

Second language discrimination vowel contrasts by adults speakers with a five vowel system

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Abstract

This study tests the ability of a group of Salento Italian undergraduate students that have been exposed to L2 in a scholastic context to perceive British English second language (L2) vowel phonemes. The aim is to verify if the Perceptual Assimilation Model could be applied to them. In order to test their ability to perceive L2 phonemes, subjects have executed an *identification* and an *odddity discrimination test*. The results indicated that the L2 discrimination processes are in line with those predicted by the PAM, supporting the idea that students with a formal L2 background are still naïve listeners to the L2.

Index Terms: L2 vowel perception, classroom foreign language acquisition, cross-language comparison.

1. Introduction

From a general point of view, it seems to be imperative to distinguish those studies which deal with Second Language Acquisition (SLA) from those about Classroom Foreign Language Acquisition (FLA), since they report very different conditions in which subjects are exposed to the L2. Actually, SLA occurs in immersion contexts, where the L2 becomes the language spoken most in everyday life, and where the use of the L1 is often restricted to limited contexts (e.g., family). On the other hand, FLA takes place in a pervasive L1 setting where the L2 is often spoken by L1 accented teachers which offer to their students incorrect instances of the L2 sounds [1].

According to this distinction, two models of L2 acquisition have been formulated: the Speech Learning Model (SLM) [2] and the Perceptual Assimilation Model (PAM) [3]. The former mainly addresses the production of L2 phonemes by *experienced L2 learners*, the latter addresses the perception of nonnative contrasts by *naïve listeners*. More specifically, L2 learners actively learn the L2 in a natural context, while naïve listeners are functional monolinguals not learning or using the L2. Actually, in the naïve listeners category, one finds those subjects with limited passive exposure to the L2, or with *limited L2 instruction* (our italic), especially classroom education with teachers having a strong L1 accent [1]. Thus, it could be possible to maintain that FLA could also reflect the naïve listener context, at least in some cases.

Even if the SLM and PAM refer to different typology of subjects and are different in some assumptions, they share some empirical beliefs, such as the necessity to assess the *phonetic distance* between L1 and L2 sounds [4]. Actually, for both the SLM and PAM, the phonetic distance – i.e. the similarity/dissimilarity of L1 and L2 sounds which determines the acquisition (SLM) and the different degree of perception of L2 phonemes (PAM) – should be assessed through cross-language experiments (see 2.1.), in order to make one able to draw some inferences about the discriminatory processes of L2 phonemes.

In this study we will concentrate on a Romance Italian variety spoken in Salento, the lower part of Southern Apulia. This variety has five vowel phonemes /i, e, a, o, u/ [5], lacking the phonemic distinction between open and close mid vowels, for both the front and back axes, i.e. /e/-/ɛ/ and /o/-/ɔ/. British English is the Germanic language spoken in Great Britain and in many other areas of the world. English, with respect to Salento Italian, has a larger vowel inventory: if one does not consider the diphthongized ones, she can find 11 monophthong vowels, i.e., /i:/, /ɪ/, /e/, /æ/, /ʌ/, /ɑ:/, /ɒ/, /ɜ:/, /ɔ:/, /ʊ/ and /u:/ [6]. Additionally, English vowels can be divided in short vs. long vowels, i.e., with a different duration. Since Salento Italian has only 5 vowel phonemes compared to the 11 English monophthongs, and since it has not the duration cue, it could be very difficult for Salento subjects to perceive (and produce) English vowels in a native-like way.

Our aim is to verify how the 11 English monophthong vowels are assimilated to the 5 Salento ones and to test the difficulty undergraduate students have perceiving (i.e., discriminating) them. Finally, the current study represents another stage in the evaluation of the influence of formal instruction on the perception of L2 phonemes. Actually, our specific aim is to understand if Salento undergraduate students are naïve listeners with respect to the 11 British English vowel phonemes or if they are to some extent “experienced”, performing in such a different way as predicted by the PAM.

2. Method

2.1. Identification test (IT)

This test examines the way in which non native phonemes are assimilated to (i.e., identified with) the native ones.

