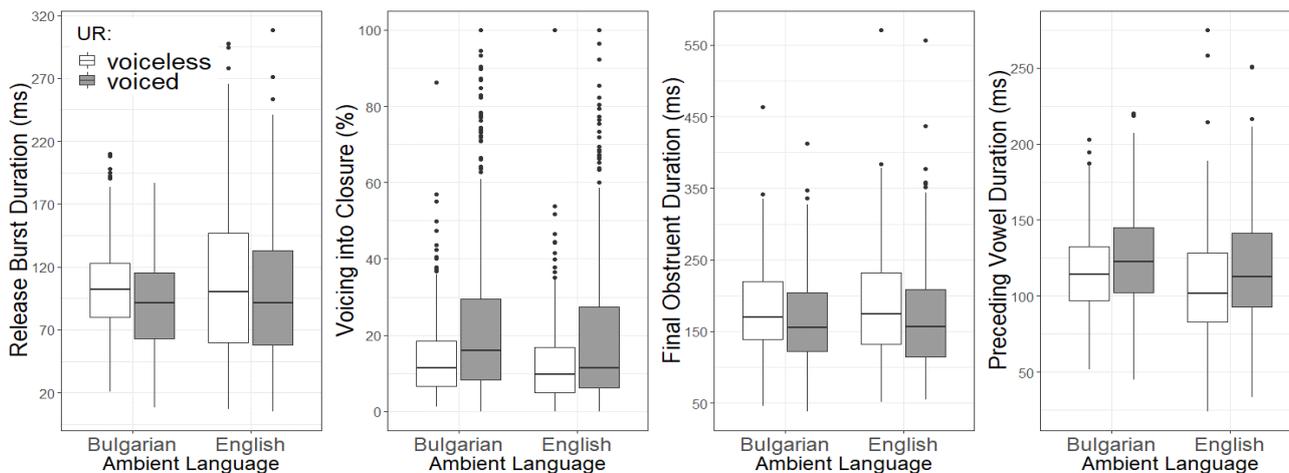
2.1.3. Procedure

Speakers were recorded in a sound-attenuated environment at either the University of California, Los Angeles in the USA or Sofia University in Bulgaria. Speakers read aloud three repetitions of the word list (in different orders) at their own pace; the present analyses are based on the second and third repetitions. Files were digitally recorded (22.05kHz) and stored as *wav* files for later acoustic analysis.

2.2. Analyses

We considered the four standard acoustic measures: duration of closure or frication (in the case of final obstruents); duration of vowels preceding final obstruents; duration of release bursts (for stops in which a release was visible in the waveform; this included both the transient and the subsequent portion of aspiration noise); and the duration of voicing into final obstruent closure/ frication. Measurements were done manually. Mixed-effects linear regression was used to test for a relation between underlying voicing (a binary categorical variable) and each acoustic measure. For each acoustic measure we also probed for effects of L2 experience by testing whether an interaction between underlying voicing and ambient language improved model fit, and if so, whether that interaction was significant in the model. In case the lack of a significant interaction was due to statistical

Figure 1: Summary of durational measures for target words with underlying voiceless (white) or voiced (grey) final obstruents. Boxplots group speakers based on the ambient language in their country of residence.



power, we tested for an effect of underlying voicing on each acoustic measure by modelling the two ambient language groups separately. Modelling was carried out on both raw and z-normalized measurements, but we present the non-normalized results as statistical patterns did not differ in any case.

2.3. Results

2.3.1. Release burst duration

A visual summary of the acoustic findings is shown in Fig 1. Weakly consistent with incomplete neutralization, an effect of underlying voicing on release burst duration was marginally significant for the group as a whole, with underlyingly voiced stops having shorter releases than underlyingly voiceless ones, a difference of approximately 12 milliseconds on average ($est. = -12.1$, $SE = 6.9$, $t = -1.75$, $p < .1$). There was a trend towards this incompleteness being slightly greater in Bulgarian-ambient speakers than English-ambient speakers (a difference of about 5 ms on average), but an interaction between underlying voicing and ambient language did not improve model fit ($\chi^2(2) = .676$, $p > .1$), and there was no significant main effect of underlying voicing when release burst duration was modelled separately for the two ambient language groups ($p > .1$ in both cases). This would seem to suggest that an effect of underlying voicing on release burst duration is a mere trend, and a very small one indeed, only detectable when all 34 speakers are combined. Among English-ambient speakers, there was no significant interaction between underlying voicing and length of English residency ($est. = 4.0$, $SE = 6.4$, $t = .629$, $p > .1$).

2.3.2. Voicing into closure/frication

Consistent with incomplete neutralization, there was a significant main effect of underlying voicing on the

