# EXPLORING THE RELATIONSHIP BETWEEN INDIVIDUAL DIFFERENCES IN CROSS-LANGUAGE PERCEIVED SIMILARITY AND L2 VOWEL PERCEPTION

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## ABSTRACT

This paper explores the relationship between cross-linguistic perceived similarity and L2 vowel identification and discrimination at the individual level. The study also investigates if the perception of cross-linguistic similarity changes as a result of a 6-session perceptual training regime found to improve L2 perception. A group of Spanish-speaking learners of English in an instructional setting completed a perceptual assimilation task before and after training. The results indicated that learners varied in their choice of L1 match for English /ɪ/ and /ɑː/, but assimilation patterns were consistent for the remaining vowels. The outcome of a series of correlations and multiple regression analyses yielded some evidence that individual differences in L2 to L1 assimilation patterns predicted L2 perception. However, this was only found in a subset of cases. Further, perceptual training generally had little effect on cross-linguistic perceived similarity, except for changes involving /ɪ/, possibly related to increased metalinguistic awareness.

**Keywords**: L2 speech, cross-linguistic similarity, individual differences, L2 vowel perception.

## 1. INTRODUCTION

According to current second language (L2) speech theories the likelihood of target-like categorization of L2 speech sounds is determined by L2 learners' ability to detect differences between native and target language sounds [1, 2]. Hence, assessing the degree of similarity between native and non-native sounds is crucial in order to make predictions about the difficulty of perceiving and producing specific L2 phones. Cross-linguistic similarity is often measured perceptually [3, 4], e.g. by means of a cross-language categorization task or perceptual assimilation task (PAT). In this task, listeners categorize L2/non-native stimuli in terms native categories and provide goodness of fit ratings for each categorization. However, predictions based on group results often overlook the fact that individual learners sharing the same L1 may differ in their perception of similarity between native and non-native sounds (e.g., [5]). Hence the need to explore if individual differences in cross-language perception of similarity may result in differences in L2 development, as has sometimes been reported [6].

Furthermore, according to current models of L2 speech, greater experience with the L2 may result in increased ability to perceive phonetic differences between L1 and L2 sounds [7]. Still the evidence from previous research is inconsistent. Some studies show that experience results in a greater ability to distinguish L1-L2 sounds [8, 9]. By contrast, other studies report no effect of experience on cross-linguistic mappings, e.g., comparing similarity judgements from learners varying in length of residence in an L2 setting (1.8 vs 7 years, [10]) or the same group of learners tested a year apart [11].

On the other hand, it is well-known that phonetic training approaches such as high variability phonetic training (HVPT) have a positive effect on L2 learners' ability to perceive and produce target language sounds accurately (see [12, 13] for reviews). However, few studies have investigated if the perception of cross-linguistic similarity changes as a result of phonetic training (e.g., [14]).

Thus the current study aims to examine the relationship between perceived cross-language similarity and L2 perception by exploring whether individual differences in perceived similarity between target and native vowels are reflected in the individuals' ability to identify and discriminate L2 vowels. In addition, the study investigates if cross-linguistic perception of similarity can change as a result of L2 exposure through high variability phonetic training.

## 2. METHODOLOGY

### 2.1. Participants

Twenty-eight Spanish-speaking learners of English participated in the study. They were all university undergraduate students in their first year of English Studies at Universitat Autònoma de Barcelona (UAB), Spain. They started learning English at school but had scarce experience in a naturalistic setting, as their time spent in an English-speaking country was

limited to short summer stays. Their average age was 19.6.

### 2.2. Tasks

Participants were tested on L2 perception as well as on L1-L2 perceived cross-linguistic similarity before and after completing the training program. Specifically, learners completed an identification task, a categorical AX discrimination (same/ different) task, and a perceptual assimilation task (PAT). The identification task involved the British English vowels /æ, ʌ, ɪ, iː, ɜː, e, ɑː/ (as in 'bat,' 'but,' 'bit,' 'beat,' 'Bert,' 'bet' and 'Bart'), totalling 104 trials (four words per vowel per talker and several repetitions). The response options were pairs of two common English words containing and representing each of the vowels tested. The discrimination task involved the following vowel contrasts: /æ-ʌ/, /ɪ-iː/, /ɜː-e/, /ɜː-ɑː/. The total number of trials was 96 (48 same, 48 different). Vowel stimuli were presented in CVC non-sense words produced by two different talkers.

