Learning phonotactically complex L3 words: Are bilinguals more successful?

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ABSTRACT

Bilinguals are often claimed to acquire new languages more easily than monolinguals due to enhanced meta-/linguistic abilities driven by prior experience with languages. When it comes to learning how to pronounce foreign words, empirical evidence is inconclusive and mostly limited to analyses of single speech sounds. Less is known about the acquisition of complex phonotactics in a foreign language during adulthood. The focus of this study is on the very initial phase of foreign language production, specifically examining whether the frequency of dominant language use predicts the ease of imitation of phonotactically complex words in a delayed repetition task. To this end, 251 Spanish and Spanish/Basque speakers imitated Slovak words (e.g. [str̩t͡ʃ] "stick"). Preliminary analyses of vowel epenthesis revealed more insertions with higher language use, supporting the notion that sensorimotor and perceptual flexibility improves with frequent and sustained experience with different languages.

Keywords: phonotactics, epenthesis, L3 acquisition, production, bilingualism, individual differences

1. INTRODUCTION

Many learners of a foreign language struggle to pronounce unfamiliar speech sounds so that proficient listeners of that language can easily understand them. Yet some learners achieve this with apparent ease. What is responsible for such individual differences? Here we explored the extent to which bilingualism contributes to such differences by focusing on production of phonotactically complex words.

It is well known that the acquisition of an additional language (L2/L3) later in life is often accompanied by the presence of an audible accent in the pronunciation. Not only production is affected, but also the perception often remains imprecise. This is the case because learners hear new languages through the ears trained for their first or dominant (L1) language [1]. Researchers have long sought the answer to questions such as a) why mastery in an additional language perception and production is so difficult in adulthood compared to childhood, and b) why there is such great variability in performance.

A number of both linguistic and non-linguistic factors determine acquisition success as well as the individual differences. Linguistic factors such as markedness, universal preferences, characteristics of the L1 compared to the L2/L3, and language transfer can explain part of the difficulties [2-4]. Non-linguistic factors such as motivation, quality of training, amount of L2/L3 input, socio-psychological effects, personality, and intelligence can explain some of the individual differences between learners [4-6]. A vast number of cross-disciplinary studies have claimed neurocognitive plasticity and age of acquisition (AoA) to be among the main contributors to the decay of learning abilities in adulthood [for a review, see 7]. Native phonetic categories are believed to be less influential in childhood than in adulthood, resulting in better perception and production abilities in a child's L2 [4, 8, 33]. However, there is no strict age limit to speech-learning abilities [9]. Adults can exhibit exceptional phonetic abilities as shown in reports on (10 to 20% of) late learners who sound almost native-like in the newly acquired language [10-12]. Thus considerable plasticity is available for adult speech learning, and further factors such as experience need to be considered [33].

The majority of research within this area has focused on ultimate proficiency attainment after several years of language acquisition, which has the disadvantage of being strongly determined by diverse non-linguistic factors. Other studies focus on training perception or production of phonetic contrasts or on individual differences in consonant clusters perception and production after only a very short exposure to an unfamiliar language [13]. [13] report large individual differences but the underlying cause for performance variation remains unclear.

Apart from the factors mentioned above, some studies suggest that bilingualism provides learners with benefits when learning an additional language. Previous studies have demonstrated that bilinguals outperform monolinguals across various language related tasks, such as learning new words [14, but see 31], phonetic contrasts [15], and pronunciation [16]. Studies that address the initial stages of phonotactic acquisition are mostly limited to late bilingual populations [13]. It thus remains unclear to what extent bilingualism and other linguistic factors provide learners with benefits in word learning, and more specifically in complex phonotactics. In addition, most studies do not consistently isolate the influence of language use and treat bilingualism categorically. An alternative and perhaps better way to capture the influence of bilingualism on learning and linguistic skills is the amount of active use or exposure to one or more languages. We therefore operationalized language use as a continuous variable [for a similar approach, see 29-31].

