Lexical Knowledge Effects on the Discrimination of Non-Native Phonemic Contrasts in Words and Non-Words by Spanish/Catalan Bilingual Learners of English

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Abstract

This paper reports on the results of a study investigating the effect of L2 lexical knowledge on the perception of nonnative phonemic contrasts. An AX auditory discrimination task was used to test the ability of a group of bilingual Spanish/Catalan advanced learners of English (*N*=74) to perceive 9 English phonemic contrasts. The aural stimuli consisted of 144 word pairs (108 minimal pairs and 36 distractors), 50% of which were English nonwords. The subjects' knowledge of the words in the discrimination task was assessed by means of a lexical knowledge post-test. The advanced learners of English were found to be more successful in perceiving nonnative contrasts in minimal pairs with known words than in minimal pairs with nonwords and unknown words. The results reveal that lexical knowledge has a significant effect on the perception of nonnative phonemic contrasts leading to better dicrimination results in the subjects' performance on known words than on unknown words and nonwords, and suggest that this factor be taken into account in L2 learners' perceptual ability assessment.

1. Introduction

AX auditory discrimination tasks are among the experimental techniques used in L2 speech perception research for the assessment of L2 speakers' ability to perceive nonnative phonemic contrasts and for testing their L2 phonological competence [1] . The use of L2 real-word instead of nonword minimal pairs in auditory discrimination tasks intended for advanced foreign L2 learners raises the question of whether learners' lexical knowledge is a factor that significantly affects their ability to discriminate phonemic contrasts.

Speech perception studies investigating the relationship between lexical knowledge and phonetic processing or categorial phonemic discrimination [2,3] suggest that listeners make use of lexical knowledge in the phonetic and phonological categorization of sounds. For example, Yamada *et al.* [4] found a significant correlation between word familiarity and correct identification of English /r/, /l/ and /w/ by native speakers of Japanese, highlighting the importance of taking into account the lexical knowledge factor in cross-language speech perception research. Recourse to nonword-based discrimination tasks, however, does not necessarily guarantee the absence of lexical knowledge effects: several studies [5] provide evidence of the pervasiveness of a lexical bias in discrimination tasks with nonwords. If, as these studies suggest, phonetic decision making always involves the lexicon, the influence of lexical knowledge on the ability of L2 learners to perceive phonemic contrasts should be observable in real-word as well as in nonword phonemic discrimination tasks and should be taken into consideration as a conditioning factor irrespective of the type of stimuli used. This study follows this line of research by investigating the effect of lexical knowledge on the discrimination of nonnative phonemic contrasts in words and nonwords; in particular, it sets out to determine whether lexical knowledge has an influence on the perception of 9 nonnative phonemic contrasts reported to present producion and perception difficulties for Spanish/Catalan bilingual learners of English.

2. Method

It was hypothesized that lexical knowledge would condition the perception of nonnative phonemic contrasts making the discrimination of such contrasts harder in unknown, unfamiliar lexical items than in known words. Underlying this hypothesis is a large body of research demonstrating the effect of linguistic experience on the perceptual learning of nonnative speech contrasts [6] and the intuitively well-founded assumption that acoustic differences between sounds that function contrastively in the language are easier to perceive for the L2 language learner if these occur in lexical items he/she has heard and pronounced many times than in novel unknown words. The aim of the study is twofold. On the one hand, the lexical bias hypothesis was tested by including in the discrimination task words and nonwords that were matched with respect to phonemic contrast. On the other hand, we wished to assess the perceptual phonological competence of Spanish/Catalan advanced learners of English by testing their ability to discriminate 9 nonnative phonemic contrasts in minimal pairs through an AX discrimination task.

2.1. Subjects

Two groups of subject took part in the study: 109 first-year university students in the English department at the University of Barcelona and a control group of 6 native speakers of British English (EFL teachers at a language school in Barcelona). The students had all passed the English Language I course in the department and their general level of competence ranged from upper-intermediate to advanced. Information about the students' linguistic background and language use was obtained by means of a questionnaire. Bilingual Spanish/Catalan speakers were thus identified (*N*=74) and Spanish monolinguals and native speakers of other languages were assigned to a different group and filtered out in the statistical analysis of the data.