As for cross-linguistic perception, in the PAT learners were presented with L2 (English) stimuli that had to be identified in terms of L1 (Spanish) categories and then rated in terms of their goodness of fit on a 7-point scale. The stimuli included the English vowels /iː ɪ e ɜː æ ʌ ɑː/, which had been elicited from three male native speakers of British English in bVt sequences, and edited so that each stimulus contained from the release of the /b/ to the beginning of the /t/ closure. The response alternatives involved the Spanish vowel set (/i e a o u/) and the diphthongs /ai ei oi/. The total number of trials was 108 (9 vowels x 3 talkers x 2 tokens x 2 repetitions).

### 2.3. Procedure

The participants took part in a HVPT program and were tested on their L2 perception as well as on cross-linguistic perceived similarity before and after training (pretest and posttest). The training program consisted of six 30-minute sessions over several weeks and was carried out at a UAB's speech laboratory. The training tasks (a 7-alternative forced choice identification task or a categorical AX discrimination task) were similar to the pretest and posttest tasks, although different stimuli were used and corrective feedback was provided after each trial during training.

### 2.4. Data analysis

In order to examine the relationship between learners' cross-linguistic similarity judgements and their ability to identify and discriminate L2 vowels, two different types of analyses were carried out. First, a series of Spearman correlations were conducted involving the identification and discrimination accuracy and the modal responses obtained in the PAT, at both testing times. The measures used to quantify the PAT results were the assimilation scores as well as the goodness of fit rating (GR). In addition, a fit index score (FI), a composite score resulting from multiplying the assimilation percentage by the corresponding GR, was also calculated [15]. Next, a series of multiple regression analyses were conducted so as to determine whether the PAT results (independent variables) predicted identification and discrimination results (dependent variables) at both testing times. Separate analyses were carried out for high and low vowels, for pre and posttest results. All mathematical assumptions, including no perfect collinearity, were met.

## 3. RESULTS

### 3.1. Pretest and posttest results

The results of the PAT are shown in Table 1, which presents the main assimilation patterns observed at pretest and at posttest. As can be observed, every English vowel received assimilation scores equal to or higher than a 70% categorization threshold [16]. The English to Spanish assimilation modal responses were: /æ/-/a/, /i/-/i/, /e/-/e/, /ʌ/-/a/, /ɑː/-/a/, /ɪ/-/e/ and /ɜː/-/e/. Still, some English vowels received non-modal responses ranging from 9% to 29%, namely /ɪ/ as /i/ (29%), /ɑː/ as /o/ (22%), and /ɜː/ as /o/ (14%) or /a/ (13%) and /ʌ/ as /o/ (9%). Particularly in the case of English /ɪ/, the different assimilation patterns corresponded to patterns observed for different individuals. Thus, at pretest 14 listeners assimilated /ɪ/ to Spanish /e/, six to /i/ and for the remaining eight /ɪ/ was uncategorized (i.e., did not reach 70% assimilation to any L1 vowel). At posttest, the numbers were 11 (/ɪ/ to Spanish /e/), 10 (/ɪ/ to /i/) and 6 (uncategorized).

The results of the discrimination and identification pretest and posttest are presented in Tables 2 and 3. The English vowel pairs /ɜː/-/e/ and /ɜː/-/ɑː/ were the most accurately discriminated, followed by /iː/-/ɪ/, and /æ/-/ʌ/, which obtained the lowest scores. In terms of identification accuracy, English /e/, /ɪ/, /iː/ and /æ/ obtained the highest scores, followed by /ɑː/, while /ʌ/ and /ɜː/ were the most challenging.

As can be observed, overall there is an improvement in identification and discrimination from pre to posttest (these results are addressed in a separate paper). The focus of the current paper is on the effect of training on cross-language perception and its relationship with L2 perception at the

individual level. Regarding changes in cross-language perception from pretest to posttest, Table 1 shows that most assimilation patterns remain stable. The only vowels that show some change are /ɪ/, with an increase in assimilations to Spanish /i/ from 29% to 45%, and, to a lesser extent, /ɑ:/ as Spanish /o/ from 22% to 30%. These changes may be attributable to increased metalinguistic awareness, as discussed in section 4. The results of the correlational analysis and the multiple regression analyses relating the PAT and L2 perception results are reported the next section.