Phonetic production ability for newly-learned consonant clusters requires sensorimotor flexibility to minimize the influence of native language articulation, and this ability is likely to be more limited in adults compared to children. Individual differences in sensorimotor flexibility could have a genetic basis or arise from experiential factors, such as growing up speaking different languages [see also 17, for vocal flexibility of singers], and may be related to phonological working memory [18]. Similarly, phonetic perception ability may depend on perceptual plasticity or be shaped by experience with diverse phonologies [20, 33]. It has been suggested that speech-specific capabilities could partly explain individual differences in phonetic mastery of early bilingual speakers [19].

Whether active bilinguals who grew up speaking two languages of comparable complexity in terms of consonant clusters will exhibit better imitation skills than active monolinguals is yet unclear. The present study addresses this issue by a) exploring the mastery of complex words at the very onset of exposure to a new language, and b) including speakers of typologically unrelated languages with relatively comparable consonant clusters and phonology (Basque and Castilian Spanish). This allows us to examine the relationship between active bilingualism and L3 acquisition in cases where the quantity and quality of the phoneme repertoire is less likely to provide bilinguals with benefits in speech processing (as shown for L3 perception [20]).

2. THE PRESENT STUDY

The objective of this study was to explore the performance of monolingual and bilingual speakers in imitating words with complex consonant clusters in a foreign language (Slovak). The analysis reported here focuses on the question of whether language habits predict successful production skills, as measured by vowel insertions. If bilinguals exhibit fewer insertions compared tomonolinguals, it would suggest that sensorimotor flexibility and perceptual flexibility are influenced by the amount of experience in multiple languages. This result would shed light on the interface between bilingualism and language learning, and would provide insights into whether there is a physiological basis for speech production difficulties in late learners.

To examine individual differences in L3-speech learning, we administered a delayed imitation task using auditorily presented Slovak words to participants who had not learned Slovak before. In addition, we used a Spanish/Basque nonword-repetition task to control for variability in phonological short-term memory, which is known to differ among learners. This task assessed the ability to store and repeat unfamiliar phonological sequences.

Slovak is well suited for these purposes due to its relatively complex syllabic structure [for more details, see 21, 22]. In Slovak, consonant clusters of up to four consonants are allowed in onset position (e.g. *pstruh* [pstrux̯] 'trout'). In contrast, Spanish and Basque have a maximum of two onset consonants [for more details on combinatory restrictions, see 23, 24] and tend to prefer CV syllables over consonant clusters in onset positions [24, 25]. Word initially, Castilian Spanish permits clusters of a stop or /f/ followed by a liquid, and /f/ is the only possible fricative as the first cluster member. Spanish also avoids impermissible /s/ + obstruent clusters through epenthesis in word-initial and word-medial positions (e.g. stop /es.ˈtop/). Despite many shared phonological characteristics, Basque has a larger set of sibilants and palatals compared to Spanish.

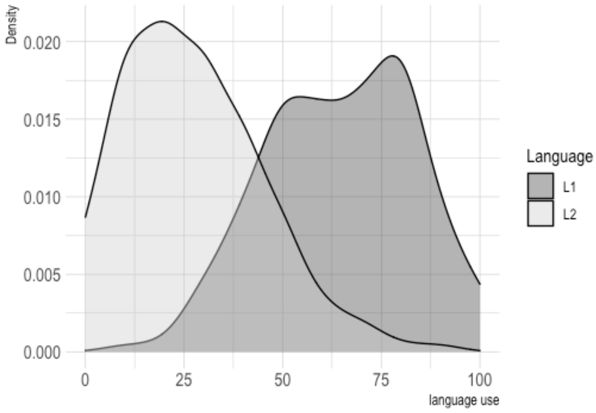
It is expected that there will be individual variation among speakers, with participants who use their L1 more frequently imitating phonotactically complex structures with less ease, resulting in more insertions, compared to active bilinguals who use their L1 less often. In the preliminary analysis reported here, imitation success was measured by schwa and /e/ insertion at the cluster onset and within the word.

