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Editors

Rosa Alonso
Marta Dahlgren

Predicting ease of acquisition of L2 speech sounds. A perceived dissimilarity test

Lucrecia Rallo Fabra

Dept. Filologia Espanyola, Moderna i Llatina.
Universitat de les Illes Balears
lucrecia.rallo@uib.es

Abstract

Two current models of L2 speech learning, the *Speech Learning Model* (Flege, 1995) and the *Perceptual Assimilation Model* (Best, 1994) hypothesize that ease of acquisition of nonnative speech sounds can be predicted from the similarities between the native and the target sounds. In the present study, we use a mapping task to test a group of experienced Catalan learners of English and a group of native speakers of Catalan with no experience in English, on their ability to identify English vowel categories in terms of their native Catalan vowel categories. Specifically, we intended to test the hypothesis that, as had been suggested by Flege (1991), experience with the target language could influence assimilation patterns of nonnative sounds to native sounds. The results showed that English /i/ and /u/ were highly assimilated to Catalan /i/ and /u/, respectively. Four English vowels /æ/ /ʌ/ /ɑ/ /ɔ/ were assimilated to a single Catalan vowel /a/. For vowels /ɪ/ /ɛ/ /ʊ/, there was no clear map onto a Catalan category. Many listeners identified /ɪ/ and /ʊ/ as 'non-Catalan' but they were not systematic in their responses: /i/ and /u/ were chosen on many occasions. Response categories for /ɛ/ included Catalan /ɛ/, /e/ and 'non-Catalan'. The significant effects of group for /ɔ/ and /ɪ/ indicated that experience with the target language influenced how listeners mapped these two vowels.

Keywords: speech learning model, PAM, vowel category, native sounds, target language.

Resumen

Dos de los modelos de adquisición del habla de una segunda lengua, el *Modelo de Aprendizaje del Habla* (Flege, 1995) y el *Modelo de Asimilación Perceptiva* (Best, 1994) hipotetizan que la dificultad de adquisición de los sonidos de la lengua meta se puede predecir en base a la similitud perceptiva entre los sonidos de la L1 y la L2. En este estudio se investiga la percepción de las vocales del inglés mediante un test de mapping que se administró a dos grupos de oyentes catalanes con y sin experiencia con el inglés. En concreto, se pretende compro-

bar si, tal como demuestra un estudio de Flege (1991), la experiencia con la lengua meta puede influir en los patrones de asimilación percceptiva de las vocales de la L2 a la L1. Los resultados indican que la /i/ i la /u/ inglesas se asimilaron a la /i/ i la /u/ catalanas, respectivamente. Las vocales bajas /æ/ /ʌ/ /ɑ/ /ɔ/ se asimilaron a la única vocal baja del catalán /a/. En cuanto a /ɪ/ /ɛ/ /ʊ/ no hubo un equivalente catalán bien definido. Muchos oyentes clasificaron /ɪ/ y /ʊ/ como 'no catalanas' pero no fueron muy sistemáticos en sus juicios. Para /ɛ/ las respuestas incluían /ɛ/ /e/ y 'non-Catalan'. El efecto significativo de grupo para las vocales /i/ /ɔ/ corrobora la hipótesis de que la experiencia con la lengua meta ejerce una influencia sobre como los oyentes clasifican auditivamente estas dos vocales.

Palabras clave: SLM, PAM, categoría vocal, sonidos nativos, lengua meta.

1. Introduction

Adults learning a second language (L2) are hardly ever successful at producing the target sounds without an accent. This is partly due to the fact that they already possess a phonetic system when L2 learning commences. In consequence, there is a tendency for L2 learners to replace a certain L2 sound for the closest L1 counterpart.

At present, two theoretical models provide a thorough account of the difficulties encountered by learners in the process of acquisition of L2 speech sounds: the *Speech Learning Model* (Flege, 1995) and the *Perceptual Assimilation Model* (Best, 1994). The *SLM* has focused on the learning of vowels and consonants during the process of naturalistic L2 acquisition. *PAM*, on the other hand, has focused on the discrimination o sounds in an unknown foreign language. But both models share a common trait, in that they suggest that ease of acquisition of L2 sounds can be predicted on the basis of similarities and discrepancies between L1 and L2 sounds. Best (1994) takes the ecological stand and claims that "it is primarily the evidence about articulatory gestures in the speech signal that informs the perceiver" (Best, 1994:190).