Twelve male Salento Italian undergraduate students participated in the study. They attended the first year (namely, the end of the first semester) at the Salento University, Faculty of Foreign Languages and Literatures (mean age = 21.3 years). They reported in a background questionnaire they have started studying English as a foreign language at school at the mean age of 10.8 years and that they had never been in a foreign country for a period superior to a month, except one of them who stated he had been in England for about 6 weeks for work. Six of them stated that they had had lessons with a English native speaker in middle and/or secondary school, so they all have been exposed to English only in formal contexts. They were individually tested in the CRIL soundproof room for a duration of about 40 minutes.

2.1.1. Stimuli

The stimuli both for IT and OT were produced by three adult male British English native speakers. They were told to read a list of real monosyllabic words: in /p_t/ context for the

phonemes /i:/, /ɪ/, /ɛ/, /æ/, /ʌ/, /ɑ:/, /ɒ/, /ɜ:/, and in /s_ʌ/ context for the phonemes /i:/, /ɔ:/, /ʊ/ and /u:/, for a total of 36 stimuli (3 speakers X 12 phonemes). These stimuli were recorded in the CRIL soundproof room by CSL 4500, at a sampling rate of 22.05 kHz, and were segmented and normalized in peak amplitude with Praat 4.2.

2.1.2. Procedure and results

Students were tested individually in a soundproof room via headphones at a comfortable level. The 36 stimuli were randomly presented 3 times and students identified each of them in terms of one of the 5 Salento Italian vowels by clicking on the computer using a mouse. The silence duration between the click of the chosen phoneme and the listening of the subsequent phoneme is of 0,5 sec. Students couldn't replay a stimulus but they were told to guess if unsure. After selecting the Italian vowel judged the most similar to the English one just heard, students had to say how much the English vowel was similar to the chosen Italian one, by clicking on a five-point scale of degree of similarity from "1" (totally different) to "5" (totally equal) in order to finally obtain a goodness of fit (Gof) [4].

By multiplying the percentages of identification by the goodness rating of that identification, we obtained the *fit index* whose aim is to raise the scores of those identifications that were considered good tokens of the L1 category and to lower the scores of those identifications that were selected because they had no good competitors [7].

Before making the test, students were orally instructed and administered a training test of 10 stimuli in the presence of the experimenter, in order to ensure that each student had completely understood the task. These stimuli were not analyzed.

The identification results and the Gof has been derived from a total of 1296 judgments (12 subjects X 36 stimuli X 3 repetitions), see Table 1. Following [7], the identifications of single L2 phonemes to Salento phonemes equal or higher than 75% have been considered as consistent classifications (e.g., /i:/ identified with Salento /i/) while for the identifications which were lower than 75%, shared between two Salento phonemes, the first two identifications have been considered (e.g., /ʌ/ identified with Salento /a/ and /o/). Fit indexes are illustrated in Table 2.

2.2. Oddity discrimination test (OT)

The role of this test is to examine the category formation of L2 phonemes in non native speakers.

Participants and stimuli are the same as the experiment in 1. Additionally, the test has been taken by a group of ten British English native speakers as a control.

2.2.1. Procedure and results

As for the previous perceptual test, students were tested individually in a soundproof room via headphones at a comfortable level.

For each contrast detected by the IT, 8 *change trials* and 8 *catch trials* were submitted to each student, for a total of 144 trials X student. For instance, in order to test the control contrast /i:/-/u:/, the *change trials* have been /i:/-/i:/-/u:/, /i:/-/u:/-/i:/, /u:/-/i:/-/i:/ and /u:/-/u:/-/i:/, /u:/-/i:/-/u:/, /i:/-/u:/-/u:/. Similarly, the *catch trials* have been /i:/-/i:/-/i:/ and /u:/-/u:/-/u:/.

Table 1. Percentages of identification and Gof in parenthesis.