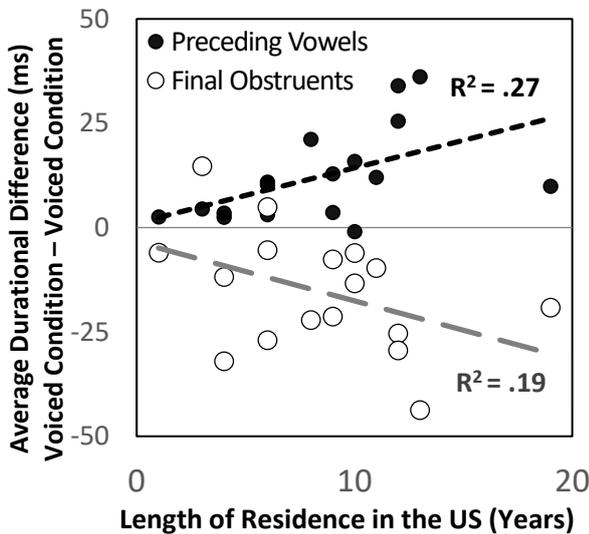
duration of voicing into final obstruent closure for the group as a whole, with underlyingly voiced final obstruents showing evidence for phonation through about 12% more of their duration on average ($est. = 12.1$, $SE = 4.5$, $t = 2.71$, $p < .01$). Worth noting, and apparent in Fig 1, is that a considerable number of underlyingly voiced tokens were in fact more than 60% voiced. On average, the effect was only one percent larger for English-ambient speakers compared with Bulgarian-ambient speakers, and thus unsurprisingly, an interaction term between underlying voicing and ambient language did not contribute to the model ($\chi^2(2) = 1.023$, $p > .1$) and there was no main effect of underlying voicing when the two ambient language groups were modelled separately ($p > .1$ in both cases). Finally, among English-ambient speakers, there was no significant interaction between underlying voicing and length of residency in the US ($est. = 1.7$, $SE = 1.1$, $t = 1.65$, $p > .1$).

2.3.3. Final obstruent duration

Although there was a numerical trend in the direction of underlyingly voiced obstruents being shorter by about 15 ms than underlyingly voiceless ones for the whole group, this was not significant ($est. = -15.0$, $SE = 14.9$, $t = -1.0$, $p > .1$). The size of this trend was only about 2 ms greater for English-ambient speakers than Bulgarian-ambient speakers on average and an interaction testing this didn't improve the model ($\chi^2(2) = 0.142$), nor was a main effect apparent when modelling groups separately ($p > .1$ in both cases). However, among English-ambient speakers, an interaction between voicing and length of US residency contributed to model fit ($\chi^2(2) = 7.89$, $p < .05$) and was significant ($est. = -1.8$, $SE = .7$, $t = -2.49$, $p < .05$).

To further illustrate this pattern, we plotted correlations between the size of incomplete neutralization effects (i.e., the mean difference in

Figure 2: Degree of incomplete neutralization for each English-ambient speaker as a function of length of US residence. Plot shows the difference in each speaker's mean final obstruent duration (white) and preceding vowel duration (black) for words in the underlying voiced condition relative to those in the voiceless condition. Stronger incomplete neutralization is thus indicated by negative values for final obstruents and by positive values for preceding vowels.



final obstruent duration in underlyingly voiced items relative to underlyingly voiceless items) for each speaker against their length of residence in the US. As seen in Fig 2, we found length of US residence to account for approximately 1/5th of the variance across speakers. Fig. 2 also plots the findings for preceding vowel duration, to which we now turn.

2.3.4. Preceding vowel duration

The pattern of results for preceding vowel duration resembled that for final obstruent duration. Again, although vowels preceding underlyingly voiced stops were on average about 10 ms longer than those preceding voiceless ones, a main effect of voicing wasn't significant for the group ($est.=9.9$, $SE=8.2$, $t=1.2$, $p>.1$). On average, the difference was about 3 ms longer for English-ambient speakers than for Bulgarian-ambient speakers, but an interaction between underlying voicing and ambient language didn't improve model fit ($\chi^2(2)=1.882$) and no significant main effect of underlying voicing was obtained when modelling ambient lang. groups separately ($p>.1$ in both cases). However, among English-ambient speakers, an interaction between underlying voicing and length of US residence marginally improved model fit ($\chi^2(2)=5.38$, $p<.1$) and was significant in the model ($est.=1.3$, $SE=.52$, $t=2.48$, $p<.05$). As seen in Fig 2, speakers with longer residence in the US were associated with a larger effect of underlying voicing on preceding vowel

duration (accounting for approximately 1/4th of the variance across speakers).

3. DISCUSSION & CONCLUSION

The results of the present study provide evidence that word-final devoicing in Bulgarian is phonetically incomplete, as previous studies have found for several other languages. In line with most of that work, the effects were quite small; although each of the acoustic measures we tested showed numerical differences in the direction of incompleteness, group-level statistical support was only clearly obtained for the proportion of voicing into closure. This is likely due both to the small size of incomplete neutralization effects generally, but also the considerable variation across speakers. We also found, however, that L2 experience in a language that lacks final devoicing, namely English, predicted some of this cross-speaker variation. In particular, while comparison across English-ambient and Bulgarian-ambient groups did not reveal significant differences, closer inspection *within* English-ambient speakers did, since length of US residence (a rough measure of L2 experience) was fairly strongly related to the degree of incomplete neutralization in terms of obstruent and vowel duration. This finding, which closely resembles a finding [2] reported for their Russian-English bilinguals, suggests that incomplete neutralization may only be sensitive to relatively high levels of L2 experience. However, we also note that even among speakers with extensive L2 experience, the consequence seems to be slight increases in typical incomplete neutralization effects rather than something approaching categorically-voiced realizations. We think this suggests that these L2-related differences reflect subtle modifications to subphonemic effects rather than attrition of phonological knowledge, and may lend further support to arguments that incomplete neutralization in general reflects speech production's sensitivity to subtle patterns related to lexical activation rather than coarse underlying phonological representations ([3]). Further study of individual differences, in particular those arising from bilingual experience, may thus help address the long-standing problem of the mechanisms underlying incomplete neutralization ([3],[6],[7], [8], [9], [11]).

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