THE INFLUENCE OF ABSTRACT PHONOLOGICAL PROCESSES ON THE ACQUISITION OF A FOREIGN LANGUAGE – AN EXAMPLE OF GERMAN, SPANISH, AND ENGLISH

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This preliminary study examines the transfer of abstract phonological rules targeting word-final obstruents from the L1 to the L2/Ln in adult learners. Specifically, we investigate the production of the word-final /d/ in German, Spanish, and English. In German and Spanish, the surface representations differ from the underlying representations, while English does not exhibit a difference, albeit phonetic differences do arise. The results indicate that L1 German/Ln Spanish speakers apply an abstract phonological rule targeting word-final segments more consistently in their production of the surface alternations than L1 English/L2 Spanish speakers. L1 Spanish/Ln German speakers are also more consistently applying a phonological rule in their production of the surface alternations than L1 English/L2 German. We argue that these differences across L1 groups are due to the presence of a phonological rule in the L1 targeting the same segment, in the same word position, even if the phonetic realization is different across L1s.

INTRODUCTION

When learning a foreign language, it is not only important to acquire lexical items and grammatical structures, but also the sound system of the language of interest. An important part of learning a sound system involves learning the variability inherent to it. This variability can be due to, among other things, indexical and phonological variation. Phonological variation is conditioned by what has traditionally been considered "rules", or processes, resulting in changes from the level of underlying representation to the level of surface representation.

In the present study, we examine a set of processes that target word-final underlying voiced obstruent segments in German and Spanish and compare their realizations by native speakers of English, German and Spanish. Both German and Spanish exhibit word-final phonological processes that target /d/. German exhibits final fortition (e.g., *Rad* [rat] 'bicycle') while Spanish exhibits lenition (e.g., *salud* [saluð] 'health'). English, on the other hand, does not demonstrate a fully allophonic alternation of either kind. English word-final voiced obstruents can be either partially or completely devoiced but, this process is generally recognized as phonetic and not phonological (Davidson, 2016; Iverson & Salmons, 1995).

Cebrian (2000) examined the interference of an L1 rule in productions by L1 Catalan speakers acquiring English. Elicited production tasks and word repetition tasks were used to measure the

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participants' production accuracy. The voicing contrast in final position in Catalan is neutralized by devoicing rules. Cebrian's results suggested a high degree of devoicing in his L1 Catalan speakers' English, confirming transfer effects for this group. In another study, Eckman & Iverson (2013) examined the /s/- /ʃ/ contrast in English productions by L1 Korean and L1 Japanese speakers. In Korean [s] and [ʃ] are in complementary distribution, due to an allophonic alternation. In Japanese, the two sounds are different phonemes and a neutralization rule is present in favor of [ʃ]. With the help of a picture naming task and an elicited production task, the study examined whether the L1 impacts the acquisition of the /s/- /ʃ/ contrast in English. It was found that the two learner groups exhibited different paths when acquiring the contrast in English. L1 Japanese leaners demonstrated a positive transfer of their L1 phonological knowledge when learning English, while L1 Korean speakers showed a negative transfer of their L1 knowledge. In order to acquire the English contrast, L1 Korean speakers needed to suppress their L1 phonological rules and acquire new ones in their L2.

The current study focuses on phonological processes targeting word-final segments in German and Spanish. L1 German/Ln Spanish, L1 English/L2 Spanish, L1 English/L2 German, L1 Spanish/Ln German speakers carried out two production tasks. Task 1 involved the production of real words, while task 2 involved the production of nonce words. Productions were recorded and subsequently acoustic measurements were made of the target word-final /d/ segment. We restricted our analysis to /d/ because of the shared location across our three target languages and the processes that target it in German in Spanish.

We hypothesize that if there is an abstract phonological rule present in word-final position in the L1, learners of an additional language are more likely to apply an L2 phonological rule in said position in the additional language, even if the rules in question do not necessarily result in the same phonetic outcome as in their L1.

Since it is virtually impossible to find L1 German acquirers of Spanish, or, conversely, L1 Spanish acquirers of German without English as a second language, we will use L2/Ln to characterize participants.

