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EMPIRICAL STUDY

Phonetic and Lexical Crosslinguistic Influence in Early Spanish–Basque–English Trilinguals

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A central question in multilingualism research is how multiple languages interact. Most studies have focused on first (L1) and second language (L2) effects on a third lan-

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guage (L3), but a small number of studies dedicated to the opposite transfer direction have suggested stronger L3 influence on L2 than on L1 in postpuberty learners. In our study, we provide further support for stronger L3-to-L2 than L3-to-L1 influence and show that it extends to (a) phonetics and the lexicon and (b) childhood learners. Fifty Spanish–Basque–English trilingual adults who had acquired Spanish from birth and Basque between 2 to 4 years of age through immersion participated in a speeded trilingual switching task measuring production of voice onset time and lexical intrusions. Participants experienced more phonetic and lexical crosslinguistic influence from L3 English during L2-Basque production than during L1-Spanish production. These findings show that even highly proficient early bilinguals experience differential influence from a classroom-taught L3 to L1 and to L2.

Keywords trilingualism; speech production; crosslinguistic influence; regressive transfer; phonetics; lexicon

Introduction

Learning a new language is an intricate task characterized by interference from the first language (L1; among many others, see Flege, 1995; Flege et al., 1999; Piske et al., 2001; Stoehr et al., 2017) and possibly from an already acquired second language (L2; e.g., Llama et al., 2010; Wrembel, 2010). Most research on phonetic or phonological[1] and lexical transfer in multilinguals has focused on progressive transfer, a type of crosslinguistic influence in which a L1 or L2 influences a more recently acquired third language (L3; for phonetics and phonology, see Cabrelli Amaro & Wrembel, 2016; for the lexicon, see De Angelis & Selinker, 2001; Hammarberg, 2001; Meisel, 1983). These studies have suggested that L3 learners' phonetic or phonological properties of speech production are primarily influenced by the L2 (e.g., Llama et al., 2010; Wrembel, 2010) or by both the L1 and the L2 (Llama & Cardoso, 2018; Wrembel, 2011), but the L3 lexicon is mostly influenced by the L2 in production, at least when L2 and L3 are typologically closer than are L1 and L3 (De Angelis & Selinker, 2001; Hammarberg, 2001; Meisel, 1983). In other language domains, especially in morphosyntax, the stronger influence of L2 on L3 than of L1 on L3 has been confirmed in both production and comprehension (for an overview, see Puig-Mayenco et al., 2020).

Languages are plastic systems that undergo constant change, and learning an additional language may also affect the linguistic systems of the already acquired languages. Regressive transfer is a type of crosslinguistic influence in which a more recently acquired language, usually a L3, impacts already acquired languages. This may lead to phonetic or phonological changes in

L1 and/or L2 speech production (Beckmann, 2012; Cabrelli Amaro, 2017b; Cabrelli Amaro & Rothman, 2010; Nelson, 2022) or the accidental use of L3 lexical items in L1 or L2, although this is an understudied area (e.g., de Bruin et al., 2023). Most research on phonological regressive transfer has suggested that L3 affects L2 more strongly than it affects L1, at least when the L2 has been acquired after puberty. For instance, in a small pilot study, L3 Portuguese impacted L2-Spanish speech production in English–Spanish–Portuguese trilinguals in a variety of phonological processes, including nasality, spirantization, vowel neutralization, and treatment of codas (Cabrelli Amaro & Rothman, 2010). No such effects were observed in L1-Spanish speech production by Spanish–English–Portuguese trilinguals. This pattern was later confirmed in a larger study, this time focusing on vowel reduction. L3 Portuguese influenced English–Spanish–Portuguese trilinguals' production of midvowels in word final position in L2 Spanish more than Spanish–English–Portuguese trilinguals' production in L1 Spanish (Cabrelli Amaro, 2017b). Stronger L3-to-L2 than L3-to-L1 influence has also been found in the phonetic domain. L1-German speakers with L2 English and frequent exposure to L3 Dutch produced English plosives in a more Dutch-like manner than did their peers with less frequent exposure to L3 Dutch, but plosive production in L1 German remained within native ranges regardless of L3-Dutch exposure (Beckmann, 2012). Longitudinal changes in plosive production after L3 onset have been demonstrated in L1-German–L2-English adolescent learners of L3 Polish. After learning L3 Polish in the classroom, adolescents' but not adults' plosive production changed in L2 English and also in L1 German (Nelson, 2022). These differences between adolescents and adults and the finding that the adolescents' L1 was also affected by their L3 were arguably due to less stable L1 and L2 systems in adolescents compared to adults. In contrast to the other studies reported above, these participants started learning their L2 before puberty (ages of acquisition were 6.5 and 9.4 years for the adolescents and adults, respectively), which may have contributed to the L1 and L2 behaving more similarly than in previous studies on postpuberty learners (Beckmann, 2012; Cabrelli Amaro, 2017b; Cabrelli Amaro & Rothman, 2010). Taken together, these findings suggested that a L2 is more prone to L3 phonetic and phonological influence than is a L1, at least in adults who acquired their L2 and L3 after puberty. It remains an open question whether the same applies to lexical influence.

Background Literature

Competing Hypotheses

The few studies investigating regressive phonological transfer predominantly observed a relatively stronger impact of the L3 phonological system on the L2 than on the L1. These findings led to the formulation of the phonological permeability hypothesis that predicts that a L2 acquired after puberty is more vulnerable to phonological L3 influence than the L1 due to differences in mental configuration driven by maturational constraints (Cabrelli Amaro & Rothman, 2010). Given the role of maturational constraints, the phonological permeability hypothesis argues that an early acquired L2 is not vulnerable and thus impermeable to L3 influence (Cabrelli Amaro & Rothman, 2010).

The L1 sound system has a very early window for nativelike acquisition in both perception (Best et al., 1995; Werker et al., 1981) and production (Flege et al., 1999). The L1 perceptual system is tuned to native sounds after the first year of life, and nonnative sounds are generally no longer distinguished (Best et al., 1995; Werker et al., 1981). The early acquisition window of the sound system also becomes evident in production as even L2 learners who started learning their L2 in immersion in early childhood may have a perceivably different accent from native speakers (Flege et al., 1999). For this reason, it is plausible that the sound system of a L2 acquired in early childhood, but after the first year of life, is more prone to L3 influence than is the L1 sound system. Our study tested this hypothesis by comparing L3-to-L1 and L3-to-L2 phonetic influence at the sound level in trilinguals who had acquired their L2 in early childhood.

Although evidence is sparse, the stronger influence of L3 on L2 than on L1 does not appear to be limited to the phonological domain and extends at least to morphosyntax (Cabrelli Amaro, 2017a; Cabrelli Amaro et al., 2015). This has been attested for subject-to-subject raising, a morphosyntactic feature inherent to Portuguese but absent from Spanish. In a grammaticality judgment task, L2-Spanish speakers rated ungrammatical sentences in Spanish manipulated to include Portuguese subject-to-subject raising as being significantly more acceptable than did L1-Spanish speakers (e.g., the sentence *Ana me parece adorar a Miguel* “Ana seems to me to adore Miguel” is ungrammatical in Spanish but grammatical in Portuguese). From these findings, the phonological permeability hypothesis was extended to the differential stability hypothesis (Cabrelli Amaro, 2017a) to include other language domains, thus suggesting that there is a fundamental difference in stability between early and late acquired languages in general.

Besides acquisition order, typological proximity between languages has been considered a crucial variable in multilingual crosslinguistic influence. In the research on progressive transfer, it has been suggested that the L3 starts out as a copy of the typologically closest previously acquired language (e.g., Leung, 1998; Rothman, 2015). Research on lexical transfer in Spanish–Basque–English trilingual children has shown that lexical items of Spanish—which is typologically more similar to English than is Basque—transferred more into English than Basque lexical items regardless of whether Spanish was the children's L1 or L2 (Cenoz, 2001, 2003). However, children with L2 Spanish experienced more lexical transfer from Spanish into English than did children with L1 Spanish, suggesting that a typologically similar L2 transfers more into the L3 than a typologically similar L1 (Cenoz, 2001).