2.2. Task Design

The AX discrimination task contained 144 aural stimuli consisting of 108 minimal pairs expressing 9 English phonemic contrasts (see Table 1) and 36 distractors (i.e. word pairs consisting of two realizations of the same word) in a variety of positions in the word (initially, medially and finally; whenever possible). Half of the minimal pairs and distractors were English nonwords, so that the measure of the subjects' ability to perceive a given phonemic contrast was obtained from their performance on 12 minimal pairs (6 real-word pairs and 6 nonword pairs). The target phonemes in the minimal pairs were presented to listeners in alternating order (i.e. /iː/-/ɪ/; /ɪ/-/iː/; as in *feet -fit*; *sit-seat*) and randomized. Real-word and nonword minimal pairs and distractors were matched with respect to stress and phonetic context.

The phonemic contrasts (PhCs) in the discrimination task were selected due to their reported difficulty for Spanish/Catalan bilinguals in production and perception. Both languages lack a tense-lax distinction for high front vowels (PhC1: /iː/-/ɪ/) and have the phoneme /i/ in this area of the vowel space. A front-back distinction for open vowels (PhC2-3: /æ/-/ʌ/-/ɑː/) is also lacking in Spanish and Catalan, whose only fully open vowel is a relatively front /a/. PhC4 (/ɪ/-/ə/) and PhC5 (/e/-/eə/) were selected on the basis of their acoustic similarity in unstressed syllables (e.g. *boxes* /ˈbɒksɪz/ vs. *boxes* /ˈbɒksəz/) and in stressed syllables before liquids (e.g. *merry* /ˈmeri/ vs. *Mary* /ˈmeəri/). Although Spanish lacks a schwa-like vowel, Catalan does have /ə/ as a result of vowel reduction in unstressed syllables (neutralizing the opposition between /e/, /ɛ/ and /a/), but neither Spanish nor Catalan have falling diphthongs ending in a central vocalic element, as in PhC5 (/e/-/eə/), a contrast that is not realized by all native speakers in all contexts.

As far as consonantal contrasts are concerned, three contrasts based on voicing were included: PhC6 (/t/-/d/) and PhC7 (/s/-/z/) were restricted to word-final position, a context in which Spanish and Catalan have no voiced obstruents at the phonetic level. Catalan has a rule of terminal devoicing whereby underlyingly voiced obstruents are realized as voiceless in word-final position, but the voicing contrasts /t/-/d/ and /s/-/z/ are exploited in other word positions. In Spanish, /d/ (phonetically dentialveolar [d̪]) is the only voiced oral stop which may occur in word-final position, but it is realized as either [ð], [ð̞] or [θ], depending on dialectal variation. Spanish lacks voiced fricative phonemes. A voiced alveolar fricative [z] is found as an allophone of /s/ before voiced consonants (e.g. *mismo* [ˈmizmo] "same", *desde* [ˈdezð̞e] "from") but never in word-final position. The voicing contrast /tʃ/–/dʒ/, as opposed to the contrasts /t/-/d/ and /s/-/z/ which appeared in word-final position only, also included stimuli with word-initial occurrences of the contrast (e.g. *chew* /tʃuː/ vs. *Jew* /dʒuː/). The voiced and voiceless palatoalveolar affricates occur in Spanish and Catalan at the phonetic level but do not contrast phonologically in word-initial and word-final position. The contrast /d/–/ð/ was chosen because of the structural mismatch between the phonetic and phonological categories these sounds belong to in Spanish/Catalan and English. In Spanish and Catalan, [ð] is the spirantized (approximant) realization (i.e. [ð̞]) of the voiced dentialveolar phoneme /d/ in all contexts except after a pause, a nasal or a lateral. The fact that in Spanish and Catalan [d̪] and [ð̞] are two realizations of the dentialveolar phoneme /d/ often leads to learners' mispronunciation of English /ð/ as [d̪] in those contexts where they do not spirantize /d/ in their L1.

Table 1: Phonemic contrasts in the AX discrimination task

	Phonemic Contrasts		Examples	
1	/iː/-/ɪ/	tense-lax	6+6	*feet-fit*
2	/æ/-/ʌ/	front-central	6+6	*ran-run*
3	/æ/-/ɑː/	front-back	6+6	*back-bark*
4	/ɪ/-/ə/	close front-central	6+6	*boxes-boxers*
5	/e/-/eə/	front mid-centring D	6+6	*belly-barely*
6	/t/-/d/	voiceless-voiced	6+6	*card-cart*
7	/s/-/z/		6+6	*loose-lose*
8	/tʃ/-/dʒ/		6+6	*chew-jew*
9	/d/-/ð/	plosive vs. fricative	6+6	*day-they*
108 minimal pairs + 36 same-word pairs = 144 word pairs				