METHODS

Twenty college-level language learners (Table 1 and 2) were recruited for this preliminary study and received monetary compensation for their participation. The L1 Spanish speakers acquiring German were recruited at a large public university in south-west Germany during their study abroad program. They were enrolled in the mandatory German course for non-native speakers. The L1 German speakers acquiring Spanish were recruited at the same German university. All German natives were recruited from Spanish 1 and 2, which require students to have a prior knowledge of the language. The L1 English speakers were recruited at a large public university in the American Midwest. The L2 German learners were enrolled in a general education language class, while the L2 Spanish learners were either enrolled in a general education language course or a Spanish-major level class.

In the L1 German/Ln Spanish group, three participants had English as their L2 and two French and Spanish as their L3. In the L1 Spanish/Ln German group all participants acquired English before German. All L1 English speakers learned the target language as their L2.

Table 1

L2/Ln Spanish

	Age (yrs)	Age of acquisition (AoA)(yrs)	Time spent abroad (months)	Speaking self-proficiency rating (0-10)	Self-perception of own foreign accent (0-10)
L1 German (n=5)	21.2	12.6	5.2	5.4	6.2
L1 English (n=5)	20.4	13.4	1	6.2	8

Table 2

L2/Ln German

	Age (yrs)	AoA (yrs)	Time spent abroad (months)	Speaking self-proficiency rating (0-10)	Self-perception of own foreign accent (0-10)
L1 Spanish (n=5)	21.8	15.6	11	7	5.2
L1 English (n=5)	19.6	11	0	5.4	4.1

Stimuli

Since the languages of interest allow different vowels to precede word-final /d/, Spanish had a total of 32 target words (16 real, 16 nonce), while German had 24 (12 real, 12 nonce) (Table 3).

Table 3

Stimuli

	Spanish	German
Real words	Madrid, ciudad, venid, solicitud, merced, huésped, césped, amistad, universidad, exactitud, Valladolid, juventud, comunidad, esclavitud, David, pared	Konrad, Neid, Fahrrad, Bescheid, Kleid, Mitglied, Bad, Lied, Abschied, Pfad, Eid, Unterschied
Nonce words	malladalud, nerped, pinerid, granandad, tiliped, clavelad, losalud, mancidud, palid, cantuted, calellad, malgred, torid, palencid, nerjud, duliad	Tied, Miersgad, Gobad, Kanied, Muleid, Frad, Bremmeid, Wankelad, Luebereid, Hummeid, Riesumied, Ahrensied

In the L2/Ln German task, 60 real words (12 words x 5 participants) and 60 nonce words were analyzed and in the L2/Ln Spanish task, there was a total of 80 real words (16 words x 5 participants) and 80 nonce words produced across groups. Due to mispronunciation, tokens had to be removed from the calculations. In the L2/Ln German task, 112 tokens (55 real words, 57 nonce words) were analyzed in the L1 Spanish group and 107 (53 real words, 54 nonce words) in the L1 English group. In the L2/Ln Spanish task, 84 tokens (43 real words, 41 nonce words) were analyzed in the L1 German group and 80 (40 real words, 40 nonce words) in the L1 English group.

Method

The tasks were set up in a parallel way for both target languages and followed the same order. First, participants went over the consent form and filled out the LEAP-Q background questionnaire for multilingual speakers (in their native language). Second, a list with the stimuli was presented to ensure familiarity. The participants' pronunciation was recorded using a Marantz PMD661 MKII Professional solid-state hand-held recorder. Task 1 focused on real words and task 2 on nonce words. Participants listened to a sentence in the target language and had to answer a question using the target word, which was always located at the end of the sentence (1: Spanish example). The recordings of the prompt sentences were done by native speakers of the language.