A current line of research has suggested that regressive transfer may be similarly driven by typological proximity (Brown & Chang, in press). L3-Spanish speakers with L1 English and L2 German experienced greater influence from Spanish on speech rhythm in English than in German but no Spanish influence was observed in a group of bilinguals speaking L1 German and L2 English. On the assumption that Spanish is typologically closer to English than it is to German in terms of lexical overlap, the results led Brown and Chang (in press) to propose the similarity convergence hypothesis that states that a L3 has a relatively stronger impact on the typologically closest already acquired language. However, their finding that L3 Spanish only affected L1 English but not L2 English suggested that besides typological proximity, the order of acquisition also plays a role. Finally, not only general typological similarity but also structural similarity between specific linguistic properties may affect crosslinguistic influence. The degree and direction of transfer might depend on the structural similarity of the given properties between the languages (Westergaard et al., 2017).

In our study, we tested the differential stability hypothesis in a language combination in which the L3 (English) is typologically closer to the L1 (Spanish) than to the L2 (Basque). We considered general similarity between languages (Brown & Chang, in press; Rothman, 2015). Spanish and English have considerable lexical overlap (e.g., Schepens et al., 2012) and, as Indo-European languages, they are also grammatically similar. By contrast, Basque is a non-Indo-European highly inflected ergative and agglutinative language that is very distinct from English (Saltarelli, 1988). If the L3 were still found to influence the L2 more than the L1, it would provide strong evidence for the differential stability hypothesis and challenge the similarity convergence hypothesis. Moreover, we tested if the differential stability hypothesis also applies to a L2 acquired in early childhood.

Challenges in Trilingualism Research

Studies investigating regressive L3-to-L1 and L3-to-L2 influence are inherently affected by logistical challenges such as unbalanced language proficiency. For example, Cabrelli Amaro's (2017b) English–Spanish–Portuguese trilinguals lived in their L1 (English) environment and attended universities in the United States at the time of testing, suggesting they were strongly immersed in their L1, and their L2 was a classroom language. These differences between L1 and L2 environments may have made the L2 less stable than the L1 and thus more vulnerable to L3 influence. The Basque Autonomous Community in Spain is an optimal environment for recruiting more balanced bilinguals who use and are exposed to two languages daily. In the Basque Autonomous Community, Spanish and Basque have official status and are compulsory in education (Cenoz, 2005). In Donostia-San Sebastián—where we recruited the participants for our study—Spanish and Basque are omnipresent and routinely used in social contexts, and English is taught as a foreign language at school.

Recently, de Bruin et al. (2023) made use of this unique test environment and investigated lexical intrusions in Spanish–Basque–English trilinguals' speech production elicited in a speeded trilingual switching task. Their study compared progressive and regressive transfer by asking whether the L2 experiences greater influence from the L1 or L3. Despite participants' relatively low L3-English proficiency, their L2 Basque was affected more strongly by L3 English than by L1 Spanish. Our study also used Spanish–Basque–English trilinguals but compared regressive transfer in the L3→L1 and L3→L2 directions to test the differential stability and similarity convergence hypotheses. We specifically tested whether L3 English has a greater impact on L2 Basque than on L1 Spanish for phonetic transfer as measured through production of voice onset time (VOT). Since the differential stability hypothesis argues that regressive transfer may affect all language domains, we extended our question to lexical transfer and tested whether the participants produced more L3-English lexical intrusions in L2 Basque than in L1 Spanish.

Lexical Intrusions and Voice Onset Time

The (L1) lexicon seems to be a particularly vulnerable language domain since it is the first domain of language to undergo attrition, resulting from, for example, infrequent use due to immersion in a different language environment after emigration (Ecke, 2004; Paradis, 2004; Schmid, 2007). Although to our

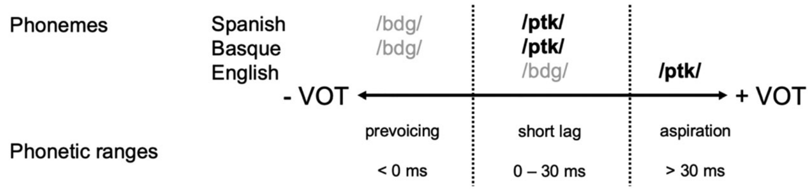

Figure 1 Voice onset time (VOT) in Spanish, Basque, and English. Relevant plosives /ptk/ in bold.

knowledge it has not yet been tested whether the L3 lexicon transfers more into the L1 or L2, research on the opposite direction of transfer has suggested a stronger link between the L2 and L3 lexicon, at least when these languages are typologically related (De Angelis & Selinker, 2001; Hammarberg, 2001; Meisel, 1983). Here, we investigated whether the L3 lexicon transferred more into a L2 that is typologically more distant from the L3 than is the L1.

VOT is among the most widely studied phonetic features in multilingualism research and it is similarly vulnerable to attrition (Cabrelli Amaro, in press). VOT is the time interval between a plosive's burst release and the onset of voicing (Lisker & Abramson, 1964). The VOT continuum (see Figure 1) can generally be divided into three phonetic categories: prevoicing (negative VOT), short lag (short positive VOT, usually < 30 ms) and aspiration (long positive VOT > 30 ms, usually around 70 ms).

Spanish and Basque are true voicing languages in which /ptk/ have short lag VOT (e.g., Lisker & Abramson, 1964; Souganidis et al., 2022), but English is an aspirating language in which /ptk/ have substantially longer aspirated VOT (e.g., Lisker & Abramson, 1964). Importantly, although Spanish–Basque–English trilinguals often do not produce monolingual-like aspiration in English, they generally produce longer VOT in English than in Spanish and Basque (Martínez Adrián et al., 2013). These phonetic differences between English, on one hand, and Spanish and Basque, on the other hand, constitute a suitable test case for the differential impact of L3 English on L2 Basque and on L1 Spanish.

The Present Study

Our study tested the differential stability and similarity convergence hypotheses by investigating whether a L3 impacts L2 or L1 production more strongly. We tested this potential influence through lexical and phonetic crosslinguistic influence in Spanish–Basque–English trilinguals' speech production. If we observed differential L3 influence on L1 and L2 in an early bilingual population, it would provide evidence that this effect is not restricted to postpuberty learners.

We adapted de Bruin et al.'s (2023) speeded trilingual switching task that has proven suitable for eliciting crosslanguage intrusions when administered as an online experiment, as we did in our study. In this task, the participants had to name pictures under time pressure, switching among Spanish, Basque, and English. All languages were highly active, thus increasing the possibility of observing L3 influence in L1 and L2 production (Cabrelli Amaro, in press). Importantly, the differential stability and similarity convergence hypotheses make opposite predictions regarding the outcome. Under the differential stability hypothesis, we expected lexical transfer to surface as more L3-English intrusions in L2 Basque than in L1 Spanish. This meant that Spanish–Basque–English trilinguals would incorrectly substitute English words for Basque words (e.g., *cheese* instead of *gazta*) more frequently than English words for Spanish words (e.g., *cheese* instead of *queso*). The opposite result—more L3-English intrusions in L1 Spanish than in L2 Basque—would be expected under the similarity convergence hypothesis. For phonetic transfer, the differential stability hypothesis predicts stronger L3-English influence on L2 Basque than on L1 Spanish, which in our study would manifest as longer (more L3-English-like) VOT in the speeded trilingual switching task compared to a baseline task blocked by language in L2 Basque but not in L1 Spanish. The similarity convergence hypothesis would predict the opposite results, with longer VOT in the speeded trilingual switching task compared to a baseline task blocked by language in L1 Spanish but not in L2 Basque.

