EFFECTS OF LEARNING AN ADDITIONAL LANGUAGE ON VOT PERCEPTION

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ABSTRACT

Studies on cross-linguistic influence often investigate the effect of the L1 on subsequently learned languages. This paper reports the results of two studies exploring the effect of language learning on the perception of VOT in the L2/L3 but also in the L1. First, Spanish learners of English differing in learning setting and experience identified stimuli from a /pi/-/bi/ continuum in English and in Spanish. Then, two groups of Mandarin speakers living in Spain performed similar identification tasks involving Mandarin, English (L2) and Spanish (L3).

Evidence of bidirectional cross-linguistic influence was found: a) experienced learners resembled native target language speakers more closely than inexperienced learners showing a positive effect of L2 exposure; b) L2/L3 learners differed from monolingual speakers of their native languages indicating an effect of L2/L3 on L1. Still, little evidence of separate perceptual systems was found among bilinguals and trilinguals. Results are discussed in light of previous findings.

Keywords: L2 perception, L3 acquisition, VOT, L1 attrition

1. INTRODUCTION

Amount of second language (L2) experience has often been shown to have a positive effect on L2 performance, both in perception and production (e.g. [3, 11, 13]). For instance, Bohn and Flege [3] reported that German experienced learners of English, but not inexperienced learners, relied more on spectral cues than on duration in their perception of the English /ɛ/-/æ/ contrast, in line with English monolinguals. Still, some studies have failed to find an effect of L2 experience. Cebrian [7] found no difference in the perception of /i/-/ɪ/ between Catalan learners of English in their home country and long-term Catalan residents in Canada. Interestingly, Cebrian found that the Catalans living in Canada were less accurate in their L1 perception than the L2 learners in Spain, showing an effect of L2 experience on the L1.

Recent work has also explored the nature of cross-linguistic influence in cases of additional or third language (L3) acquisition. These studies explore the role that previous learnt languages play in the acquisition of a new language. Factors suggested to contribute to cross-linguistic influence (CLI) include typological proximity, proficiency, recency of use and exposure, among others [9, 18]. Some scholars argue that the mother tongue is the main source of CLI [15], while others propose it is the L2 [10, 12] or a combined effect of both [23].

While many studies examine the effect of L1 on L2 or L3, few studies have looked at regressive influence, i.e., the effect of later learnt languages on the previous ones [4, 20, 21, 23]. According to the Phonological Permeability Hypothesis [5], a L2 phonological system is less resistant to L3's effect than the L1 since the L1 system is more stable than the L2. Evidence was found in L3 Portuguese influence on L2 Spanish vowel production by L1 English speakers who had acquired Spanish after the age of 12 [4]. The effect of L3 on L2 was not found in perception. Further, Wrembel [23] found that L1 Polish, L2 English and L3 French leaners were successful in producing native-like stops in their L2, but not in their L3, despite similarities between the L1 and the L3. Moreover, learners produced L1 /t, k/ with longer VOT than Polish monolinguals did, but not /p/. Finally, Sypiańska [21] compared the production of vowels in L1 Polish, L2 Danish and L3 English by monolinguals, bilinguals and trilinguals of these languages. Influence from L3 English was found in L1 Polish, but not in L2 Danish.

Some other studies have also reported a relationship between L2 experience and regressive CLI (e.g., [11, 16, 17]). Flege [11] found that amount of L2 experience affected the production of L2 English and L2 French stops, but also that L2 experience had an effect on the L1: experienced L2 speakers (English speakers living in France and French speakers living in the US) produced L1 stops with VOT values that differed significantly from those of monolingual English and French speakers. Further, the French speakers in the US had a merged category for English and French stops, which differed from both monolingual groups' values. Few studies have looked at the effect of L2 experience on L1 perception [6, 22]. For instance, Williams [22] investigated both the production and the perception of Spanish and English initial /p, b/ and found that Spanish-English bilinguals patterned like monolinguals in their production of stops in each language, but they differed from monolinguals in the perception of the VOT: the bilinguals' crossover location was intermediate between the category boundaries of the two monolingual groups.