(1) *Ana vive en Madrid. - ¿Dónde vive Ana?*
Ana live-3SG in Madrid. – Where live-3SG Ana?
'Ana lives in Madrid. – Where does Ana live?'
Expected answer: Madrid

Analysis

German L2 obstruent targets were analyzed using the following phonetic parameters: duration of the vowel preceding the target obstruent, vowel-consonant duration ratio (closure duration plus release) and percentage of glottal pulsing during the target obstruent. Duration was measured in Praat (Boersma & Weenik, 2021) by isolating the sound of interest. Since there are no control groups in this study, the results are compared to findings of previous studies.

For English and German, studies have shown that there is a consistent vowel lengthening preceding lenis stops, while the vowels before fortis obstruents are shorter (e.g., Purnell et al., 2005; Smith & Peterson, 2012). Based on these studies, the range for German vowels preceding fortis obstruents was between 89-141 ms (English: 57-101 ms) and preceding lenis obstruents averaged 115-177 ms (English: 142-157 ms). The ratio of vowel duration to target obstruent duration for fortis obstruents ranged between 1.17-1.85 ms in German (English: 0.47-0.83 ms).

The second variable was the ratio of glottal pulsing to overall consonant duration. Purnel et al. (2005) found that the pulsing in lenis consonants is more than 50% of the entire obstruent duration, while fortis consonants show less than 50%. These results were determined by a production study examining surface productions. Another indicator for fortis realizations is aspiration (Jessen & Ringen, 2002). The presence of aspiration was determined by examining the duration of the interval from the release burst of the stop to the start of voicing.

The Spanish targets were realized as fricatives, approximants or elided segments that result from an underlying word-final /d/. To distinguish between fricatives and approximants, the presence or absence of aperiodic energy was noted. While there is aperiodic energy present in the waveform and the spectrogram in the production of fricatives, there is no aperiodic energy present in the production of approximants (Hualde & Eager, 2016). This was estimated both impressionistically and qualitatively. Additionally, the intensity difference between the preceding vowel and the word-final obstruent is an indicator for lenition. The smaller the intensity difference, the less constricted and more lenited the realization is (Broś et al., 2021). If no acoustic signal is present in the waveform and the spectrogram after the periodicity of the vowel preceding the target obstruent, the word-final segment has been elided.

In each target word, the word-final /d/ and its preceding vowel were isolated. Praat was used to measure their duration, maximum and minimum intensity. When the target sound realization was found to be different from a stop sound realization, the absence or presence of aperiodic energy was noted to distinguish fricatives from approximants.

RESULTS

L2/Ln German

Duration of the vowel preceding the target obstruent, vowel to obstruent duration ratio and percentage of glottal pulsing were calculated in order to investigate if the rule of word-final fortition was applied. The ranges for the preceding vowel duration (for both learner groups and in both tasks) showed greater variability than previous studies (real words: 15.6-246.1ms, nonce

words: 78.3-237.2ms), which could be due to speaking rate. However, looking at the average preceding vowel duration per participant, we found that four out of five L1 Spanish speakers produced a preceding vowel duration (in both tasks) that falls within the expected range before a German fortis sound (89-141ms) sound, while one participant produced a slightly longer vowel. Four L1 English participants realized preceding vowel duration on average within the German fortis obstruent category, while one participant showed a longer vowel duration in the real word task, closer to those preceding lenis obstruents. In the nonce word task, two participants produced longer vowels, as would be expected for vowels preceding lenis obstruents. Figure 1 shows the results of the preceding vowel duration, including the standard deviation (SD).