Method

Participants

Fifty Spanish–Basque–English trilinguals completed the study (38 women, $M_{\text{age}} = 24.78$ years, $SD = 5.45$, $range = 18–39$ years; see Statistical Analyses section for sample size and statistical power information). Another nine participants started the study but either did not finish all three sessions ($n = 6$), had technical problems resulting in data loss ($n = 1$), or were ineligible to participate because they reported speaking a fourth language ($n = 2$). The participants resided in the Basque Autonomous Community in Spain, where they had also been born and raised. The participants reported their ages of acquisition for each language to research assistants trained to obtain this information. For all the participants, the acquisition order was L1 Spanish, L2 Basque

Table 1 Participant characteristics

	Spanish			Basque			English		
Characteristic	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range
Age of acquisition (years)	0.00	0.00	0–0	2.76	0.56	2–4	6.32	1.54	4–10
Vocabulary (0–65)	64.70	0.78	61–65	54.64	7.85	30–64	44.70	9.59	19–63
Word recognition (% correct)	93.70	3.71	85–100	86.44	7.37	69–99	66.07	9.62	47.5–95.0
Interview (1–5)	5.00	0.00	5–5	4.06	0.68	3–5	3.26	0.53	2–4
Self-reported exposure (%)	63.20	14.35	30–90	25.20	12.82	0–60	11.02	7.42	0–30

($M_{\text{AoABasque}}$ = 2.76 years, SD = 0.56, *range* = 2–4 years), and L3 English ($M_{\text{AoAEnglish}}$ = 6.32 years, SD = 1.54, *range* = 4–10 years). They acquired Spanish from birth in the home and Basque upon entering the school system that children can enter starting at two years of age. All but three participants reported that Basque was the primary language of instruction in their school. All participants learned English as a foreign language through formal instruction in school. Sixteen participants reported having spent some time in English-speaking countries (M = 4.63 months, SD = 4.77, *range* = 1–17 months).

We recruited the participants from the Basque Center on Cognition, Brain and Language's participant pool. As part of the participant pool registration process, the participants completed the Basque–English–Spanish Test (BEST; de Bruin et al., 2017), which includes three measures: (a) vocabulary knowledge obtained through picture naming, (b) word recognition assessed through lexical decisions similar to the original LexTALE (Lemhöfer & Broersma, 2012), and (c) general language proficiency assessed through semistructured interviews guided by a multilingual linguist and scored on a Likert-like scale from 1 (*lowest level*) to 5 *(native or nativelike level*). Across measures, the recruited participants had ceiling proficiency in Spanish, intermediate to high proficiency in Basque, and intermediate proficiency in English. Their self-reported exposure to Spanish was highest, followed by Basque, and then by English (see Table 1).

General Procedure

The participants took part in three online experimental sessions, each containing one task with one specific goal. The control task (Session 1) ensured that online experiments were sufficiently sensitive to detect VOT production differences between English and Spanish/Basque. The speeded trilingual switching task (Session 2)—our main experiment—tested for lexical intrusions and VOT influence from L3 English on L1-Spanish and L2-Basque production. The baseline task (Session 3) was also a speeded trilingual naming task but blocked by language, meaning that English was not strongly activated throughout the task. This baseline task used the same stimuli and number of repetitions of VOT stimuli as the speeded trilingual switching task to allow a direct comparison between the two tasks. One day after completing Session 1, the participants received the link to Session 2, and they received the link to Session 3 two weeks after completing Session 2. We programmed the experiments in jsPsych (de Leeuw, 2015) using the open-source study management system JATOS (Lange et al., 2015). We saved the participants' responses as .wav files with a 44.1 kHz sampling rate. We informed the participants that they would be using their three languages during the three sessions. At the beginning of each session, the participants gave informed consent and performed a microphone check; at the end of Session 1, they completed a language background questionnaire. We compensated the participants with €30 paid via bank transfer or PayPal. The Basque Center on Cognition, Brain and Language's Ethics Committee approved the study.

Picture Naming Control Task

In Session 1, the participants completed a picture naming task in Spanish, Basque, and English. This task ensured that the online experiments were suitable for detecting VOT production differences between English versus Spanish and Basque in a standard naming condition (5,000 ms response window) and in a speeded naming condition (900 ms response window as in the main experiment). This control task was important because speeded naming likely causes a faster speech rate (Ladefoged & Maddieson, 1996; Volaitis & Miller, 1992) that may lead to shorter VOT durations, possibly reducing the VOT difference between English and Spanish/Basque. Therefore, it was crucial to ensure that the participants produced longer VOT in English than in Spanish and Basque even in speeded naming because the main experiment that also employed speeded naming relied on this difference.

Materials

Within each language, we presented the same 15 plosive-initial items (5 /p/, 5 /t/, 5 /k/) in the standard and in the speeded naming conditions, resulting in a total of 90 productions per participant (3 languages × 15 items × 2 conditions). These items were mono- or disyllabic, stressed on the first syllable, and we could easily represent them with pictures. The vowels following the plosives were either high (6 Spanish, 6 Basque, 4 English), mid (6 Spanish, 7 Basque, 5 English) or low (3 Spanish, 2 Basque, 6 English). None of the words were true cognates between Spanish/Basque and English (see corrected orthographic Levenshtein distance as a measure of cognate rate in Appendix

S1 in the Supporting Information online). We took the pictures representing the items from the MultiPic database (Duñabeitia et al., 2018) when they were available (Basque 8/15; Spanish 12/15; English 14/15) or from open content online sources.

Procedure

First, we familiarized the participants with the picture–word pairs: They saw each picture–word pair on the screen and listened to an audio recording of the word provided by a L1 speaker.[2] We instructed the participants to repeat the word and press the "Enter" key to continue with the next trial. The repetition aimed at ensuring that the participants paid attention and did not move too quickly through the familiarization phase. We did not record these repetitions and provided no feedback for them. After familiarization, the picture naming task started. All pictures appeared in two blocked conditions: standard naming and speeded naming in fixed order. We broke up each condition into three language blocks. We presented the Spanish and Basque blocks in a randomized order and always presented English last. We chose this randomization structure because our participants habitually use Spanish and Basque—but not English—in day-to-day interactions. For this reason, we argued that the influence of Spanish and Basque on English would persist even if we presented the English block first. On the contrary, presenting the English block before the Spanish and/or Basque blocks might artificially have affected VOT production in these two languages. The participants could take breaks between the blocks. Each block started with instructions in the target language. Within each block, we randomized items. Each trial began with a fixation cross in the center of the screen for 1,000 ms. Afterward, the picture appeared for 5,000 ms in the standard condition and for 900 ms in the speeded condition. The trials ended with a blank screen for 500 ms. We instructed the participants to name the picture while it was on the screen, but in the speeded naming condition, the recorder remained active until the next trial started to ensure that the participants' full responses were recorded. The picture naming task—including familiarization—took around 20 minutes.

Speeded Trilingual Switching Task

In Session 2, the participants performed a speeded trilingual switching task to test whether L3 English transfers more into L2 Basque or L1 Spanish for the lexicon and phonetics.

Table 2 Trial distribution by language

Trial	Spanish	Basque	English	Total
Nonswitch	180	180	96	456
Switch	116	116	116	348
First[a]	4	4	4	12
Total	300	300	216	816

Note. [a]The first trial on a list was presented after an optional break.