The model distinguishes four different patterns of perceptual assimilation of non-native phones:

(1) A nonnative contrast is assimilated to two native categories (TC type).

(2) The non-native phones may be also assimilated to a single native category (SC type).

(3) Pattern 2 necessarily implies that the two non-native phones will vary in category goodness (CG type).

(4) Some nonnative sounds may be too distant from the gestural properties of the native categories. These are perceived as non-speech sounds and are thererefore unassimilable (NA type).

2. The present study

The experiment presented in this paper tries to provide some insight into ease of acquisition of American English vowels by a group of adult Catalan learners of English who acquired the target language in a non-naturalistic setting.

It is not easy to make predictions on possible assimilation patterns of English vowels to Catalan vowels. The findings of previous cross-language mapping experiments found in the literature (Flege, 1991; Flege, Munro and Fox, 1994; Cebrián, 2002) indicate that predictions on possible assimilation patterns of L2 sounds to L1 sounds cannot be made on the basis of acoustic similarities. Flege (1991) found that native Spanish listeners identified English /ɪ/ mostly as instances of Spanish /i/ instead of /e/, which is the acoustically closest sound.

Previous studies reported cross-language mapping experiments (Strange et al., 1998; Guion and Flege, 2000; Flege and McKay, 2004) where participants who had to judge nonnative phones as instances of the native phones had no prior experience with the target language. It is reasonable to think that experience with the L2 could alter perceptual identification patterns of L2 sounds, but not L1 sounds. In order to test this hypothesis, the test was administered to two groups of listeners: a group of highly experienced Catalan learners of English (CLE) and a group of native Catalans (Ncat) with no experience in English.

3. The experiment

3.1. Stimuli collection

The target vowel stimuli were obtained from the recordings of six native Catalan speakers (3 male and 3 female) and six native American English speakers (1 male and 5 female). They were all university students and had an average age of 21. The Catalan speakers elicited the Catalan vowels only and they were all speakers of the Eastern variety of Catalan. The American speakers produced the English tokens and were from various areas in the U. S. (Illinois, Idaho, Chicago, Missouri, Pensylvania). They had learned Spanish as a foreign language in the U. S. for an average of five years and had been living in Barcelona for about six months.

The stimuli consisted of monosyllabic words of the type /s/+vowel+/t/. Seven Catalan vowels /i e ɛ a ɔ o u/ and nine American English pure vowels /i ɪ ɛ æ ʌ ɑ ɔ ʊ u/ were recorded. The purpose of including Catalan stimuli is to check that listeners understood the task and could reliably perform it. The choice of a consonant context with a fricative sound at he onset was preferred to the b_t context used in the Flege et al. study (1997). In English, /b/ is known to belong to the short-lag stop category and is characterized by having short VOT values (Lisker & Abramson 1964; Zampini, 1988). It follows that English /b/ is acoustically similar to Spanish or Catalan /p/. Given the acoustic overlap between these two sounds, I reasoned that the onset consonant might mislead listeners' perceptual judgments of the target vowel stimuli. In other words, they might map the stimuli on the basis of the cross-language difference between English and Catalan voiced stops but not on the basis of vowel spectral differences.

The target words were presented visually using one flashcard per word. The experimenter showed each individual card containing an s_t word to the subjects through the window of a sound booth. This procedure minimized possible effects on intonation that would otherwise been derived from reading the target words from a list.

The words were recorded using a Marantz tape-recorder model CP-300 and subsequently digitized using a waveform editor at 22000 kHz sampling rate and 16 bit accuracy. The s_t words were then edited to eliminate the final plosive and normalized for peak intensity. This was done to prevent listeners from basing their perceptual judgments on the differences of VOT between the Catalan short-lag /t/ and English long-lag /t/.