| Target vowel | L1 vowel | Pretest % | Pretest GR | Posttest % | Posttest GR |
|---|---|---|---|---|---|
| /æ/ | /a/ | 99% | 6.2 | 100% | 6.4 |
| /ʌ/ | /a/ | 90% | 5.8 | 88% | 5.1 |
| | /o/ | 9% | 4.5 | 10% | 3.6 |
| /i:/ | /i/ | 93% | 6.5 | 92% | 6.5 |
| /ɪ/ | /e/ | **70%** | 5.8 | **55%** | 5.7 |
| | /i/ | **29%** | 5.5 | **45%** | 5.5 |
| /ɜ:/ | /e/ | 70% | 4.0 | 75% | 3.5 |
| | /a/ | 13% | 3.2 | 10% | 2.3 |
| | /o/ | 14% | 3.7 | 15% | 2.6 |
| /e/ | /e/ | 99% | 5.2 | 99% | 5.5 |
| /ɑ:/ | /a/ | 74% | 4.8 | 70% | 4.7 |
| | /o/ | 22% | 4.7 | 30% | 4.7 |

**Table 1**: PAT results at pretest and posttest showing for each target English vowel the corresponding L1 match(es); %. = % assimilation, GR = goodness of fit rating.

| Vowel contrast | Pretest | Posttest |
|---|---|---|
| /æ/-/ʌ/ | 54 (19) | 63 (21) |
| /i:/-/ɪ/ | 62 (20) | 68 (21) |
| /ɜ:/-/ɑ:/ | 71 (23) | 73 (27) |
| /ɜ:/-/e/ | 80 (18) | 93 (12) |

**Table 2**: Discrimination of each target vowel at pretest and posttest (SD are given in parentheses).

| | Pretest | Posttest |
|---|---|---|
| /æ/ | 59 (21) | 59 (19) |
| /ʌ/ | 31 (24) | 47 (26) |
| /i:/ | 64 (18) | 71 (19) |
| /ɪ/ | 63 (24) | 78 (19) |
| /ɜ:/ | 36 (20) | 51 (25) |
| /ɑ:/ | 50 (17) | 68 (27) |
| /e/ | 67 (25) | 89 (15) |

**Table 3**: Identification of each target vowel contrast at pretest and posttest (SD are given in parentheses).

### 3.2. Relationship between PAT and L2 perception

Overall, the results of the correlational analyses did not show a clear relationship between the accuracy scores of the perception tests and the PAT results given that few outcomes were correlated. The significant results obtained are presented in Table 4, which are limited to some identification results and goodness ratings (GR) obtained in the PAT. The negative correlations indicate that the lower the GRs for English /ɪ/ as a match to Spanish /i/, the more accurately English /i:/ was identified; and also the lower the GRs in the assimilation of English /ʌ/ to Spanish /a/, the better that both /æ/ and /ʌ/ were identified. No significant correlations were obtained involving discrimination results.

| Ident. result | PAT result | $\rho$ | $p$ | $N$ |
|---|---|---|---|---|
| /i:/ in NW | GR /ɪ/ as /i/: | -.581 | .009 | 19 |
| /æ/ in NW | GR /ʌ/ as /a/: | -.527 | .006 | 26 |
| /ʌ/ in NW | GR /ʌ/ as /a/: | -.501 | .009 | 26 |

**Table 4**: Significant Spearman's correlations between identification and PAT measures.

Regarding the multiple regression analyses, the individual results obtained in the PAT predicted the perception accuracy scores on very few occasions. Regarding high vowels, cross-linguistic perception did not significantly predict any of the identification or discrimination results at pretest, as shown both by the regression equations ($p > .05$). As for low vowels, neither the regression equations nor the individual coefficients revealed that the PAT results predicted ID or DIS scores ($p > .05$).

At posttest, the multiple regression analyses did not reveal any significant result for high vowels, indicating that PAT results did not significantly predict ID or DIS accuracy scores. Some significant results were found for low vowels. Specifically, the ID of /æ/ was found to be significantly predicted by the PAT results. In this case, the PAT's FI score for English /ʌ/ as Spanish /a/ and for English /ʌ/ as Spanish /o/ negatively predicted the identification of English /ʌ/ ($F(5, 20) = 2.638$, $p = .055$, $R^2 = .397$; /ʌ/ as /a/: $\beta = -1.103$, $p = .035$; /ʌ/ as /o/: $\beta = -1.0447$, $p = .030$). This indicates an unclear relationship between PAT results and identification accuracy, as both assimilation patterns are inversely related to identification accuracy. No significant results were obtained regarding PAT results and discrimination results.