Materials

We selected 12 pictures of noncognate words. The participants had to name these pictures repeatedly in Spanish, Basque, and English as indicated by a flag icon representing the target language and located in the upper right corner of the picture. The translations did not overlap in the initial sound in the three languages, which allowed us to identify crosslanguage intrusions even if only the onset of the word was produced (e.g., [tʃ] of *cheese* /tʃiːz/ produced instead of Basque *gazta* /gas̺ta/ or Spanish *queso* /keso/). We matched the stimuli on the number of phonemes and log frequency across Spanish and Basque (see Appendix S2 in the Supporting Information online). We obtained eight pictures representing the words from the MultiPic database (Duñabeitia et al., 2018) and selected four from open content sources on the internet.

Of these 12 stimuli, four were plosive-vowel-initial and had stress on the first syllable in Spanish (e.g., *tapa* /ˈta.pa/), four met these criteria in Basque (e.g., *tanta* /ˈtan.ta/), and four in English (e.g., *tail* /ˈteɪl/). We used these eight Spanish and Basque stimuli for the phonetic analyses; hereafter we refer to them as VOT stimuli. In total, the speeded trilingual switching task consisted of 816 trials composed of 300 Spanish trials, 300 Basque trials (both relevant for the analyses), and 216 English trials (see Table 2). We presented the pictures in 12 pseudorandomized lists of 68 words. Spanish, Basque, and English trials similarly preceded Spanish and Basque trials.

Procedure

First, the participants completed the familiarization phase described in Appendix S3 in the Supporting Information online. Afterwards, they started the speeded trilingual switching task. Within this task, each trial began with a fixation cross displayed in the center of the screen for 1,000 ms. Then, a picture appeared for 900 ms in the center of the screen and the flag icon in the picture's upper right corner provided the language cue. Each trial ended with 500 ms of blank screen. Recordings started at picture onset and remained active for 1,900 ms, but we instructed the participants to name the picture while it was visible. The participants could take optional breaks after 68 trials. The total duration of the task (excluding breaks) was 33 minutes.

Speeded Baseline Naming Task

In Session 3, the participants completed a speeded baseline naming task. We blocked this task by language but used the same materials and trial procedure as in the speeded trilingual switching task. This task provided the baseline VOT production. This was a crucial comparison because, despite being true voicing languages, Spanish and Basque may slightly differ in the exact VOT values (Souganidis et al., 2022). Moreover, VOT differs slightly from word to word, mostly depending on the plosive, the vocalic context, and the number of syllables, further complicating a direct comparison between Spanish and Basque words. This became clear when we compared Spanish and Basque VOT for the four VOT items that were also part of the larger set of words in the control picture naming task in Session 1: The participants produced these four Spanish and four Basque words with 19 ms and 23 ms VOT, respectively. This meant that, although Spanish and Basque have virtually identical VOT in general, word-specific characteristics alone might cause a small VOT difference regardless of transfer from English. For this reason, we included the speeded baseline naming task in Session 3, which allowed for a direct comparison between Basque words during switching and baseline tasks and Spanish words during switching and baseline tasks.

Materials

We also used the 12 pictures from the speeded trilingual switching task here. The Spanish and Basque blocks on which our main analysis focused each contained 204 trials that included 27 repetitions of the four VOT items in each language (i.e., 108 trials as in the speeded trilingual switching task) and 12 repetitions of the other eight items as fillers (i.e., 96 trials). The English block contained 62 trials. We presented the items in pseudorandomized order.

Procedure

The speeded baseline naming task had the same trial procedure and 900 ms response window as the speeded trilingual switching task. We counterbalanced Spanish and Basque blocks, and the English block always appeared last. We offered the participants two breaks within the Spanish and Basque blocks;

we gave no breaks in the shorter English block. The task took approximately 25 minutes.

Data Analysis

Acoustic Analyses

We conducted the phonetic analyses in the Praat software (Boersma & Weenink, 2021). The first author measured the VOT of voiceless plosives as the interval in milliseconds between the release of the burst and the onset of the following vowel, determined through visual inspection of the waveform and the spectrogram viewed at 0–5,000 Hz.

Statistical Analyses

We conducted the statistical data analyses in RStudio (RStudio Team, 2022) run on R (R Core Team, 2022) and using the lme4 package (Version 1.1-29; Bates et al., 2015). We obtained *p* values for *t* statistics through the lmerTest package (Version 3.1-3; Kuznetsova et al., 2017). We employed an alpha level of .05 for interpreting statistical significance. We log-transformed VOT as indicated by the Box–Cox transformation (Box & Cox, 1964) performed using the MASS package (Version 7.3-57; Venables & Ripley, 2002). We removed data points with standardized residuals more than 2.5 standard deviations from 0 using the LMERConvenienceFunctions package (Tremblay & Ransijn, 2020). We obtained marginal and conditional R^2 with the MuMIn package (Bartoń, 2022). We investigated significant interactions with Bonferroni-corrected pairwise comparisons using the emmeans package (Lenth, 2022). We visualized the data using the ggplot2 package (Version 3.3.6; Wickham, 2016). We have provided the result tables and model formulas for all analyses in the Supporting Information online. A databased power calculation using the MixedPower package (Version 0.1.0; Kumle et al., 2021) showed that a sample size of 50 provided high power for the effects of interest (i.e., 99.9% power for the fixed effect language in the lexical intrusion analysis and 100% power for the interaction of language and task in the VOT analysis; both based on 1,000 simulations).

Results

Picture Naming Control Task

Out of the possible 4,500 productions (15 target words × 2 conditions × 3 languages × 50 participants), the participants either incorrectly named or did not name 477 trials (57 Spanish, 184 Basque, 236 English). Of the remaining trials, we excluded 40 productions (18 Spanish, 18 Basque, 4 English) because

Table 3 Mean voice onset times in ms (*SD* in parentheses) by condition, language, and plosive

	Standard condition (5,000 ms)			Speeded condition (900 ms)		
Plosive	Spanish	Basque	English	Spanish	Basque	English
/p/	20 (6)	22 (7)	33 (14)	19 (6)	20 (6)	23 (8)
/t/	20 (5)	20 (6)	45 (14)	20 (6)	21 (7)	35 (11)
/k/	36 (8)	37 (10)	54 (19)	31 (8)	33 (10)	42 (13)

we could not measure VOT due to background noise and similar forms of interference. We removed another 79 trials (1.76% of the data) as outliers (see Statistical Analyses section). We analyzed the remaining 3,904 productions (1,405 Spanish, 1,273 Basque, 1,226 English). In the standard naming condition, the participants produced on average 26 ms VOT in both Spanish and Basque and 44 ms in English. In the speeded naming condition, the participants' VOT decreased slightly in Spanish ($M = 23$ ms) and Basque ($M = 25$ ms), and more so in English ($M = 33$ ms). Table 3 and Figure 2 show VOT durations by condition, language, and plosive.