The productions of two Catalan speakers were not used in the final test. Speaker C5 did not produce good examples of Catalan vowel /e/; speaker C6 did not perform the task well. Therefore, the total number of stimuli for the PDT was 100 (see Table 1): 28 Catalan vowel stimuli (7 vowels x 4 speakers) and 72 English vowel stimuli (9 vowels x 6 speakers). The vowels of English speakers 5 and 6 were presented twice because only these two speakers differentiated the /ɑ/-/ɔ/ contrast.

	Vowels	**Speakers**	**TOTAL**
Catalan	7	4	28
English	9	8 (6+2)	72

Table 1. Total number of stimuli used for the perceived dissimilarity test.

3.2. Test administration

Thirty-eight Catalan learners of English (CLEs) and fifteen Catalan speakers (Ncat) were tested by the same experimenter. The CLEs were third/fourth-year English Philology undergraduates at the Universitat Rovira i Virgili in Tarragona. They had all enrolled in an American English Phonetics and Phonology course which lasted two terms. Participants filled a questionnaire about their language background (see appendix). When asked about their first language (L1) use, seventeen of these subjects self-reported to be Catalan-dominant speakers, nine subjects reported they spoke mostly Spanish and, finally, twelve reported to speak both Spanish and Catalan on a daily basis. The NCat speakers were Catalan Philology undergraduates. None of them reported speaking any foreign language fluently. Both, CLEs and Ncats were speakers of the central variety of Catalan.

The 99 vowel stimuli were randomized and presented to the subjects for perceptual judgment. Each subject was tested in individual sessions which lasted about ten minutes. The user interface used for the Perceived Dissimilarity Test (PDT) consisted on eight pushbutton boxes on the computer screen. Seven of these buttons represented the seven Catalan vowel categories with IPA symbols /i e ɛ a ɔ o u/. The other button had the label nc, which stands for "non Catalan". Catalan /ə/ was not provided as a response category because it only occurs in unstressed position (Recasens 1986, Prieto 2001).

Listeners were informed that they would hear syllables of the type CV. They were instructed to click one of the eight buttons which represented the seven Catalan vowel categories. The "nc" button could only be clicked if the vowel they heard did not sound like any of the above seven vowel categories. In previous studies of perceived dissimilarity between L1 and L2 vowels reported earlier (Strange et al., 1998; Guion et al., 2000; Cebrián, 2002) listeners were also asked to rate each stimuli for goodness-of-fit to the response category selected. Guion (personal communication) found that listeners felt overwhelmed by performing two perceptual judgements in the same trial and, consequently, the goodness ratings were strongly biased by the identification responses. Consequently, goodness ratings were not included in this task.

4. Results

4.1. Data analysis

To analyse statistically possible effects of speakers and group (NCat vs. CLE) on the variation of the listeners' responses, I used a method reported by Strange

et al. (1998) for application in perceptual assimilation tasks. The Proportional Reduction in Error (PRE) is recommended by Reynolds (1984) and Wickens (1989) for use with categorical data.

The logic of PRE is straightforward: Table 2 shows PRE analysis of an hypothetical vowel, such as Spanish or Catalan /e/. First, we score the response category for each vowel summed over speakers and words. This gives us a value for the overall mode that for the case of /e/ accounts for of 40% of all responses. This means that we have 60% error remaining to be accounted for, that is the Base Rate of Error. Scoring each group on its own modal response, I can now account for 55% of the responses. The reduction in error is then 15%, which means that we have reduced error moderately so the effect of group yields a PRE value of 0.25 (15/60=0.25).

	C1	C2	C3	C4			
CLE /i/	45.9	51.4	29.7	59.5	46.62		
NCat /e/	73.3	73.3	80	26.7	63.32		
	59.6	62.35	54.85	43.1	54.97	Residual Error	45.02
			Overall Mode /i/		39.9	Base Rate of Error	60.1
						Reduction in Error	15.75
						PRE	0.25

Table 2: PRE analysis examining the effect of group for vowel /e/.

Significant main effects should have a PRE value of 0.1 or more. Significant interactions should reduce error at least 1.00 more than either main effect alone (Strange et al. 1988). PRE is not necessary when a vowel is perceived consistently (85-90 %). In these cases further analysis is not relevant.