The present paper reports the results of two studies examining the perception of stops in L1, L2 and L3. The shared goal of the two studies was to assess if learning an additional language affects the perception of the previously learned languages, particularly when learning occurs in the target language setting. Study 1 looked at Spanish-English bilinguals, while Study 2 looked at L1 Mandarin Chinese, L2 English and L3 Spanish speakers. Spanish contrasts short voice lag and voice lead VOT, while English distinguishes between short lag (or possibly voice lead) and long lag VOT [14]. Mandarin Chinese has an opposition between short lag and long lag VOT, and VOT generally tends to be longer than in English [8].

2. STUDY 1

The purpose of this study was to assess the effect of L2 experience on both L1 and L2 perception of bilabial stops. L1 and L2 perception of Spanish learners of English living in Spain was compared to that of Spanish speakers living in London (UK).

2.1. Method

2.1.1. Participants

20 Spanish learners of English were divided into two groups: inexperienced learners of English (INEXP, N = 11), who were English majors at a Spanish university, and had not spent time in an English speaking country except for short visits, and experienced learners of English (EXP, N = 9), who had lived in the UK for a mean of 3.9 years. A group of functional monolinguals of Spanish (SMONO, N = 7) and English (EMONO, N = 9) were also tested for comparison purposes.

2.1.2. Identification task

A VOT continuum ranging from -30 ms to +60 ms was created by modifying a selected ambiguous natural token. To that effect, the production of 10 aspirated, 10 short-lag and 10 prevoiced bilabial stops, followed by /i/, were elicited from a phonetically trained male speaker. The token with the burst that was the closest in duration to the mean of all productions was selected as the ambiguous token, and its intensity was set to the mean value of all productions. Prevoiced steps were created by manually adding 5 ms cycles of prevoicing before the burst. Similarly, the aspirated steps were created by manually adding 5-ms periods of aspiration. The resulting continuum had a total of 17 stimuli varying in VOT in steps of approximately 5 ms.

2.1.3. Procedure

The same stimuli were used in two identification tasks created in Praat [2] – a Spanish one and an English one. The 17 stimuli were randomized and repeated four times, resulting in 68 trials. Six practice trials preceded the test. The tasks differed in the response alternatives. In the Spanish test, the stimuli had to be labelled as the first syllable in *bicho* (bug) or in *pico* (peak), and in English the response labels were *peeler* and *beetle*. In order to control for language mode participants read a list of sentences in the target language before each test and watched a 5-minute video clip in that language prior to the task. The INEXP group was tested in Spain, the EXP group was tested in London, UK.

2.2. Results

The results obtained in the identification tasks were converted using a logistic function, and the category boundary for each participant was obtained by applying the formula -LN(b0)/LN(b1) [1], where b0 is the constant and b1 the slope of the function obtained. Table 1 shows the values for each group. A one-way ANOVA was conducted for each language with group as the independent variable and perceptual boundary as the dependent variable. In English, a significant effect of experience was found ($F(2, 26) = 7.152$; $p < .01$). Tukey HSD post-hoc comparisons revealed significant differences between INEXP and EMONO ($p < .01$), whereas EXP did not differ from either group.

Table 1: Perceptual boundary for each group and language in Study 1.

Group \ Language		English (ms)	Spanish (ms)
EMONO	Mean	14	——
	SD	2.5	
INEXP	Mean	9.1	8.5
	SD	3.5	3.1
EXP	Mean	12.1	11.2
	SD	2.6	3.5
SMONO	Mean	——	4.7
	SD		6

Regarding the Spanish test, experience was found to influence L1 perception significantly ($F(2,24) = 4.8$; $p < .05$), as the post-hoc analyses showed that EXP differed significantly from SPMONO (p < .05), whereas INEXP did not. Finally, a paired samples t-test was carried out to compare the perception in Spanish and in English of the INEXP and EXP. The boundaries of neither of the groups in Spanish and in English were found to differ significantly (INEXP: $t(11) = .54$; $p = .6$; EXP: $t(9) = 1.12$; $p = .3$).