L2 \ L1	/i/	/ɛ/	/a/	/ɔ/	/u/
/i/	100% (4,1)				
/ɪ/	93% (3,5)	7% (2,8)			
/ɛ/		100% (4,1)			
/æ/		20% (2,9)	80% (3,4)		
/ʌ/			68% (3,7)	32% (3,4)	
/ɑ:/			74% (3,9)	25% (2,9)	
/ɒ/			6% (2,7)	93% (3,8)	
/ɔ:/				92% (3,5)	7% (1,8)
/ɜ:/		43% (1,8)	16% (1,8)	31% (2,4)	11% (2,6)
/ʊ/				44% (3,1)	56% (3,2)
/u:/					99% (3,6)

Table 2. Fit index

L2 \ L1	/i/	/ɛ/	/a/	/o/	/u/
/i/	4,1				
/ɪ/	3,2	0,1			
/ɛ/		4,1			
/æ/		0,5	2,7		
/ʌ/			2,5	1	
/ɑ:/			2,8	0,7	
/ɒ/			0,1	3,5	
/ɔ:/				3,2	0,1
/ɜ:/		0,7	0,2	0,7	0,2
/ʊ/					3,5
/u/				1,3	1,7

Change trials were made up of 3 items produced by three different English Native speakers. The *odd item*, i.e., the different one students had to discriminate, was placed alternatively in the first, in the second or in the third position of the trial, so it occurred with near-equal frequency in all these positions [8]. The *change trials* tested students' ability to discriminate two English different phonemic categories. Also *catch trials* were made up of 3 items produced by three different English Native Speaker, so that each item was phonetically but not phonemically different from the other two. The *catch trials* tested students' ability to ignore acoustic differences between the same phonemic categories.

If students heard a stimulus as different between the three items, they had to click on the computer screen on "1", "2", or "3", which corresponded to the positions of the different item heard in the trial. If students did not hear any different stimulus, they had to click on "none". A trial could be replayed as much as needed, and response could not be

changed. The interstimulus interval of each trial was of 300 ms.

A-prime (A') was calculated for each of the 9 contrasts: it was calculated on the basis of the proportion of “hits” (i.e., the correct detection of the odd item in change trials) and “false alarms” (i.e., the incorrect detection of the odd item in catch trials) by the formula of [9]. This provides an unbiased measure of perceptual sensitivity by taking into account the responses to the change trials and the catch trials: an A' score of 1.0 indicated perfect discrimination of a contrast (i.e., the correct response to all eight change trials and catch trials), while an A' score of 0.5 indicated insensitivity to a contrast [8].

The A' score obtained by the undergraduate students was compared with those obtained by the group of ten British peers (Table 3), in order to evaluate the performance (i.e., the ability of discrimination) of the Salento students. Thus, a General Linear Model has been carried out with a Group (2) x Contrast (9) ANOVA with A' score as dependent variable. The ANOVA showed a significant effect for the Group factor [$F(1,198) = 117,947$ $p < 0,01$], a significant effect for the Contrast factor [$F(8,198) = 2,697$ $p < 0,01$] and also for the Group (2) x Contrast (9) interaction [$F(8,198) = 3,257$ $p < 0,01$]. These significances have been closely examined through a series of univariate ANOVA in order to tell whether some of the L2 contrasts were discriminated in a native-like way. Salento students discriminated the L2 contrasts with lower A' scores than those of the British subjects and these differences were significant for all contrasts ($p < 0,05$), except for the control contrast /i:/-/u:/ [$F(1,20) = 1,579$ $p > 0,05$]. Thus, none of the contrasts was discriminated in a native like-way, and, in order to verify the significant effect for the contrasts, an univariate ANOVA with Contrast as factor has been carried out for the Salento group. The result showed that there was a significant difference among contrasts: $F(7,88) = 3,715$ $p < 0,05$. A Tukey test ($\alpha = 0,05$) revealed that the significant difference existed between /a:/-/ʌ/ – most difficult to discriminate – and /e:/-/ɜ:/ and /i:/-/u:/, very easy to discriminate. On the contrary, there were no differences among the other contrasts, so the results showed that some contrasts are more learnable than others. In the case of /i:/-/u:/ contrast – apart from the fact that they are acoustically assimilable to Salento /i/ and /u/ – it's well known that these sounds, as the most prominent peripheral vowels, have a relevant perceptive salience. Perceptive salience is involved also for /e:/-/ɜ:/: /ɜ:/ is sufficiently distant from /e/ in the acoustic space – being in the centre of Salento acoustic space which is empty there – and these spectral patterns can produce the necessary perceptive salience for L2 discrimination. On the contrary /a/ and /ʌ/ are collocated in close proximity in the acoustic space, resulting in no perceptive salience.