4.2. Assimilation patterns of American English vowels to Catalan vowels

Average modal responses for identification of English vowels in terms of Catalan categories is detailed in Table 3. Both groups of listeners identified consistenly two GA vowels /i u/. The overall pattern for /ɪ/ varied as a function of group. The Ncat group identified it as instances of Cat /e/ 62% of times but the CLE group selected the response category /i/ in 38% of instances and also the "non-Catalan" option 35% of times.

Identification patterns for vowels /ɛ æ ʌ ɑ ɔ/ did not vary much across groups. What is noticeable is that, on average, CLEs selected the "non-Catalan"

option more often than the native Catalans. The overall mode for four English vowels /æ ʌ ɑ ɔ/ was Cat /a/. This suggests that discrimination will probably be poor for these vowel contrasts. To classify /ʊ/, native Catalan listeners selected the /u/ and 'non-Catalan' response 30% of times each. The CLEs showd similar trends, only that the 'non Catalan' option was mostly preferred.

vowel	RESPONSE CATEGORY (NCat)							
stimuli	a	ɛ	e	i	o	ɔ	u	nc
i				**99.2**				
ɪ		19.2	**62.5**	15.8				2.5
ɛ	11.7	**50.8**	25					10.8
æ	**45**	35	5.8					11.7
ʌ	**57.5**	5	5.8			11.7		16.7
ɑ	**78,3**					9.2		10
ɔ	**55,8**							
ʊ		5	11.7		15.8	6.7	30.8	**30**
u							**95**	

vowel	RESPONSE CATEGORY (CLEs)							
stimuli	a	ɛ	e	i	o	ɔ	u	nc
i				**95.9**				
ɪ		12.2	11.5	**39.5**				35.8
ɛ	13.9	**60.5**	7.8					16.9
æ	**57.8**	6.8						34.5
ʌ	**47**					11.1		37.5
ɑ	**64.2**					14.5		20.3
ɔ	**40.5**				3.5	33.1		22.3
ʊ						9.5	34.9	**47.5**
u							**81.1**	18.2

***Table* 3.** Percent identification of GA vowels by 15 native speakers of Catalan and 37 Catalan learners of English. Bold figures indicate the modal identification vowel. Responses selected 3% or less are omitted.

			Proportion Reduction in Error (PRE)		
	Modal response	Base Rate of Error	Speaker	Group	T/G interaction
i	/i/ 97.55	—	—	—	—
ɪ	/i/ 32.7	67.3	**0.13**	**0.21**	**0.34**
ɛ	/ɛ/ 57.7	42.3	0.097	-0.10	**0.13**
æ	/a/ 54.1	45.9	-0.05	-0.11	**0.10**
ʌ	/a/ 50	50	**0.10**	0.09	0.11
ɑ	/a/ 68.3	31.7	-0.0002	-0.0002	-0.0002
ɔ	/a/ 45	55	**0.18**	**0.106**	0.21
ʊ	"nc" 42.4	57.6	**0.18**	- 0.05	0.181
u	/u/ 88.05	—	—	—	—

Table 4. Proportion Reduction of Error (PRE) indicating the main effects of group and speaker and the speaker x group interaction for GA vowels. Boldfaced values are significant.

4.2.1. Front vowels

Overall percent identification for /ɪ/ is shown in fig. 1. Mean values for the CLE group are based on 228 judgments (6 stimuli x 38 listeners), mean values for the Ncat group are based on 90 judgments (6 stimuli x 15 listeners). PRE analysis revealed a great deal of variation across speakers and groups (see table 4). The closest fit /i/ only accounted for 32 % of the responses. The main effect of speaker was significant (PRE=0.13); the vowel stimuli of speakers E1, E2 and E6 were heard as /i/ but those elicited by speakers E3 and E5 were classified as 'non-Catalan' and /e/, respectively. Speaker E4's stimuli were still less consistently identified since listeners used three different response categories /e/, /ɛ/ and "nc" to classify the stimuli.