In brief, the results of Study 1 show evidence of CLI from L1 to L2 for INEXP, who differed from EMONO in their perception of English stops. In addition, regressive CLI was also found as EXP differed from SMONO in the perception of Spanish stops. Still, both L2 groups seemed to have a single perceptual category for both languages.

3. STUDY 2

This study attempted to explore the effect of the newly learnt language on the previous learnt ones, namely, the effect of learning L3 (Spanish) on the perception of L1 (Mandarin) and L2 (English).

3.1. Method

3.1.1. Participants

The participants were 10 Mandarin Chinese native speakers with L2 English (Group B, for bilinguals) and 10 Mandarin Chinese native speakers with L2 English and L3 Spanish (Group T, trilinguals). The groups were comparable in the average number of years learning English, about 12.5 years. No participants had lived in an English speaking country and all of them had spent 1.2-1.8 years in a Spanish speaking country. Despite living in Spain, participants in Group B reported speaking only English and Mandarin, whereas participants in Group T had a degree in Spanish and reported daily use of the language. The control group included 8 speakers: 4 Mandarin monolinguals (MMONO), 2 English monolinguals (EMONO), and 2 Spanish monolinguals (SMONO).

3.1.2. Identification task

A VOT continuum was created from natural tokens produced by the same phonetically trained speaker as in Study 1 in a similar fashion. In this case, the selected ambiguous burst had a duration and intensity that were closest to the average across the productions in all three languages (Spanish, English and Mandarin). The prevoiced steps were created following Schuttenhelm [19]. Cycles of about 9 ms were extracted from the middle of the prevoicing period of a selected voiced stop. The voiceless steps were created by adding periods of aspiration extracted from a selected voiceless aspirated stop using a Praat script. The resulting continuum ranged from -105 ms to 135 ms, varying in steps of 4.5 ms between -34 ms to +27 ms and in steps of 9 ms for the rest, resulting in a total of 33 stimuli, covering all VOT models in the three languages under study. Smaller (4.5 ms) steps were used in the center of the continuum where the perceptual category boundary was more likely to be located [22]. A two-alternative forced choice task was created with Praat [2]. All stimuli were embedded in a carrier sentence in each language, spoken by the same male speaker as in Study 1, and found unaccented by native listeners.

3.1.3. Procedure

As in Study 1, there was one task for each language. The stimuli were randomized and each stimulus appeared three times, resulting in 99 trials per task, preceded by a few practice trials. The response alternatives were 鼻 /pi/ (nose) and 皮 /p^{h}i/ (skin) in the Mandarin test, *beach* and *peach* in English, and *pita* and *bita* in Spanish. Prior to each test, a short video was shown in the tested language to set the right language mode. Groups B and T, the Spanish monolinguals and English native speakers were tested in Spain; the Chinese monolinguals were tested in China.

3.2. Results

A perceptual boundary was calculated using the same procedure as in Study 1. Table 2 presents the means and standard deviations for each group and language.

Table 2. Perceptual boundary for each group and language in Study 2.

Group \ Language		Mandarin (ms)	English (ms)	Spanish (ms)
B	Mean	26.53	20.17	——
	SD	6.73	4.82	
T	Mean	28.09	24.69	23.04
	SD	5.11	5.96	6.72
MMONO	Mean	40.97	——	——
	SD	7.39		
EMONO	Mean	——	22.68	——
	SD		1.49	
SMONO	Mean	——	——	-2.27
	SD			6.99

The results for the English and Spanish monolingual speakers differ slightly from those obtained in Study 1, which may be due to differences in the vowel continua and in the number of monolinguals tested. Nevertheless, in both cases, monolingual speakers patterned as expected for each language group: Spanish has the earliest perceptual boundary, followed by English, and Mandarin has the latest one.