3. METHODS

4.1. Participants

A total of 251 participants with self-reported normal hearing were recruited from the BCBL subject pool and received payment for their participation. We excluded 28 adults due to double/missing/noisy recordings or incomplete questionnaires. Participants who did not indicate Spanish and/or Basque as their L1/L2 were excluded from the analysis, leaving a final sample of 189 (mean age 22.9, SD 4.7, range 15-43, 99 women, 90 men, 106 simultaneous bilinguals who learned both languages from birth, 142 Spanish dominant, 47 Basque dominant). The amount of self-reported daily L1 use was used to calculate active bilingualism, as shown in Figure 1, which displays a density plot of the relative proportion of L1 and L2 use on a scale from 0 to 100, where 0 refers to no L1/L2 use. On average, speakers used their L1 64.8% of the time (SD 18.7) and L2 27% of the time (SD 17.7). None of the participants reported knowledge of any Slavic language. All but 17 of the participants indicated English as their dominant L2 or L3, all but two had knowledge of Basque, and all but six adults reported skills in an L3, using it 7% of the time (SD 8.1).

Figure 1: Density plot for the variable language use.



4.2. Material

The stimuli for the delayed repetition task comprised seven Slovak words (the dot indicates syllable boundaries): strč [str̩t͡ʃ] “stick”, žblnkot [ˈʒbl̩n.kot] “fizz”, šmrnc [ʃmr̩n͡ts] “twist”, žgrloška [ˈʒgr̩.lɔʃ.ka] “curmudgeon”, poštrngať [ˈpɔ.ʃtr̩n.gac] “clink glasses”, tvŕdza [ˈtvr̩.d͡za] “dire straits”, zvlchčiť [ˈzvl̩x.t͡ʃi̯c] “moisten”. A female Slovak speaker recorded the words in a soundproof booth at 44.1 kHz sampling rate with 16-bit resolution. She read the words in a clear speaking style at a normal speech rate with a flat intonation. For the nonword repetition task, five Spanish/Basque nonwords were selected from the Syllabarium database [27]. All nonwords were phonotactically permissible in both languages. A female Spanish/ Basque speaker recorded the nonwords and the instructions. The recordings were then cut into single speech files, normalized for amplitude, and put in one audio file together with the Spanish instructions using the Praat speech editor [26]. There was one experimental list with an identical randomisation across all participants.

4.3. Procedure

Participants were tested individually in a lab. Prior to the testing session, which took about five minutes, they filled in an extensive language background questionnaire, and most of them also completed language interviews to assess their Basque and/or Spanish skills. This was the standard procedure for participants registered in the subject pool.

In the first task, participants heard nonwords of increasing syllable length hrough head-phones, one at a time. In the delayed imitation task, participants were asked to listen to each Slovak word presented to them and repeat it twice after a short instruction presented in Spanish, which delayed the imitation. After the task, participants were asked to guess the language of the speaker, with only three participants guessing correctly.

4.4. Data Coding and Analysis

One Slovak speaker and one phonetically trained research assistant transcribed the imitations of the second repetition of each word. The agreement was low (78.6%), and a third rater is currently evaluating the data. Here, we focus on schwa and /e/ insertions, which were annotated by a third rater for a subset of 102 participants. The agreement was high (98.59%), and the first author resolved the remaining cases. Two research assistants transcribed the nonword-repetition task, and a third rater resolved 4.6% cases of disagreement. We calculated the average accuracy of correctly remembered items per participant.

The analysis focuses on vowel insertion at word onsets and within words, in which insertions were expected (e.g. in /s/ + obstruent clusters). One word that did not start with a cluster (poštrngať) was excluded from the analysis (there were no onset insertions and only 10% word-medially, with /u/ being the predominant insertion in this word). Epenthesis was taken as the dependent variable and was coded in a binary fashion (present or not). The variable L1 use was the main predictor (note that it strongly correlated with L2 use: Spearman’s $r(1321) = -.86$, $p < .001$). A mixed effect logistic regression model for binary responses was fitted to the data (glmer, implemented in the R package lme4, R Core Team, 2018 [28]). The full model included the main predictor and the control variables age and nonword repetition as fixed effects. Random intercepts for participants and items were included in both models. All continuous variables were centred and scaled.

5. RESULTS

Across all participants, the proportion of epenthesis was 48.2% (SD 23). The statistical model showed a main effect of L1 use (see Table 1), in that insertions increased with higher L1 use. None of the other two variables reached significance but there was a tendency for more insertions with increasing age. The result is in line with the hypothesis that bilingualism-related factors may predict production accuracy.