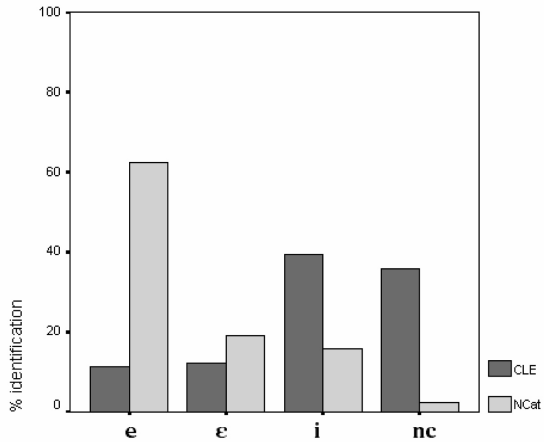

Fig. 1. Identification of English /ɪ/ in terms of the eight Catalan vowel categories /i e ɛ a ɔ o u/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Response categories selected 3% of times or less have been omitted.

The main effect of group for /ɪ/ is significant resulting in almost 23% reduction in error (PRE= 0.21). Each group shows different trends in identifying English GA /ɪ/**:** CLEs classified this vowel as instances of Cat /i/ but NCat group identified /ɪ/ in terms of Cat /e/. Finally, considering the best response for each speaker and group yields also a significant interaction (PRE =0.34) indicating that identification of GA /ɪ/ varied considerably across speakers and group.

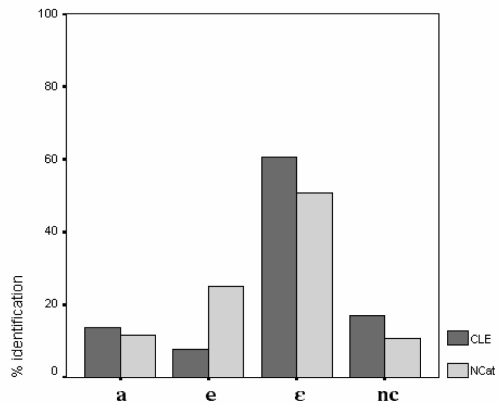

Fig. 2. Identification of English /ɛ/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Mean values for the CLE group are based on 228 judgments (6 stimuli x 38 listeners), mean values for the Ncat group are based on 90 judgments (6 stimuli x 15 listeners)

GA /ɛ/ was identified as intended in 57% times so 42% error still remains to be accounted for (see Table 4 and Fig. 2). The closest fit for this vowel varied as a function of speaker: in some cases they were heard as /a/, others as 'non-Catalan'. Yet, the effect of speaker wes only marginally significant (PRE=0.097). Rearranging the scores across groups did not reduce error, neither the speaker x group interaction (PRE=0.13).

GA /æ/ was classified as Cat /a/ in 54 % so a residual error of 46% remains to be accounted for (see also Fig. 3). The main effects of speaker and group do not further reduce error (PRE=-0.05 and -0.11 respectively) but considering the best score for each speaker and group together results in just a marginal reduction of error marginally (PRE=0.10).

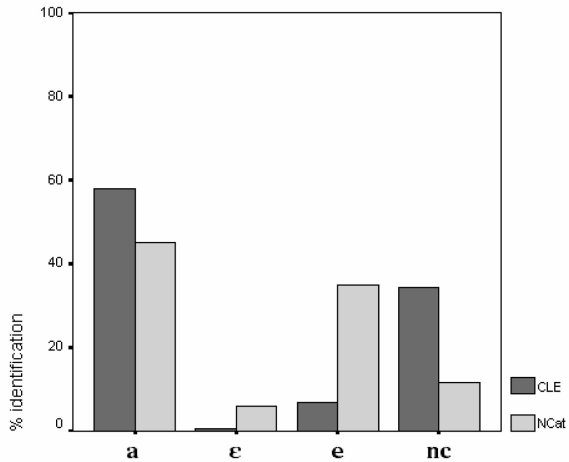

Fig. 3. Identification of English /æ/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Mean values for the CLE group are based on 228 judgments (6 stimuli x 38 listeners), mean values for the Ncat group are based on 90 judgments (6 stimuli x 15 listeners)

4.2.2. Central and back vowels

The overall mode for GA /ʌ/ only accounted for 50% of the responses (Fig. 4). Examining the scores by speaker reveals a small significant effect of this variable. All stimuli were identified as /a/ except for the stimuli produced by speaker E6 which were mostly heard as 'non-Catalan'**.** Examining the scores across groups suggests that percent identification was more consistent in the Ncat group than in the CLEs, however the main effect of group only reached marginal significance (PRE=0.09). The speaker x group interaction did not further reduce error.