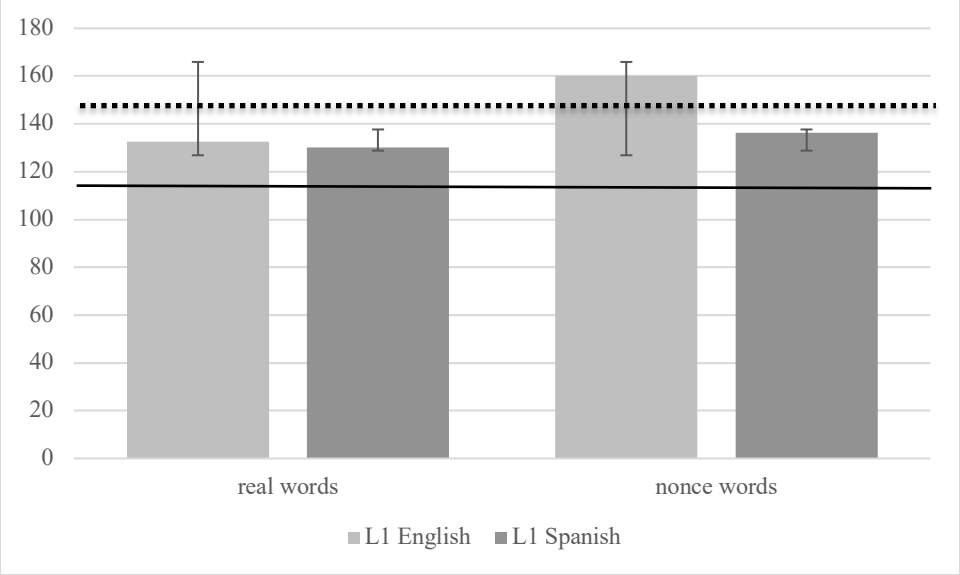

Figure 1. Average preceding vowel duration in L2/Ln German (ms). The solid horizontal line represents the average duration of German vowels preceding fortis obstruents, from the previous studies mentioned above (mean = 115ms), while the dotted line presents the average duration of German vowels preceding lenis obstruents (mean = 146ms).

In order to make a more conclusive description of the word final segment, the ratio of the preceding vowel duration and the target obstruent was calculated. Previous studies suggest a ratio range of 1.17-1.85ms for word-final surface fortis segments in German (English: 0.47-0.83ms). In the real word task, the average of vowel/obstruent ratio calculated for L1 Spanish speakers aligns with English fortis realizations. The average ratio was slightly smaller than what was expected. Since all L1 Spanish participants have English as their L2 and German as their L3, it is possible that the realizations were influenced by English. Two participants realized one final obstruent as a fricative during this task, which were removed from the calculations. The average vowel/obstruent ratio for the L1 English speakers all fall in the range of the expected German fortis realization durations, suggesting that the phonological rule was applied successfully in this task for these speakers.

In the nonce word task, as in the real word task, all the L1 Spanish participants fell outside the range of German surface fortis obstruent realizations. There were two fricative realizations and four elisions. In the L1 English group, two participants realized word-final segments that were in

the range of English word-final fortis obstruents, and one participant was in the German range. There were five nonce word tokens produced with word-final fricatives. Figure 2 shows the average vowel-obstruent duration ratio and the SD.