The analysis tested whether the participants produced longer VOT in English than in Spanish and Basque in both naming conditions. Because VOT differs by place of articulation (labial /p/ < coronal /t/ < dorsal /k/; e.g., Volaitis & Miller, 1992) and gender (male < female; Swartz, 1992), we also included these variables in the model. The linear mixed-effects model had log-transformed VOT as the dependent variable with fixed effects for language, condition, plosive, and gender. We used deviation coding for the binary variables condition (standard 0.5; speeded −0.5) and gender (female 0.5; male −0.5). We used Helmert contrast coding for the three-level categorical variable language to create two contrasts of interest. The first contrast (language_ESB) compared the difference between the first level (English, an aspirating language) to the mean of the last two levels (Spanish and Basque, both true voicing languages). The second contrast (language_SB) compared the difference between the mean of the last two levels (i.e., Spanish vs. Basque). This coding scheme provided the maximal power to test for a difference between English versus Spanish and Basque (Schad et al., 2020). We used deviation coding for the three-level variable plosive to create two contrasts of interest. The first contrast (plosive_pt) compared /p/ [−0.5] to /t/ [0.5]; and the second contrast (plosive_tk) compared /t/ [−0.5] to /k/ [0.5]. These two contrasts captured the predicted VOT increase from /p/ to /t/ and

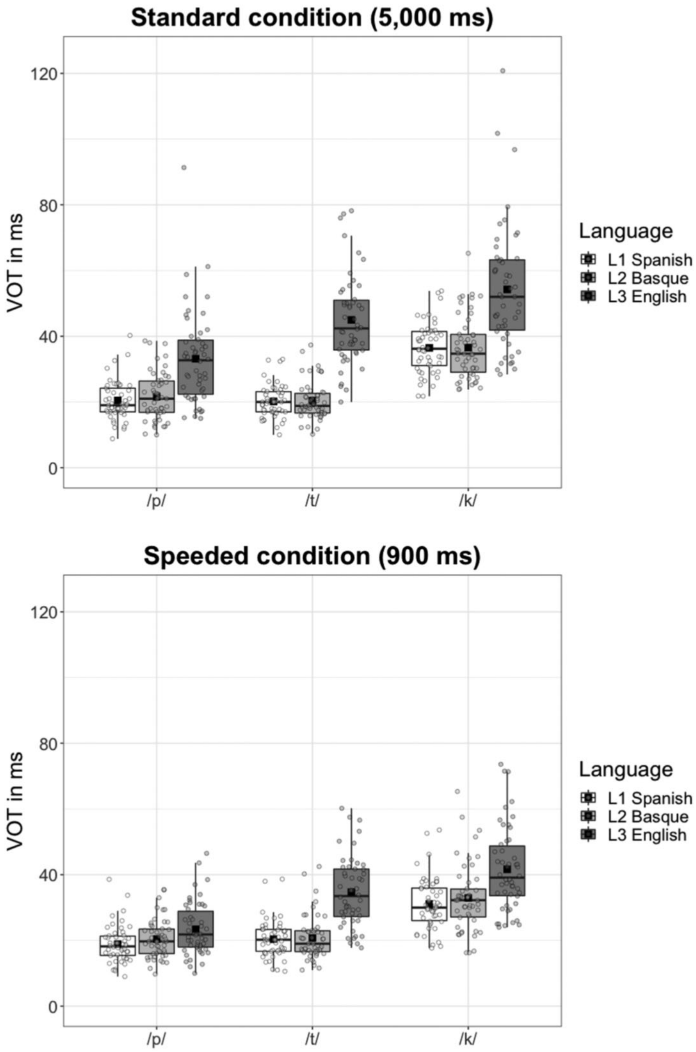

Figure 2 Voice onset times (VOT) by language and plosive in the standard (top) and speeded (bottom) naming conditions. Each dot shows an individual participant; the black square shows the mean.

from /t/ to /k/ (Volaitis & Miller, 1992). The model included a Language × Condition interaction term; we included random intercepts for participants and items, as well as by-participant random slopes for language, condition, and plosive and by-item random slopes for condition and gender.

The participants produced shorter VOT for /p/ than for /t/, $b = 0.509$, 95% CI [0.348, 0.670], $SE = 0.082$, $t = 6.185$, $p < .001$, and shorter VOT for /t/ than for /k/, $b = 0.541$, 95% CI [0.382, 0.699], $SE = 0.081$, $t = 6.688$, $p < .001$. A significant effect of language_ESB showed that L3 English had longer VOT than L1 Spanish and L2 Basque, $b = 0.375$, 95% CI [0.227, 0.523], $SE = 0.076$, $t = 4.965$, $p < .001$. We observed no significant effect of language_SB, suggesting that Spanish and Basque VOT were not detectably different, $b = -0.019$, 95% CI [−0.176, 0.137], $SE = 0.080$, $t = -0.243$, $p = .810$. The standard naming condition elicited longer VOT than the speeded condition, $b = 0.131$, 95% CI [0.083, 0.178], $SE = 0.024$, $t = 5.395$, $p < .001$, and a significant Condition × Language_ESB interaction showed that the effect of condition differed between languages, $b = 0.198$, 95% CI [0.142, 0.255], $SE = 0.029$, $t = 6.855$, $p < .001$. We observed no other significant main effects or interactions (see Appendix S4 in the Supporting Information online for results table).

Pairwise comparisons by language showed that the effect of condition was strongest in L3 English ($M_{\text{standard}} = 3.63$, 95% CI [3.48, 3.78]; $M_{\text{speeded}} = 3.37$, 95% CI [3.24, 3.50]), $b = -0.263$, $SE = 0.031$, $z = -8.442$, $p < .001$, substantially smaller in Spanish ($M_{\text{standard}} = 3.16$, 95% CI [3.02, 3.29]; $M_{\text{speeded}} = 3.08$, 95% CI [2.96, 3.20]), $b = -0.078$, $SE = 0.030$, $z = -2.570$, $p = .010$, and absent in Basque ($M_{\text{standard}} = 3.16$, 95% CI [3.02, 3.30]; $M_{\text{speeded}} = 3.11$, 95% CI [2.98, 3.24]), $b = -0.051$, $SE = 0.031$, $z = -1.653$, $p = .098$. Of critical importance for the main experiment, pairwise comparisons by condition demonstrated that in both conditions, VOT was longer in L3 English than in L1 Spanish: standard condition ($M_{\text{English}} = 3.63$, 95% CI [3.48, 3.78]; $M_{\text{Spanish}} = 3.16$, 95% CI [3.02, 3.29]), $b = 0.477$, $SE = 0.094$, $z = 5.10$, $p < .001$; speeded condition ($M_{\text{English}} = 3.37$, 95% CI [3.24, 3.50]; $M_{\text{Spanish}} = 3.08$, 95% CI [2.96, 3.20]), $b = 0.293$, $SE = 0.079$, $z = 3.72$, $p < .001$, and in L3 English than in L2 Basque: standard condition ($M_{\text{English}} = 3.63$, 95% CI [3.48, 3.78]; $M_{\text{Basque}} = 3.16$, 95% CI [3.02, 3.30]), $b = 0.472$, $SE = 0.095$, $z = 4.972$, $p < .001$; speeded condition ($M_{\text{English}} = 3.37$, 95% CI [3.24, 3.50]; $M_{\text{Basque}} = 3.11$, 95% CI [2.98, 3.24]), $b = 0.260$, $SE = 0.080$, $z = 3.248$, $p = .004$. In sum, the results of the control picture naming task confirmed that online experiments and speeded naming were suitable for eliciting the expected VOT differences between English versus Spanish and Basque in Spanish–Basque–English trilinguals.

Speeded Trilingual Switching Task

In the speeded trilingual switching task, we analyzed L1-Spanish and L2-Basque nonswitch trials to test whether L3 English transfers more strongly into L2 Basque or into L1 Spanish for the lexicon, assessed through lexical intrusions, and phonetics, assessed through VOT production. We analyzed only nonswitch trials to eliminate the immediate influence of the participants' having just used another language.

Lexical Transfer

For the lexical analysis, we counted responses as intrusions regardless of how much of the intrusion was produced (e.g., when only the [tʃ] of *cheese* was produced when Basque *gazta* was required, we counted it as an English intrusion, following de Bruin et al.'s, 2023, procedure). In the case of multiple productions, we scored the first response. For example, if a crosslanguage intrusion was followed by a self-correction (e.g., *cheese gazta* when Basque *gazta* was required), we scored the first response and counted it as an English intrusion. Each participant completed 180 Spanish and 180 Basque nonswitch trials. For one participant, seven nonswitch trials (4 Spanish & 3 Basque) were not saved. The total number of nonswitch trials was 8,996 in Spanish and 8,997 in Basque. The participants responded correctly to 7,802 Spanish trials (86.73%) and to 6,891 Basque trials (76.59%). In the Spanish trials, the participants used a within-language synonym in 90 trials (1.00%), incorrectly named 396 trials in Basque (4.40%), gave an unintelligible response in 53 trials (0.59%), and gave no response in 459 trials (5.10%). In the Basque trials, the participants used a within-language synonym in 139 trials (1.54%), incorrectly named 469 trials in Spanish (5.21%), gave an unintelligible response in 57 trials (0.63%), and gave no response in 1,028 trials (11.43%). Notably, the participants produced more L3-English intrusions in L2 Basque (406 trials, 4.51%) than in L1 Spanish (194 trials, 2.16%). All but two participants produced L3-English intrusions.