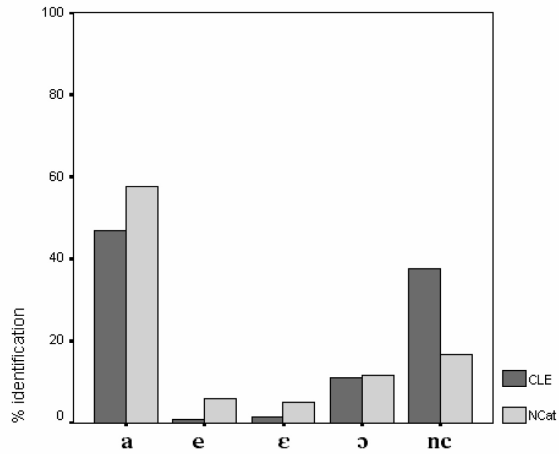

Fig. 4. Identification of English /ʌ/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Mean values for the CLE group are based on 228 judgments (6 stimuli x 38 listeners), mean values for the Ncat group are based on 90 judgments (6 stimuli x 15 listeners)

The overall mode for GA /ɑ/ was Cat /a/ in 68% of the trials. There is no variation across speakers and groups. The main effects of speaker and group were not meaningful: the response category was the same for all speakers and also for both groups of listeners. The interaction speaker x group yielded the same PRE values that either main effect alone.

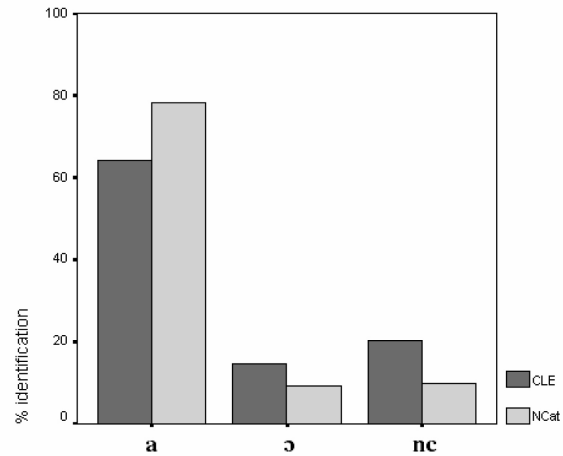

Fig. 5. Identification of English /ɑ/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Mean values for the CLE group are based on 304 judgments (8 stimuli x 38 listeners), mean values for the Ncat group are based on 120 judgments (8 stimuli x 15 listeners).

Vowel /ɔ/ was primarily identified as Cat /a/ but the overall mode still yielded a residual error of 55%. Scoring the identification frequencies across speakers and group reveals significant main effects of both variables. The stimuli produced by speaker E2 were heard as /ɔ/ resulting in a significant main effect of speaker (PRE=0.18). Both native Catalans and CLEs used the same response category when identifying GA /ɔ/ but the first group's scores were significantly higher than the second's yielding a marginal main effect of group (PRE= 0.10).

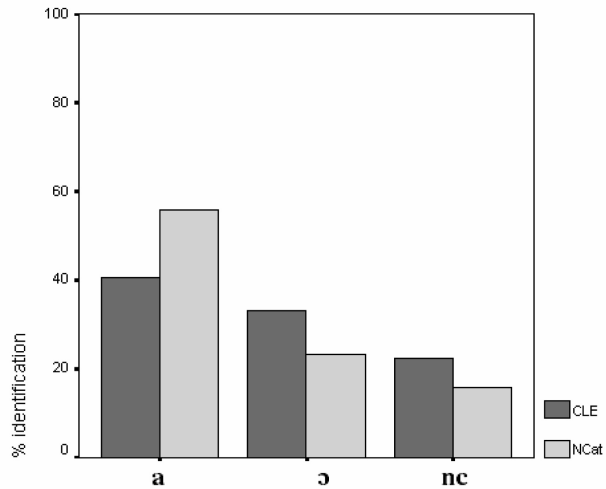

Fig. 6. Identification of English /ɔ/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Mean values for the CLE group are based on 304 judgments (8 stimuli x 38 listeners), mean values for the Ncat group are based on 120 judgments (8 stimuli x 15 listeners).