Fixed effects	*b*	*SE*	*z*	*p*
Intercept	0.281	0.451	0.622	0.534
L1 use	0.241	0.116	2.127	0.033
Age	0.229	0.117	1.955	0.051
Nonword rep.	0.075	0.115	0.658	0.510
Random effects				
σ^2	3.29			
$\tau_{00\ \text{Subject.ID}}$	1.46			
$\tau_{00\ \text{word}}$	1.14			
ICC	0.44			
N_{word}	6			
$N_{\text{Subject.ID}}$	189			
Observations	1134			
Marginal R^2 / Conditional R^2	0.019 / 0.404			

Table 1: Summary of the mixed effect model.

6. DISCUSSION

Foreign speech-sound learning exhibits substantial individual variability in adulthood. The aim of this study was to explore such differences during the very initial exposure to an L3 across Spanish and Spanish/Basque speakers. Schwa and /e/ insertions at the onset of a cluster and word-medially were used as proxies for articulation accuracy. The findings indicate an inverse relationship between L1 use and the number of vowel insertions, even after controlling for age and short-term memory, showing more insertions with an increasing L1 use. This suggests that active bilingualism may contribute to more accurate imitation of phonotactically complex words in an L3. Short-term memory did not affect vowel insertions, but there was a tendency for more insertions with increasing age, which is consistent with previous findings [4, 8].

The superior imitation skills during the initial stage of L3-phonetic learning as a result of active bilingualism cannot be easily explained by the linguistic and non-linguistic factors discussed in the introduction. Although learners' motivation or AoA were not accounted for in the present analysis, it is reasonable to assume that imitation skills are influenced by a complex interaction of multiple factors. In this study, the factor of interest was self-reported frequency of language use, which was operationalized as a continuous variable. Some may argue that such estimations are unreliable. However, recent studies on bilingual speech perception and production have shown that such approaches are valid. Language use has often been operationalized categorically using self-reports or by performance-based tasks, setting widely disparate grouping criteria. An alternative approach to capture the influence of additional languages on speech-related performance is to move away from categorical measures and instead examine input characteristics and the amount of use of different languages and varieties [30-32].

One advantage of the present design is that the effect of bilingualism may go beyond direct transfer from the bilingual's languages, because Spanish and Basque have similar phonological characteristics despite being typologically unrelated. Both languages prefer simple onsets with the maximal onset consisting of two CCs. However, there are some combinatorial restrictions within each language that require closer inspection, as they might affect overall performance. Dominant Basque speakers may have had advantages due to a larger number of sibilants and palatals compared to Castilian Spanish. Moreover, Castilian Spanish modifies /s/ + obstruent clusters by epenthesis in onset positions. Three of the Slovak clusters started with /s/ or /ʃ/, which could explain the higher frequency of epenthesis in speakers who primarily use Spanish. Indeed, an analysis limited to the onset epenthesis confirmed the effect of L1 use ($z = 2.55$, $p = .01$), refuting one of the reviewer's concerns that the present result are solely due to Slovak showing a tendency for an epenthetic schwa in clusters with syllabic consonants [34], which may be perceived vocalically by naïve listeners. All participants should be equally likely to perceive a schwa, but this was not the case.

Due to the time-intensive nature of transcriptions, the present analysis was limited to schwa and /e/ insertions. Further analyses will focus on phonetic distances based on features and factors such as proficiency in the additional languages of the participants. Replicating the effect reported here would provide stronger evidence for the role of bilingualism on imitation and would be consistent with previous studies that have shown facilitative effects of bilingualism on word learning [14-16]. It is reasonable to assume that active and proficient bilinguals have better imitation skills for L3 phonotactically complex words that arise as a result of experiential factors. The active use of multiple languages may enhance sensorimotor and perceptual flexibility, minimizing the influence of the other language articulatory habits. This explanation aligns with studies on foreign-accent imitation, where singers outperform instrumentalists due to their experience related to greater vocal flexibility [17].

In conclusion, these results suggest that imitation skills for complex words in an L3 may be predicted by bilingualism, as measured by daily use of phonologically but not typologically related languages.

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