We used a generalized linear mixed-effects model (family Poisson) to test whether the difference between the number of L3-English intrusions in L1 Spanish and L2 Basque was significant. The model had language (deviation coded as Spanish −0.5; Basque 0.5) as a fixed effect and included random intercepts for participants and pictures with by-participant and by-picture random slopes for language. A significant effect of language showed that the number of L3-English intrusions was higher in L2 Basque than in L1 Spanish, $b = 1.106$, 95% CI [0.623, 1.583], $SE = 0.244$, $z = 4.540$, $p < .001$ (see Figure 3 and Appendix S5 in the Supporting Information online for results table).

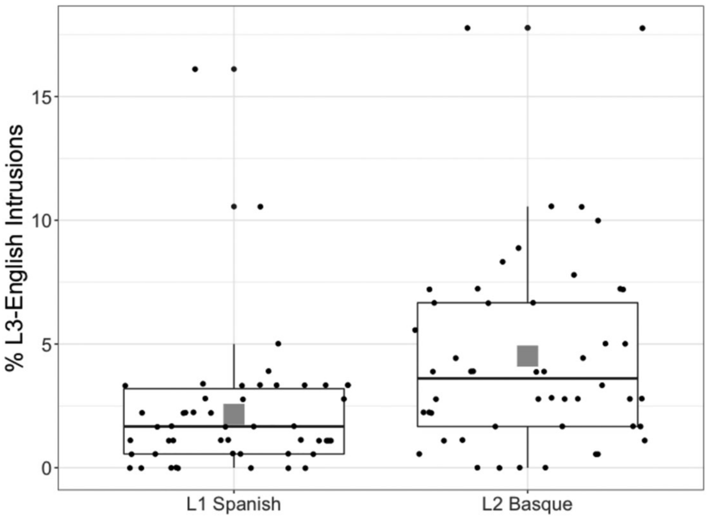

Figure 3 L3-English intrusions during L1-Spanish and L2-Basque nonswitch trials. Each black dot shows an individual participant; the grey square shows the mean.

Phonetic Transfer

Next, we analyzed the VOT trials from the speeded trilingual switching and speeded baseline naming tasks to determine whether VOT increased more from baseline to switching in L2 Basque or in L1 Spanish. Each participant completed 108 VOT nonswitch trials in the speeded trilingual switching task and another 108 VOT trials in the speeded baseline naming task in both Spanish and Basque, resulting in 432 possible productions per participant. As we described above, due to a technical problem, we lost four VOT trials from the switching task (2 Spanish; 2 Basque) for one participant, resulting in a total of 21,596 possible productions for all 50 participants combined. We removed trials for which the participants provided an incorrect response (507 Spanish [2.35%]; 545 Basque [2.52%]), as we did for trials in which we could not measure VOT due to background noise and similar forms of interference (177 Spanish [0.82%]; 247 Basque [1.14%]). We removed another 405 trials (1.88% of the data) as outliers (see Statistical Analyses section). We analyzed the remaining 19,715 productions (91.29% of the data; 9,909 Spanish trials; 9,806 Basque trials).

We ran a linear mixed-effects model to test whether the presence of L3 English during the speeded trilingual switching task was associated with longer VOT production compared to baseline in L2 Basque or in L1 Spanish. In contrast to the lexical intrusion analysis, we avoided a direct comparison between Spanish and Basque VOT because VOT changes slightly from word to word. For this reason, we might have observed longer VOT in Basque than in Spanish and falsely concluded that this was due to L3-English influence, although it resulted only from between-word differences. Consequently, we included the speeded baseline naming task blocked by language, which allowed for a within-language comparison with the same items. The model had log-transformed VOT as a continuous dependent variable and language (deviation coded as Spanish −0.5; Basque 0.5) and task (deviation coded as baseline −0.5; switching 0.5) as fixed effects including an interaction term. Due to the absence of a gender effect in the control task, we did not add gender as a variable. The model had random intercepts for participants and items with by-participant random slopes for language and task and by-item random slopes for task. The model detected a significant Language × Task interaction, $b = 0.314$, 95% CI [0.250, 0.378], $SE = 0.033$, $t = 9.657$, $p < .001$. We detected no significant main effects (see Appendix S6 in the Supporting Information online for results table). Pairwise comparisons by language showed that in L1 Spanish, participants produced shorter VOT in the speeded trilingual switching task ($M = 20.6$ ms [2.89 ms(log)], 95% CI [2.56, 3.19]) than in the speeded baseline naming task ($M = 23.1$ ms [3.03 ms(log)], 95% CI [2.68, 3.36]), $b = 0.147$, $SE = 0.041$, $z = 3.603$, $p < .001$. We detected the opposite pattern in L2 Basque, where the participants produced longer VOT in the speeded trilingual switching task ($M = 28.3$ ms [3.23 ms(log)], 95% CI [2.92, 3.55]) than in the speeded baseline naming task ($M = 24.7$ ms [3.09 ms(log)], 95% CI [2.73, 3.40]), $b = -0.167$, $SE = 0.041$, $z = -4.094$, $p < .001$ (see Figure 4). This suggested that the strong coactivation of L3 English (which has longer VOT) during the speeded trilingual switching task was associated with a VOT increase in L2 Basque but not in L1 Spanish, providing evidence for stronger L3-to-L2 phonetic transfer.

Exploratory Analyses

To explore whether L2 Basque proficiency played a determining role in L3 transfer during L2 production, we took participants' Basque language background measures (vocabulary knowledge, word recognition, and interview) and calculated one composite Basque score ((% vocabulary knowledge + % word recognition + % interview) / 3) and added it as a predictor to the analyses on the Basque data.[3]

For the lexical intrusion analysis, we considered only the Basque data from the 46 participants who produced English intrusions during L2-Basque trials. We ran a generalized linear mixed-effects model (family Poisson) to

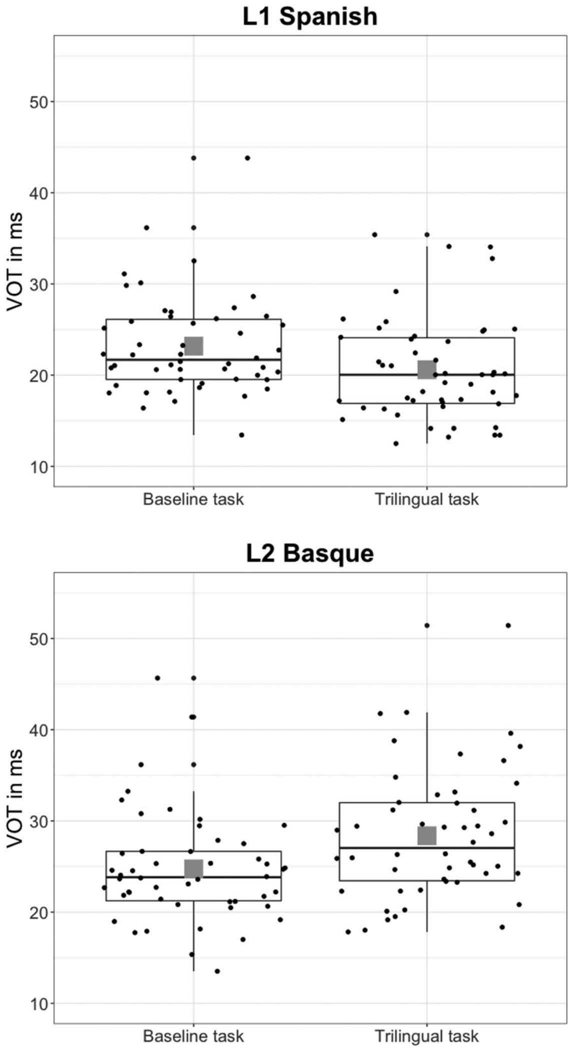

Figure 4 L1-Spanish (top) and L2-Basque (bottom) voice onset time (VOT) duration in the baseline task and speeded trilingual switching task (nonswitch trials). Each black dot shows an individual participant; the grey square shows the mean.