It's possible to hypothesize that during the growth of the L2 discrimination process the position occupied by the L2 contrasts in the vowel spectrum increases salience perception, leading the way in which non-native phonemes are perceptually assimilated to native ones (see 3.).

In Table 3 the results of both Italian and British groups are described (standard deviation in parenthesis) and in Figure 1 the same results are illustrated.

3. Discussion

According to the PAM, the way two non-native phonemes are perceptually assimilated to native ones, could predict how

naïve listeners discriminate the former in minimal pairs. On the base of a precise taxonomy, L2 phonemes can be

Table 3. A' of Italian and British subjects

	Contrasts	Italian subjects	British subjects
1	/a:/-/ʌ/	0,52 (0,24)	0,97 (0,02)
2	/æ/-/ɑ:/	0,69 (0,25)	0,96 (0,01)
3	/æ/-/ʌ/	0,71 (0,24)	0,99 (0,00)
4	/e/-/ɜ:/	0,83 (0,15)	0,96 (0,03)
5	/ɜ:/-/ɒ/	0,79 (0,15)	0,96 (0,03)
6	/i:/-/ɪ/	0,70 (0,21)	0,99 (0,00)
7	/i:/-/u:/	0,93 (0,05)	0,96 (0,03)
8	/ɔ:/-/ɒ/	0,66 (0,21)	0,99 (0,01)
9	/u:/-/ʊ/	0,71 (0,27)	0,97 (0,03)

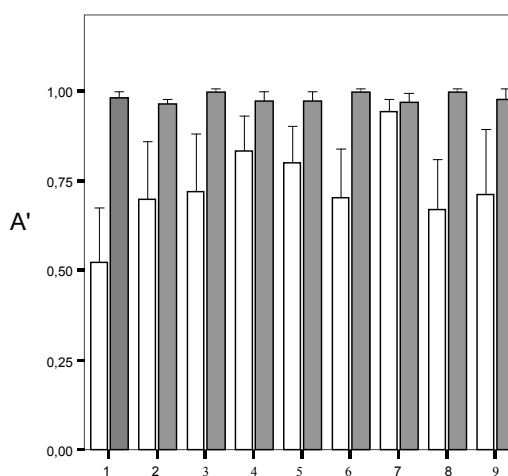


Figure 1: A' of Italian (white) and British subjects (gray)

categorised or uncategorised with respect to the L1 phonemes. Categorised phonemes are those consistently assimilated to L1 phonemes, the Uncategorised ones are those that fall in between native phonemes, so not consistently assimilated to any L1 phonemes. Consequently, the model suggests different degrees and types of assimilation of the L2 phonemes to those of the L1.

First of all, in order to establish how consistently the English phonemes have been assimilated to the Salento phonemes, we have referred to the percentage of identification criterion (2.1.4) according to which those phonemes assimilated to an L1 phoneme with a percentage > 75% have been considered as consistently identified, while those assimilated with a percentage less than 75% have been considered as not consistently identified. Moreover, in order to assess which English phonemes could be considered as good/poor instances of Italian vowels, we have adopted the standard deviation criterion (s.d.) inspired by [7]. We have calculated the mean GoF and s.d. of the two English phonemes totally identified with an Italian one, namely /i:/ and /e/ – equated respectively with /i/ and /e/ (see Table 1) – which could easily represent phonemes common to both Salento Italian and British English. The mean fit index was 4,1 and the s.d. was 0,8. So, from now on, by subtracting the s.d. from the fit index, we have stated that those English phonemes with a

fit index included between 4,1 and 3,3 could be considered as good instances of Italian phonemes (i.e., /i:/, /e/, /u:/ and /ɒ/). Those whose fit index were included between 3,2 and 2,5 could be considered as fair instances (/ɔ:/, /ɪ/, /ɑ:/, /æ/ and /ʌ/), while those whose fit index was lower than 2,4 could be considered as poor instances (/ɑ:/, /ʌ/, /ʊ/ and /ɜ:/). Thus, we could interpret the contrasts identified and tested in the two previous tests in terms of PAM predictions.