The average mode for GA /ʊ/ only accounted for 42 % of the stimuli, leaving a high residual error. Table 3 shows that the main effect of speaker accounts for part of this error (PRE=0.18). The stimuli produced by speakers E1, E2 and E5 where heard as 'non-Catalan' but the tokens produced by the other speakers were classified as Cat /u/. Although CLEs and NCat used diferent response categories, the final scores yielded negative PRE values, the main effect of group is thus not meaningful neither the speaker x group interaction.

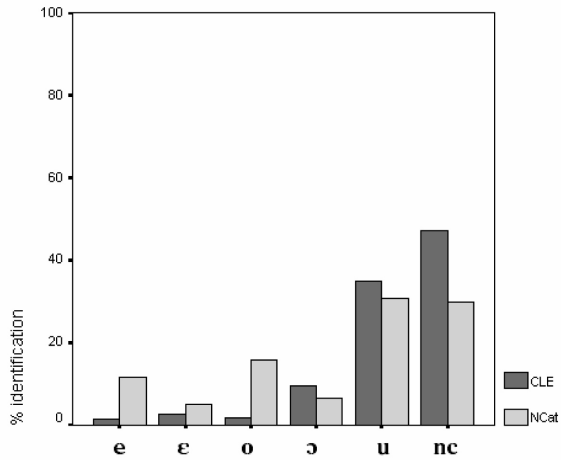

Fig. 7. Identification of English /ʊ/ by a group of native speakers of Catalan (Ncat) and a group of Catalan learners of English (CLE). Percentages for the CLE group are based on 228 judgments (6 stimuli x 38 listeners), percentages for the Ncat group are based on 90 judgments (6 stimuli x 15 listeners).

5. Discussion

A recapitulation of the perceptual relatedness of English vowels to Catalan vowels reveals different assimilation patterns. Vowels /i u/ were quite consistently identified (75%) in terms of Catalan categories, which suggests that these two vowels represent a good fit to their Catalan counterparts /i u/. By contrast, some English vowels were not consistently assimilated to the closest Catalan sound. These sounds were either classified as intermediate between two Catalan vowels or as instances of several Catalan vowels. For instance, English /ʊ/ was equally classified both as Catalan /u/ and as 'non-Catalan'. Front /ɛ/ was mapped onto Catalan /ɛ/, /e/ and 'non-Catalan'. Finally, /ɪ/ was heard as Catalan /i/, 'non-Catalan', /e/ and /ɛ/, indicating a lack of direct map onto one Catalan category.

The perceptual assimilation patterns of vowel /ɪ/ are partially in line with those obtained by Cebrian (2002). Just like the native Catalans in our study, he found that English /ɪ/ had no clear map onto a Catalan vowel category. Listeners mapped this vowel onto Catalan /e/ with an average of 60% consistency, but there was considerable overlap with Catalan /ɛ/ and /i/. However, it is interesting to note that Cebrian found no differences between experienced and inexperienced learners.

As for English /ɛ/, I found some discrepancies with Cebrian's study. He reports that listeners classified this vowel quite consistently in terms of Catalan /ɛ/. However, the listeners of the present study were less consistent in their responses: many stimuli were mapped onto Catalan /ɛ/, /a/ and 'non-Catalan'. Two methodological aspects may have contributed to these discrepancies: first, the vowel stimuli in Cebrian's study were produced by two speakers. Second, listeners did not have the choice of the 'non-Catalan' response. Overall, these two factors may have favored less dispersion in responses.

Vowels /ʌ æ ɑ ɔ/ were classified as instances of the same Catalan category /a/. On average, percent identification was more consistent for vowel /ɑ/ (68%) so it may be considered the best fit to Cat /a/ followed by /æ/ (54 % consistency), /ʌ/ (50% consistency) and /ɔ/ (45% consistency). In terms of Bests's PAM, these patterns suggest that discrimination will be poor for these vowels because all four vowels have been assimilated to a single L1 category.