test whether the number of L3-English intrusions during L2-Basque production was associated with Basque proficiency. The model had Basque score (centered and scaled) as a fixed effect and included random intercepts for participants and pictures. A significant effect of Basque score showed that the participants with lower Basque scores produced more English intrusions during Basque production than did the participants with higher Basque scores, $b = -0.182$, 95% CI [−0.310, −0.054], $SE = 0.065$, $z = -2.780$, $p = .005$ (see Appendix S7 in the Supporting Information online for results table).

To test for a possible effect of Basque proficiency on phonetic transfer from L3 English to L2 Basque, we ran a linear mixed-effects model with log-transformed VOT as a continuous dependent variable and task (deviation coded as baseline −0.5; switching 0.5) and Basque score (centered and scaled) as fixed effects including an interaction term. The model had random intercepts for participants and items with by-participant and by-item random slopes for task. The model did not detect a significant effect for Basque score, $b = 0.047$, 95% CI [−0.009, 0.103], $SE = 0.029$, $t = 1.633$, $p = .109$, or a significant Basque Score × Task interaction, $b = -0.036$, 95% CI [−0.098, 0.027], $SE = 0.032$, $t = -1.122$, $p = .267$ (see Appendix S8 in the Supporting Information online for results table). In sum, Basque proficiency seemed to be a relevant predictor for lexical but not phonetic crosslinguistic influence from L3 English to L2 Basque.

Discussion

Our study investigated the differential impact of a L3 on a L1 and a L2 in terms of the lexicon and phonetics. We tested 50 early Spanish–Basque–English trilingual adults in the Basque Autonomous Community in Spain, where they were immersed in a Spanish–Basque-speaking environment. Participants acquired L1 Spanish from birth, L2 Basque shortly after within the community ($M_{\text{AoA}} = 2.76$ years), and English as a foreign language in the classroom ($M_{\text{AoA}} = 6.32$ years). We tested the participants in a speeded trilingual switching task and a speeded baseline naming task. Results showed more L3-English lexical and phonetic influence in L2-Basque production than in L1-Spanish production.

Support for and Extension of the Differential Stability Hypothesis

The L2–L3 link has been reported as being stronger than the L1–L3 link in a range of studies focusing on phonological and lexical progressive transfer, that is, transfer from either L1 or L2 to L3 (e.g., De Angelis & Selinker, 2001; Hammarberg, 2001; Llama et al., 2010; Meisel, 1983; Wrembel, 2010). This stronger L2–L3 than L1–L3 link has also been confirmed in a small number of studies investigating regressive transfer, the opposite direction of transfer from a L3 to a L1 and/or L2, which was also the focus of our study. For instance, phonological and morphosyntactic influence from Portuguese to Spanish has been found to be stronger in production of English–Spanish–Portuguese trilinguals (L3→L2) than in Spanish–English–Portuguese trilinguals (L3→L1; Cabrelli Amaro, 2017a, 2017b; Cabrelli Amaro & Rothman, 2010). This research on regressive transfer led to the differential stability hypothesis that assumes early and late acquired linguistic systems fundamentally differ in stability, resulting in a late acquired L2 being more permeable than a L1 to L3 influence (Cabrelli Amaro, 2017a). We argued that since the L1 sound system has a very early window for nativelike acquisition in both perception (Best et al., 1995; Werker et al., 1981) and production (Flege et al., 1999), a L2 acquired after the first year of life should also be more prone to L3 influence than the L1. In our study, we therefore predicted that L3-English phonetics should transfer more into L2 Basque than into L1 Spanish even in early bilinguals. The competing hypothesis, the similarity convergence hypothesis, claims that typological similarity between languages determines crosslinguistic regressive transfer (Brown & Chang, in press). Here, this would mean that L3 English transfers more strongly to L1 Spanish than to L2 Basque because English and Spanish (two Indo-European languages) are more closely related than are English and Basque (a non-Indo-European language isolate).

Our results support the differential stability hypothesis as L3 English transferred more into L2-Basque production than into L1-Spanish production not only for phonetics but also for the lexicon. When the participants were supposed to name a picture in L2 Basque, they were more likely to provide an English word than when they were supposed to name a picture in L1 Spanish. Furthermore, the participants produced longer VOT in L2 Basque in the speeded trilingual switching task in which L3 English was strongly coactivated by the nature of the task than in the speeded baseline naming task blocked by language. In L1 Spanish, the opposite pattern emerged: The participants produced shorter VOT in the speeded trilingual switching task than in the speeded baseline naming task.

This unexpected durational change in L1 Spanish appeared to be due to speech rate: The participants spoke faster in the speeded trilingual switching task ($M_{\text{SpanishWordDuration}} = 351$ ms) than in the speeded baseline naming task $M_{\text{SpanishWordDuration}} = 367$ ms). A faster speech rate may lead to shorter VOT duration, as has been reported for English (Ladefoged & Maddieson, 1996; Volaitis & Miller, 1992), and we too observed a small durational VOT change in Spanish in our standard and speeded picture naming task conducted in Session 1. Speech rate, however, cannot account for the durational VOT changes in L2 Basque: The participants also spoke faster in Basque in the speeded trilingual switching task ($M_{\text{BasqueWordDuration}} = 354$ ms) than in the speeded baseline naming task ($M_{\mathrm{BasqueWordDuration}} = 370$ ms), but their VOT was nevertheless longer in the speeded trilingual switching task. Due to the VOT differences between English (an aspirating language) and Spanish and Basque (both true voicing languages), we take this VOT increase in L2 Basque as evidence for phonetic crosslinguistic influence from L3 English.

Importantly, these findings allow us to extend the differential stability hypothesis in two ways. First, the differential stability hypothesis, which had previously been tested only on phonology and morphosyntax, has now been confirmed for new language domains: phonetics and the lexicon. Second, our findings show that the differential stability hypothesis is confirmed for a new population: early immersed bilinguals. Prior to this study, the differential stability hypothesis had been tested on trilinguals who learned their L2 and L3 postpuberty. Our participants, however, acquired L1 Spanish and L2 Basque in early childhood and grew up and resided in a bilingual community. We argue that this early trilingual population should still meet the differential stability hypothesis' predictions for phonetics because the L1 perceptual sound system is in place after the first year of life (e.g., Best et al., 1995; Werker et al., 1981) and even people who start learning a L2 in earliest childhood in immersion may develop a perceivable foreign accent (Flege et al., 1999). Notably, also the L3 lexicon interfered more in L2 than in L1, although the lexicon is a language domain without a critical acquisition time window (e.g., see James et al., 2017, for an association between rich vocabulary knowledge and better acquisition of new vocabulary). This implies that age of acquisition is not the sole variable accounting for regressive transfer, as we will discuss in the following section.

In sum, our results are in line with the differential stability hypothesis and demonstrate stronger L3→L2 than L3→L1 transfer for phonetics as well as for the lexicon. This holds despite a closer typological relation between L3 (English) and L1 (Spanish) than L2 (Basque). Consequently, the similarity convergence hypothesis (Brown & Chang, in press) that takes typological similarity as determining variable for regressive transfer cannot explain our findings.