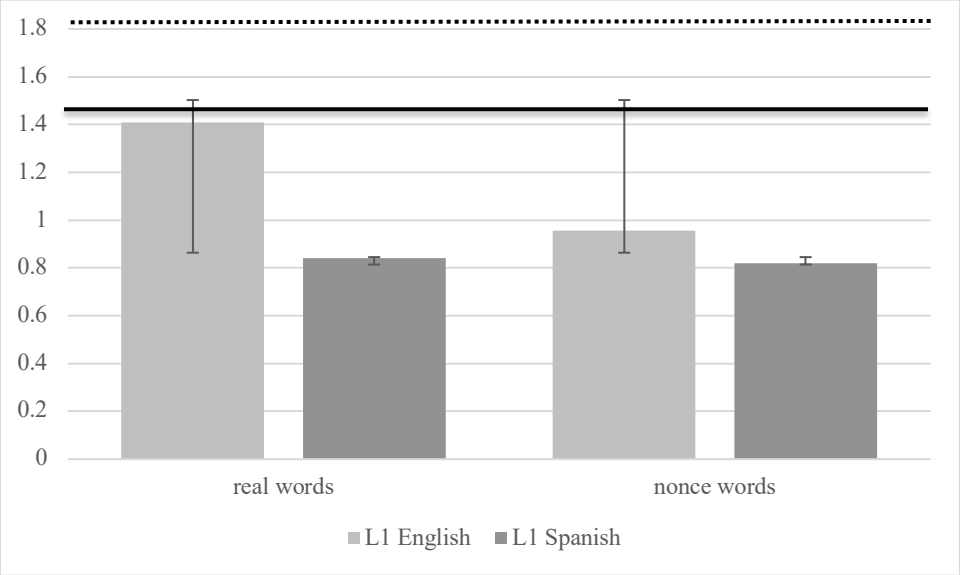

Figure 2. Average vowel-obstruent duration ratio in L2/Ln German (ms). The solid horizontal line represents the average fortis (1.33) condition and the dotted line the lenis condition (1.83) from previous studies (Purnell et al., 2005).

Glottal pulsing reflects the amount of voicing present. Across both tasks, L1 English speakers presented a percentage of glottal pulsing that was below 50%, suggesting a fortis obstruent realization. In the L1 Spanish group, all but one token had a glottal pulsing rate below 50% as well. Targets realized as fricatives or those that were elided were not analyzed for glottal pulses. Figure 3 shows the average percentage of glottal pulsing and the SD.

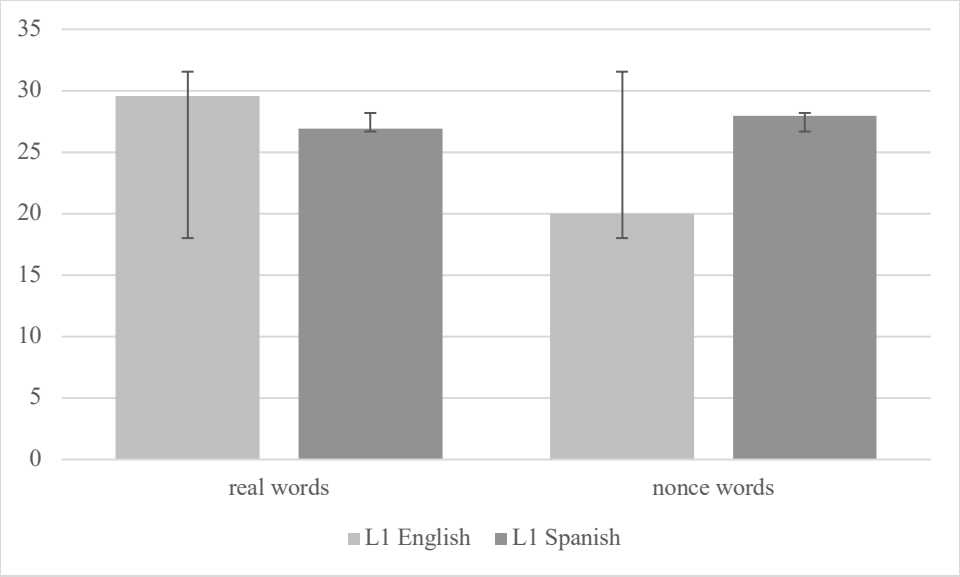

Figure 3. Average percentage of glottal pulsing in L2/Ln German.

The results suggest that both learner groups are producing word-final obstruents with less than 50% glottal pulsing; nonetheless, there is intra-speaker variability. The results also indicate that L1 English speakers have a shorter duration of glottal pulsing in the nonce word task, while the L1 Spanish speakers demonstrate a slightly smaller glottal pulsing duration in the real word task. Table 4 summarizes the results.

Table 4

Result summary L2/Ln German

	Mean vowel duration (ms)	SD vowel duration (ms)	Mean vowel-consonant ratio	SD vowel-consonant ratio	Mean % of glottal pulsing	SD % of glottal pulsing
L1 Spanish (real words)	130.1	43.67	0.84	0.16	29.57	15
L1 Spanish (nonce words)	136.37	35.31	0.82	0.39	26.9	18.1
L1 English (real words)	132.59	48.17	1.41	1.5	29.57	18.5
L1 English (nonce words)	160.2	37.45	0.96	0.48	20	18.04

L2/Ln Spanish

The intensity difference between the vowel preceding the target obstruent and the target obstruent itself was determined to investigate if the phonological process of lenition had been applied. The intensity difference was calculated by subtracting the minimum obstruent intensity from the maximum intensity of the preceding vowel (Broś et al., 2021). Previous studies found an average vowel-stop difference of 14.79 dB (Martínez-Celdrán & Regueira, 2008), while the average vowel-spirant difference is 8.81dB (Broś et al., 2021; Figueroa & Evans, 2015; Martínez-Celdrán & Regueira, 2008). Figure 4 shows the results of the intensity difference.