A more detailed analysis of responses by means of PRE analysis revealed significant main effects of speaker for four vowels /ɪ ɑ ɔ ʊ/ and a marginal effect for vowel /ɛ/. This suggests that variablity in the assimilation patterns of these vowels can be partially attributed to differences in the speakers' productions. Some studies examining the influence of speaker variability on speech perception support this assumption. For instance, Verbrugge et al. (1976) found that that identification of vowels was more accurate when the vowel stimuli were drawn from tokens produced by a single speaker than when stimuli were drawn from a variety of speakers. This was also true of experiments measuring response latencies in a variety of perceptual tasks, such as categorization of synthetic continua (Summerfield and Haggard, 1973; Summerfield, 1975) or same-different matching tasks (Cole et al., 1994). Mullenix et al. (1989) further argue that speaker variability affects processes at an early segmental acoustic-phonetic level. Finally, in training Japanese listeners to distinguish English /r/ and /l/, Lively et al. (1994) found that Japanese monolinguals' performance was strongly influenced by speaker variability at the onset of the training session but, by the end of training, listeners had learned to overcome the personal characteristics of the speakers' voices.

Strange et al (1998) also report great variation in perceptual assimilation patterns of English vowels to Japanese vowels. They offer an interesting explanation for that. It seems that, when perceiving vowel stimuli, native and non-native listeners are not equally sensitive to the phonetic variation found in different instances of the same vowel category. The L2 learner pays more attention to dialect and individual within-category differences of the tokens. In contrast, these differences are largely ignored by the native listener.

The research question addressed in this study was concerned with the possibility that CLEs and Ncat might show different assimilation patterns of English vowels to Catalan vowels. A general trend which was observed in the reponses of the two groups is that, on average, CLE selected the 'non-Catalan' response category more often than the NCat. This suggests that Catalan learners' exposure to English may have positive effects on their sensitivity to recognition of non-native phones. Flege (1997) also offers a possible explanation for this finding, he argues that, at the first stages of learning, late L2 learners tend to identify new sounds with some sounds in the L1. Eventually and with the help of phonetic input, they will be able to discern the phonetic differences between the new L2 sound and the closest L1 sounds. This might explain why CLEs used the 'non-Catalan' response more regularly that the native Catalans.

PRE analysis of the main effect of group yielded significant main effects for two English vowels, /ɪ/ and /ɔ/. Native Catalan listeners identified English /ɪ/ in terms of Catalan /e/. This was not the overall mode for the CLEs, who mapped this sound onto the Catalan category /i/ and the 'non-Catalan' response. Cebrián This provides some evidence in favour of the hypothesis that experience with the target language influences perceptual mapping of L2 vowels onto L1 categories. The finding that the CLEs chose the 'non-Catalan' response more often than the native Catalan group, provides some indirect evidence that exposure to the target language increases learners' sensitivity to discern differences between Catalan and English vowels, as it has been found in previous studies by Flege and cols. (Flege, 1991 and 1995; Fox, Flege and Munro 1999). However, a different experimental design and statistical analysis is needed to further investigate this hypothesis.

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APPENDIX: Language background questionnaire

1. NAME:

2. AGE:

3. PLACE of RESIDENCE:

4. Which is your first LANGUAGE?

a) Catalan b) Castilian c) Both

5. Which variety of Catalan do you speak? Write name of province / region.

(If the answer to question 4 is b) you do not need to answer this question)

6. At what age did you start to learn English?

7. Have you been to any English-speaking country? YES NO

Where?

When?

For how long?

8. Are you enrolled in an English Phonetics course? YES NO

9. In which situation do you speak English?

Only in class

At work

Other (specify):

10. Do you speak fluently any foreign languages other than English?

YES NO

Which one /ones ?

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4. All correspondence should be addressed to:
   Rosa Alonso (*ralonso@uvigo.es*) or Marta Dahlgren (*dahlgren@uvigo.es*)
   Universidade de Vigo
   Facultade de Filoloxía e Traducción
   Lagoas-Marcosende
   36200 Vigo Spain