## 4. DISCUSSION AND CONCLUSIONS

This study set out to examine if differences across individuals in their perceived similarity between native and target language vowels was reflected in the individuals' ability to identify and discriminate L2 vowels. The results of the PAT showed that similarity judgements were very consistent across individuals for most vowels, but individuals varied in their cross-linguistic categorization of particularly English /ɪ/, and to a lesser extent English /ɑː/ and /ʌ/. For example, some learners assimilated English /ɪ/ to Spanish /e/ while others assimilated English /ɪ/ to Spanish /i/. Given that English /iː/ was predominantly assimilated to Spanish /i/, it could be hypothesized that learners who assimilate each English vowel to a different L1 vowel (two-category assimilation in PAM-L2's terms [1]) will be more successful at identifying and discriminating English /iː/-/ɪ/ than those learners who assimilate both English /iː/ and /ɪ/ to the same Spanish vowel (single-category or category goodness difference assimilation to Spanish /i/). The same applies to the English pairs /æ/-/ʌ/ and /ɑː/-/ʌ/. English /æ/ was consistently assimilated to Spanish /a/, but both /ʌ/ and /ɑː/ obtained assimilations to Spanish /o/ in addition to Spanish /a/.

In order to examine these predictions, a series of correlations and multiple regressions were conducted, investigating if assimilation patterns were related to and predicted identification and discrimination accuracy. The results, however, found that a learner's L2 perception was generally unrelated to the assimilation preference, with very few exceptions. It was found that the lower the GRs given to English /ɪ/ as a match to Spanish /i/, the better English /iː/ was identified. Similarly, the lower the GRs obtained for English /ʌ/ as Spanish /a/, the better English /æ/ and /ʌ/ were identified. However, the assimilation of English /ɪ/ to either Spanish /i/ or Spanish /e/ did not appear to affect the identification of /ɪ/ or the discrimination between /ɪ/ and /iː/. The lack of a stronger relationship between cross-linguistic similarity differences and identification and discrimination accuracy thus runs counter to what the theoretical models would suggest (e.g., [7]). It is possible that the measures obtained in a PAT reflect a perceptual sensitivity that does not play a role in the categorization of L2 sounds. As discussed below, other factors such as the learners' metalinguistic and orthographic knowledge of the L2 may interfere with the categorization of the target sounds. Along the same lines, it is also possible that a closer relationship between PAT measures and L2 perception may be obtained from a naïve population or from learners at a more initial stage in the acquisition of the L2.

Finally, while a 6-session perceptual training regime was effective in improving identification and discrimination of L2 vowels, it was insufficient to affect cross-linguistic similarity relations, as no consistent change in perceived similarity between L1 and L2 vowels was observed from pretest to posttest. Nevertheless, there were some changes in the perceived similarity for those sounds for which there was more variability in perceived similarity. For example, at pretest English /ɪ/ was perceived as closest to Spanish /e/ 70% of the time and to Spanish /i/ 29% of the time; at posttest the percentages were 55% and 45%, respectively. Thus, there was an increase in the assimilation of English /ɪ/ to Spanish /i/. This change can be related to the claim that perceived similarity may respond to acoustic-phonetic similarity at initial stages of learning and may become more phonological as learners gain experience with the L2 [17]. In other words, enhanced metalinguistic knowledge of the L2 (in this case through perceptual training) may go beyond the raw acoustic information of the L2 and may be taken into account when judging cross-linguistic similarity. This may be particularly relevant in cases like English /ɪ/ due to familiarity with orthography (/ɪ/ is typically spelled with letter <i>, which stands for the vowel /i/ in Spanish) as well as to increased awareness of the English vowel system as a result of exposure, instruction and training (e.g., the functional load of the /iː/-/ɪ/ contrast, and instructional biases that refer to this contrast as a contrast between "long and short /i/").

In brief, L2 vowel identification and discrimination was not found to be generally affected by individual differences in cross-linguistic similarity, with very few exceptions. In addition, perceptual training was not observed to alter cross-linguistic perceived similarity for the most part. It appears that factors other than pure perceptual sensitivity to acoustic differences between native and non-native vowels may also play a role in the categorization of L2 sounds, as illustrated by the changes observed in the perceptual assimilation of vowels like English /ɪ/.

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