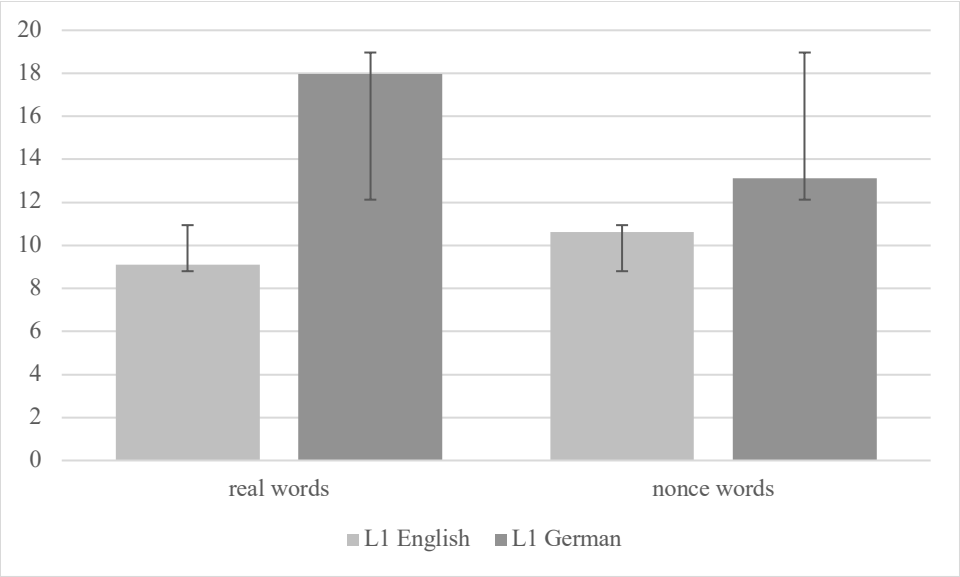

Figure 4. Average intensity difference in L2/Ln Spanish (dB).

The intensity difference in both tasks was lower for the L1 English group, suggesting that overall, this group applied the phonological rule in question more consistently than the L1 German speakers. However, considering interspeaker variability, we found that, especially in the real word task, all but one L1 German speaker showed a tendency towards lenition. Table 5 presents the word-final obstruent realizations by group and condition. Mispronounced tokens have been removed from the calculations.

Table 5

Word-final obstruent realizations Ln/L2 Spanish

	fricative	approximant	elision	fortition
L1 German (real word)	37/43 (86%)	0%	4/43(9.3%)	2/43(4.65%)
L1 German (nonce word)	30/41 (73.17%)	0%	11/41 (26.83%)	0%
L1 English (real word)	30/40 (75%)	2/40 (5%)	8/40 (20%)	0%
L1 English (nonce word)	57/40 (42.5%)	0%	23/40 (57.5%)	0%

When the lenition rule was applied, the periodicity of the waveform was looked at to establish a fricative or approximant realization. The presence of aperiodic energy suggests the realization as a fricative (Hualde & Eager, 2016). When the waveform does not indicate the characteristics of a stop consonant (e.g., no complete closure), but formants were visible on the spectrogram, the segment was characterized as an approximant. Although lenited segments can be realized as either voiceless or voiced fricatives, the overall categorization of either fricative (voiceless or voiced) or approximant was determined. Of all the targets that were realized with lenition, only two targets were characterized as approximants (both produced by L1 English speakers in the real word task), while the remaining lenited targets were characterized as fricatives.