Combining the s.d. criterion described above with the consistence of the percentage of identification, our data show the following situation with respect to Best's taxonomy:

- Two Category (TC): /i:/-/u:/ are consistently identified as good exemplars of, respectively, Salento /i/ and /u/.
- Category Goodness (CG): /i:/-/ɪ/ and /ɒ/-/ɔ:/. The first terms of the two pairs (/i:/ and /ɒ/) have been consistently identified as good exemplars of /i/ and /ɔ/, while the second terms as less good exemplars of the same Salento phonemes.
- Uncategorised Categorised (UC): /æ/-/ɑ:/, /æ/-/ʌ/, /e/-/ɜ:/, /ɒ/-/ɜ:/ and /u:/-/ʊ/. /æ/, /e/, /ɒ/, /u:/ have been consistently identified as, respectively, /a/, /e/, /ɔ/ and /u/. While /ɑ:/, /ʌ/, /ɜ:/, /ʊ/ have not been consistently identified with any Salento phoneme (/ɑ:/ and /ʌ/ shared between /a/ and /ɔ/, /ɜ:/ shared between /e/ and /ɔ/ and /ʊ/ shared between /u/ and /ɔ/).
- Uncategorised Uncategorised (UU): /ɑ:/-/ʌ/. The two phonemes have been identified as both /a/ and /ɔ/.

In order to test PAM predictions, the OT results (A'score) have been employed (Table 3). As predicted by the PAM, TC discrimination is good and this was confirmed since the contrast /i:/-/u:/ was discriminated with an high A' (0,93). CG discrimination is expected to be intermediate, and it seems to be what happened for the two CG contrasts, which were moderately discriminated (/i:/-/ɪ/ A' = 0,70; /ɒ/-/ɔ:/ A' = 0,66). Also the expectations for the UC assimilation were met, since the five contrasts were discriminated as expected, i.e., from moderately to very good levels (/æ/-/ɑ:/ A' = 0,69; /æ/-/ʌ/ and /u:/-/ʊ/ A' = 0,71; /ɒ/-/ɜ:/ A' = 0,79; /e/-/ɜ:/ A' = 0,83). The expectations for the UU assimilation were met too, since /ɑ:/ and /ʌ/ associated to the same set of Italian phonemes, /a/ and /ɔ/, were poorly discriminated (A' = 0,52). Thus, it seems possible to maintain that all the PAM predictions proved true as expected.

4. Conclusions

The general aim of this study was to evaluate the perception of British English vowels by adult native speakers of Salento Italian. The specific aim was to verify if and how adults with a scholastic L2 background, such as a group of undergraduate students, could be considered close to *naïve listeners*, thereby verifying if the PAM framework could be applied also to these kinds of subjects. The IT identified various L2 contrasts which were difficult to discriminate at different levels: /i:/-/ɪ/, /æ/-/ɑ:/, /æ/-/ʌ/, /ɑ:/-/ʌ/, /ɒ/-/ɔ:/, /e/-/ɜ:/, /ɒ/-/ɜ:/, /u:/-/ʊ/ and /i:/-/u:/. These contrasts were tested in the OT which showed that they were discriminated with different degrees of accuracy,

most of them from a moderate – i.e., /i:/-/ɪ/, /æ/-/ɑ:/, /æ/-/ʌ/, /ɒ/-/ɜ:/, /ɒ/-/ɔ:/, /u:/-/ʊ/ – to a good level – i.e., /e/-/ɜ:/ and /i:/-/u:/ – except one contrast which was not discriminated at all: /ɑ:/-/ʌ/. Both the IT and the OT results were interpreted in terms of the PAM. Namely, the OT investigates the formation of an L2 category and, in the PAM perspective, its results reflected the PAM predictions in all cases.

To summarize, we could argue that the PAM framework could be applied also to extended formal acquisition (not just that which is *limited*), since adult learners of the L2, after a long scholastic exposure to the L2, seem to still perceptually behave as naïve listeners since they follow the pattern of assimilation and discrimination predicted by the PAM, which describe the outcomes of listeners' first contact with an unfamiliar phonological system and phonetic patterning [1]. Another important issue concerns the full applicability of the PAM to vowel phonemes which are very different from consonant ones [10] – which seem to better reflect the PAM predictions – and which were thought to fail to reflect some range of perceptual assimilation patterns [11].

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