Age of Acquisition and Proficiency

Our finding that the L3 lexicon affected the early acquired L2 more than the L1 challenges the differential stability hypothesis' assumption that age of acquisition is the determining variable that makes a L2 more vulnerable than the L1 to L3 influence. One important confound in bilingualism research is that a later age of acquisition often goes hand in hand with lower proficiency, at least when comparing the L1 and L2 (e.g., Schulz & Grimm, 2019). In fact, the differential stability hypothesis presumes that participants have similar proficiency in

L1 and L2. This prerequisite, however, often cannot be met, especially in post-puberty leaners whom the differential stability hypothesis targets.

Using the comprehensive language background measures of our participants, we explored whether proficiency was a determining variable in lexical and phonetic crosslinguistic influence from L3 English into L2 Basque. Indeed, the less proficient a participant was in Basque, the more English intrusions that participant produced in Basque, but we detected no association between Basque proficiency and phonetic influence from L3 English. These findings may suggest that both age of acquisition and L2 proficiency play a crucial role in L3→L2 crosslinguistic influence: For early acquired features or language domains such as phonetics, proficiency may not be a determining variable. This may also be related to the similarity between Basque and Spanish voiceless plosives, which are phonologically and phonetically identical, suggesting that our participants had targetlike representations for L2-Basque voiceless plosives despite having overall lower proficiency in L2 Basque than in L1 Spanish. For the lexicon, however, where no critical acquisition window exists (e.g., James et al., 2017), we showed that L2 proficiency predicted how much crosslinguistic influence occurred from L3 to L2. Importantly, when adding L2 exposure to the model, it did not explain the results, $b = -0.095$, 95% CI [−0.223, 0.032], $SE = 0.65$, $z = -1.463$, $p = .144$. This highlights the contribution of L2 proficiency specifically to the number of L3 lexical intrusions in L2.

The L3–L2 Link

Regardless of the reasons driving the differential impact of L3 on L2 versus on L1, our research suggests a stronger link between L3 and L2 than between L3 and L1. Further support for the strong link between L3 and L2 has recently been found using a population and methodology similar to those of our study (de Bruin et al., 2023). Spanish–Basque–English trilinguals with intermediate proficiency in L2 Basque and L3 English showed more L3 than L1 intrusions during L2 naming. This finding emphasizes the strength of the L3–L2 link, as the relatively weak L3 interfered more with L2 naming than did the L1 that was by far the most proficient language for these participants.

If the L3–L2 link is universally stronger than the L3–L1 link, the L2 should also transfer more into the L3 than the L1 should transfer into the L3. In the context of our study, this means that participants' L3-English production should have been disrupted more by L2 Basque than by L1 Spanish despite L1 Spanish being the most proficient and dominant language. An exploratory analysis of L3-English nonswitch trials (see Appendix S9 in the Supporting

Information online for full information) confirmed this prediction: During L3-English nonswitch trials, the participants erroneously named more trials in L2 Basque ($M = 6.10\%$) than in L1 Spanish ($M = 2.42\%$). Notably, the participants who produced more L3-English intrusions in L2 Basque also produced more L2-Basque intrusions in L3 English.

The combined findings on the larger number of L3-English intrusions in L2 Basque, the larger number of L2-Basque intrusions in L3 English, and the correlation between the two provide evidence for a stronger bidirectional link between L3 and L2 than between L3 and L1. Importantly, this stronger L3–L2 link cannot be due to typological similarity between L3 and L2 since in our study, the L3 (English) was more closely related to the L1 (Spanish) than to the L2 (Basque). Moreover, the stronger L3–L2 link cannot be explained by greater cognitive similarities between L3 and L2 due to similarities in learning (e.g., Bardel & Falk, 2007), because the L2 was acquired through natural exposure within a bilingual community and not through formal classroom instruction, as was the case for the L3. Finally, we cannot explain our results by differences in language inhibition. For instance, de Bruin et al. (2023) demonstrated that overall stronger L1 inhibition could explain their finding of more L3 than L1 interference during L2 production. Stronger L1 than L2 inhibition can also explain our finding that L2 Basque interfered more than L1 Spanish during L3-English naming. Poorer L3 inhibition, however, cannot explain why L3 English transferred more into L2 Basque than into L1 Spanish for the lexicon and phonetics.

Language of Instruction

Although the observed influence of L3 English on L2 Basque was highly significant in all analyses, the influence was small: Less than 5% of participants' L2-Basque production was disrupted by L3-English intrusions, and the VOT increase in L2 Basque was on average fewer than four milliseconds. Moreover, no L3-English intrusions occurred in the speeded baseline naming task, which was blocked by language, suggesting that interference from L3 English was limited to a task which required strong coactivation of English. One possible reason for these results may be related to the participants' education: 47/50 participants were predominantly schooled in Basque and reported that their teachers used Basque and English during English classes. Although L3 learning through L2 instruction could create stronger L2–L3 than L1–L3 lexical links (which could explain the stronger interference between L2 and L3), previous work has suggested that the language of foreign language instruction modulates the amount of nonnative language transfer in the opposite direction.

When a new language is learned through L1 instruction, the L2 interferes more than the L1. However, if a new language is learned via the L2, no differences have been observed in L1 and L2 interference (Tomoschuk et al., 2021). This might be because interference between a L2 and L3 can be controlled better when the L3 is acquired in a L2-instruction environment. Since almost all our participants learned L3 English through L2-Basque instruction, this may have reduced interference between L3 and L2.

Conclusion

The predominant focus of L3 research has been on the progressive influence that L1 and L2 may have on L3, and only a small number of studies have been concerned with the possible regressive influence a L3 may have on a L1 and L2. Here, we provided new evidence for a stronger regressive L3–L2 than L3–L1 link in the domains of phonetics and the lexicon. For phonetics, an early acquired language domain, the L2–L3 link held independent of L2 proficiency. For the lexicon, a language domain without a critical acquisition age, we demonstrated that L2 proficiency is linked to the degree of L3 interference in L2 production. Moreover, we provided further support for the stronger L3–L2 than L3–L1 link by showing that in the opposite (i.e., progressive) direction, our participants experienced more L2-to-L3 than L1-to-L3 lexical transfer in production.

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Notes

1 The distinction between phonetic and phonological transfer is not always clear-cut. We considered phonetic transfer to be a change in the phonetic properties of speech sounds and phonological transfer to be a long-term change in representations resulting in loss of a phonological contrast (Chang, 2019).
2 Basque: male L1-Basque speaker from Tolosa; Spanish: female L1-Spanish speaker from Donostia-San Sebastián; English: female L1-American English speaker from the Midwestern United States.
3 We did not consider Spanish proficiency because all participants had ceiling proficiency.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Accessible Summary (Basque)
Accessible Summary (English)
Accessible Summary (Spanish)
Appendix S1. Control Picture Naming Task (Session 1).
Appendix S2. Speeded Trilingual Switching Task (Session 2) and Speeded Baseline Naming Task (Session 3) and Variable Matching across Spanish and Basque.

Appendix S3. Familiarization Procedure.
Appendix S4. Results for Control Picture Naming Task.
Appendix S5. Results for English Intrusions in the Speeded Trilingual Switching Task.
Appendix S6. Results for Voice Onset Time Production in the Speeded Trilingual Switching and Baseline Tasks.
Appendix S7. Results for English Intrusions in the Speeded Trilingual Switching Task (Basque Trials; Basque Score Included).
Appendix S8. Results for Voice Onset Time Production in the Speeded Trilingual Switching and Baseline Task (Basque Trials; Basque Score Included).
Appendix S9. Spanish and Basque Lexical Intrusions During English Naming.