The 288 words in the 144 word pairs were read by a native speaker of British English with an RP accent in a soundproof booth and recorded on tape. The words were read on a falling tone as they appeared at 2-second intervals on the screen of a laptop computer. The recorded items were digitized and the AX discrimination test was constructed with a 1-second inter-stimulus interval (ISI) between the two members of a word pair, and a 2-second ISI between word pairs. The randomized 144 word pairs were grouped into 6 sections of approximately 25 words each to avoid listeners' lack of concentration resulting from tiredness. The English nonwords had been examined for naturalness by two native speakers of English and were studied and read aloud by our informant before the actual recording took place.

The fact that our subjects were "advanced" learners of English as a foreign language did not guarantee that all real words were known to them. Moreover, some of the English nonwords might have mistakenly been identified as real words due to their phonetic similarity with existing lexical items. Given the nonnative learner nature of the population taking part in the study, the assumption that all real words are known and all nonwords are necessarily "unknown" had to be discarded. Consequently, the subjects' knowledge of the words in the auditory discrimination task had to be tested by means of a lexical post-test.

A lexical knowledge test was devised including all the words and nonwords in the discrimination task. The words were presented in a list in written form as well as aurally with a 6-second ISI. The test contained one section (S1) for respondents to select one out of three answers to the question *"Do you know the word below?"*: "Yes", "No", or "Not Sure", and a multiple-choice vocabulary translation section (S2) for them to select one out of three translations in Spanish (only one of the options was correct). Since all nonwords were also included in the lexical test, a fourth "I-don't-know-what-it-means" option was also included in S2. Three translations were also included as options for all nonwords,

one of which always identified an English word with a sound pattern similar to that of the target nonword. "Knowing" a word is here assumed to mean that the subject knows the semantic content ot the lexical item; it is also assumed that subjects would have some underlying knowledge of what qualifies as a well-formed sound sequence in English and what constitutes a possible word in accordance with English phonotactics.

Although real words marked as "known" in S1 were expected to yield correct answers in the vocabulary translation section and nonwords were expected to be marked always as "unknown" in S1 and yield an "I don't know" answer in S2 instead of one of the translations in the multiple-choice section. The test design allowed for many other possibilities, such as marking a nonword as "known" and giving it a translation; or marking a word as "not sure" but selecting the correct translation for it. The lexical post-test design in two sections allows us to have two different, but related, views on the subjects' lexical knowledge of the words in the minimal-pair test: the subjective approach to their lexical knowledge of the lexical items in S1, and their lexical knowledge as objectively tested by a multiple-choice vocabulary test in S2.

2.3. Procedure

The auditory discrimination test was administered in a quiet room and the participants (30-40 per session) listened to the aural stimuli over four loudspeakers situated in the corners of the ceiling. The task instructions and six preliminary examples were presented to the subjects aurally and in written form. The word pairs in the discrimination task were not presented in written form; the subjects were given an answersheet where they were asked to make a forced choice and tick a numbered box marked "S" for "Same" or "D" for "Different" according to whether they had heard the two items in a word pair as the same word (S) or two different words (D).

The AX discrimination task was followed by the lexical post-test. The subjects were presented with the words in a list in written form as well as aurally and, as they heard the words, they were asked to (a) tick the appropriate box in the answersheet according to whether they knew the word or not (S1); and (b) choose one out of the four options in the multiple-choice vocabulary translation section (S2).

2.4. Data Analysis

Respondents' answers in the same-different AX discrimination task and the two sections in the lexical post-test were coded independently for statistical analysis and the distractors were filtered out. The mean scores obtained for words and nonwords in the discrimination task for the 9 nonnative phonemic contrasts examined were compared. The data was then recoded to compare the mean scores obtained in the discrimination task in the 6 minimal-pair types (MPTs) resulting from S1 of the lexical test. The subjects' answers to the question "Do you know the word below?" in S1 yielded 6 MPTs: MP1 (no-no), MP2 (no-not sure), MP3 (not sure-not sure), MP4 (yes-no), MP5 (yes-not sure), MP6 (yes-yes). Lack of statistically significant differences among some of the variables suggested collapsing the 6 MPTs into three main lexical-knowledge variables MP1 (none of the words were known), MP2 (one of the words were known) and MP3 (both words were known). Since the values given to the subjects' answers in the discrimination task were "1" for correctly discriminated phonemic contrasts and "2" for failure to identify a phonemic contrast, it was expected that subjects' mean scores would be closer to "1" for word pairs where both items were known (MP3) than for word pairs where none of the words were known (MP1), which would be closer to "2" than the mean scores obtained for word pairs with only one known word.