Overall, the data suggests that both groups acquired the phonological rule targeting word-final obstruents in Spanish. It was found that across both tasks L1 English speakers tend to elide more word-final segments than L1 German speakers. The L1 English speakers demonstrated a slightly more consistent application of the rule than the L1 German speakers. There was one L1 German speaker who did not apply the rule during the real word task, only during the nonce word task. This suggests that familiarity with the orthography of a word can influence the realization of the word-final segment, while non-familiarity with orthography does not influence word repetition.

DISCUSSION

Although the results of the 20 participants used for this study were not as clear as expected, the data point to the finding that phonological rules present in the L1 can have a positive effect on the learner's L2/Ln productions. This is visible when looking at the results of the preceding vowel duration of the L1 Spanish group acquiring German. However, when looking at glottal pulsing, the L1 English group was closer to the German value than the L1 Spanish speakers. In tokens where the rule was not applied, L1 Spanish speakers either lenited or elided the word-final consonant. The L1 English speakers tended to produce lenis consonants. The results suggest

that L1 Spanish speakers suppressed their L1 rule in order to apply another phonological rule targeting the same word segment (see Cebrian, 2000, for similar results).

Although some realizations included the direct transfer from the L1 to L2/Ln, the surface realization was consistently less marked than the underlying form. None of the L1 Spanish speakers produced a voiced stop in word-final position in German which could potentially be due to the universal markedness restrictions against voiced stops in word-final position (Ellis, 1994).

The results for L1 German and L1 English speakers acquiring Spanish were also not as clear as predicted. The L1 German group had more fricative realizations when applying the rule than the L1 English group. The L1 English group elided more word-final segments than the L1 German group. Whenever the rule was not applied, the L1 English speakers demonstrated a tendency to produce lenis obstruents. When L1 German speakers did not apply the lenition rule, fortis obstruents were produced, which shows a direct transfer from the L1 to the L2/Ln.

To summarize, the results showed a slight positive tendency for learners whose L1 has a phonological rule targeting word-final segments to also apply a phonological rule targeting the same segment in a foreign language. Learners whose L1 and L2/Ln have rules targeting the same sound in the same word-position, do apply an abstract version of this rule to their L2/Ln. However, the data also show that speakers of a language without these rules can still apply it in their L2/Ln. Thus, while the L1 rule slightly boosted the L2/Ln productions, it did not prove to be as influential as predicted by our hypothesis. This suggests that other factors, such as markedness, may be at play as well.

A limitation of the study is the lack of control groups. The lack of minimal pairs, which could have made up for the lack of a control group at least in the case of German, presents another limitation. If words with word-final /t/ were included in the study, it could have been determined more accurately how devoiced the word-final /d/ was. Moreover, vowel duration was one of the deciding factors to determine if the phonological rule had been applied or not. Yet, variation in vowel duration could be due to either rule application or extraneous factors such as speaking rate. The observation of a longer vowel duration in nonce words could be simply due to a slowing speech rate with unfamiliar words. Duration ratios are a more reliable measure than vowel duration, but given the lack of comparison points, only tentative conclusions can be made.

CONCLUSIONS

This preliminary study regarding the transfer of abstract phonological rules from the L1 to the L2/Ln showed a slightly greater tendency for speakers whose L1 does possess such a rule to also apply the phonological rule in their L2/Ln.

A further factor that may have impacted the results is that the L1 German and the L1 Spanish group are multilingual speakers, who have acquired at least one language before acquiring the language of interest, while the L1 English group all acquired the target languages as their L2. It is possible that the obstruent duration produced in the L1 German group was influenced by the L2 English. Another factor that may have impacted the results is the typological similarity between English and German and the lack of typological similarity between Spanish and German.

The results from this study suggest that L1 rule transfer in contexts where the phonetic outcome is different does occur, but it is by no means the only factor, nor the overriding factor. All three language groups showed evidence of learning. The predicted 'boost' from German and Spanish L1 rule application did not apply across the board. As stated, markedness, typology and multilingual language experience could have had an influence on the results obtained here. Further research is required to tease apart these factors.

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