To compare the perceptual boundaries obtained by each group in each identification test a series of one-way ANOVA and Tukey HSD post-hoc analyses were conducted. The general effect of group within each language was significant in the perception of stops in Mandarin ($F(2,21) = 4.48$, $p < .05$) and Spanish ($F(1,10) = 22.04$, $p < .01$), but not in English ($F(2,19) = 1.81$, $p > .05$). Thus, the L3 Spanish speakers differed from monolingual Spanish speakers in their perception of Spanish, but neither group B nor T differed from English monolinguals. Regarding Mandarin, pairwise tests showed that Group B ($F(1,12) = 5.49$, $p < .05$) and T ($F(1,12) = 5.45$, $p < .05$) differed significantly from the Mandarin monolinguals, and no difference was found between B and T ($F(1,18) = 0.54$, $p > .05$).

Regarding within group comparisons, for both groups of learners, Mandarin had the latest boundary, followed by English, and Spanish had the earliest boundary. However, an effect of language was found only for Group B ($F(1,18) = 5.68$, $p < .05$), but not for Group T ($F(2, 27) = 2.58$, $p > .05$) showing that the bilinguals had a different boundary for each language, while the trilinguals appeared to have the same boundary for all three, although numerical differences were small in all cases.

In summary, the results of Study 2 show both an influence of the L1 (or L2) on the additional language, but also provide evidence of regressive CLI as L2/L3 learners differed from native Mandarin speakers in their perception of Mandarin stops.

4. DISCUSSION AND CONCLUSIONS

This paper set out to examine the effects of experience and learning setting on the perception of VOT in L1, L2 and L3. Study 1 found a positive effect of L2 experience and setting on L2 perception, as the inexperienced Spanish learners of English in their home country, but not the Spanish speakers living in the UK, differed from the native English speakers. In addition, L2 learning also seemed to affect L1 perception, since the experienced Spanish learners of English had a later (more English-like) perceptual boundary than the Spanish monolinguals, in line with previous results involving production [11]. Still, neither bilingual group appeared to perceive L1 and L2 stops differently, showing that learners were still processing VOT perception similarly in both languages.

Study 2 compared a group of L1 Mandarin L2 English speakers to a similar group who also spoke L3 Spanish. Both groups of Mandarin speakers were found to perceive English stops in a similar fashion to monolingual English speakers, which may be related to the fact that voiceless stops are aspirated in both L1 and L2, even though VOT is reported to be greater in Mandarin Chinese [8]. The trilinguals, however, did not achieve native-like perception in Spanish, showing an influence of the L1 or L2, or joint, on L3 perception. On the other hand, both the bilinguals and the trilinguals differed from the monolinguals in their perception of Mandarin Chinese: B and T had a perceptual boundary (26.5 and 28, respectively) closer to the values for English monolinguals (22.7) than for Mandarin monolinguals (41). This may indicate an influence of the L2, or L3, on the L1. Overall, these findings do not provide support for the PPH [5], as CLI seemed to affect the L1 more than the L2. These results are more in accordance with previous studies that found CLI influence on L1 [21, 23]. The similar results obtained for B and T in L1 perception may be due to the fact that participants in both groups were living in Spain and were exposed to Spanish and to Spanish-accented English, that is, to VOT productions with little aspiration. Thus, the lower perceptual boundary for B and T in their L1 could result from influence from both the L2 and the L3. This, together with the effect of L2 experience on L1 perception found with the EXP group in Study 1, may point to the role of learning setting and ambient language in L1 attrition [7,11].

Finally, neither study found evidence of separate perceptual systems in multilingual speakers, in line with [22]. Only group B in Study 2 was found to make a distinction in their perception of the two languages, with a higher boundary for Mandarin than for English. However, the difference was numerically small. Thus learners appeared to categorize stimuli similarly in all languages, with a boundary that was closer to that of the ambient language (Spanish in Spain, English in UK) in Study 1 or to intermediate English-like values in Study 2.

In conclusion, the results of the current studies provide some evidence of bidirectional influence between the native and later learnt languages in perception, in line with some previous studies on VOT production. The study also stresses the importance of the setting, as influence on the L1 was found with speakers living in the L2/L3 setting. Still, the limited number of participants and the absence comparable groups in different language settings are obvious limitations of the current paper. Further studies should involve parallel populations such as L1 English L2 Spanish speakers in Spanish and in English-speaking settings, and L1 Mandarin speakers in an English-speaking setting.

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