Minimal-pair categories defined according to the multiple-choice vocabulary translation test in S2 of the lexical test produced three minimal-pair types: none of the words are known (Type 1), one word is known (Type 2) and both words are known (Type 3). The minimal pairs in the discrimination task were labelled T1, T2 and T3 according to whether the subjects selected the correct option in the multiple choice test.

3. Results and Discussion

Statistically significant differences (t-test: $t(33.73)=14.11$, $p=.000$) were found between the native speaker control group and the nonnative speaker group. British English speakers obtained, as expected, mean results close to 100% correct performance ($M=95.68$, $SD=1.91$), whereas the advanced EFL learners obtained much lower mean percentages ($M=76.90$, $SD=9.26$). The native speakers' overall performance on the AX discrimination task was slightly better for words ($M=96.29$, $SD=2.86$) than for nonwords ($M=95.06$, $SD=1.91$), but the difference did not reach statistical significance (Wilcoxon signed rank test $Z=-1.000$, $p=.317$), nor was there any significant difference between words and nonwords when phonemic contrasts were examined individually.

The results for the advanced learners of English ($N=74$) (see Table 2), show that the percentage of perceived phonemic contrasts in minimal pairs (MPs), that is, correct minimal-pair identifications, was significantly higher for words (79.85%) than it was for nonwords (74%). The fact that perception of phonemic contrasts is harder in nonwords suggests that lexical knowledge facilitates the perception of nonnative phonemic contrasts. This overall significant difference, however, does not turn out to be statistically significant for all phonemic contrasts examined; considerable differences in the mean percentages obtained were found according to phonemic contrast.

Table 2: Mean % of perceived contrasts in MPs

M %		Wds	*SD*	NWds	*SD*	*Sig.*
MPs		79.85	9.34	74.27	10.27	.000
Vowels		85.94	9.37	84.68	10.04	.161
Consonants		71.51	12.77	61.26	14.29	.000
/iː/-/ɪ/	1	83.33	17.88	84.68	20.23	.859
/æ/-/ʌ/	2	88.96	13.31	72.75	21.11	.000
/æ/-/ɑː/	3	96.40	11.46	96.84	8.13	.646
/ɪ/-/ə/	4	93.24	12.92	86.71	14.06	.000
/e/-/eə/	5	67.79	18.16	82.43	10.99	.000
/t/-/d/	6	88.51	14.31	82.88	15.10	.005
/s/-/z/	7	78.60	23.65	61.71	27.82	.000
/tʃ/-/dʒ/	8	70.27	18.35	47.30	19.71	.000
/d/-/ð/	9	48.65	22.54	53.15	16.93	.109

Nonnative subjects performed better on vowel contrasts (*M*=85.31, *SD*=8.92) than on consonant contrasts (*M*=66.38, *SD*=12.02). No significant difference between words and nonwords was found for PhC1 (/iː/-/ɪ/) and PhC3 (/æ/-/ɑː/), and vowels in general. For PhC5 (/e/-/eə/), the vowel contrast obtaining the lowest discrimination mean percentage, the subjects obtained significantly better results in nonwords than in words. This may be due to the fact that this contrast is not always implemented by native speakers, particularly before liquids; a slight acoustic difference in this context may be more salient in nonwords (e.g. *spary-sperry*) than in well-known lexical items that are likely to be readily identified (e.g. *merry-Mary, vary-very*). Mean percentages of perceived consonantal contrasts do not only significantly differ from those obtained for vowels, they present statistically significant differences between words and nonwords (see Table 2). This is so for voicing contrasts (/t/-/d/,/s/-/z/ and /tʃ/-/dʒ/), in which correct discrimination percentages are always significantly higher in words than in nonwords, but not in the perception of PhC 9 (/d/-/ð/), which is the most difficult contrast to perceive (*M*=50.90, *SD*=16.00) and for which no significant difference is found between words (*M*=48.65, *SD*=22.54) and nonwords (*M*=53.15, *SD*=16.93). The reason for such poor discrimination percentages on PhC9 is to be sought in the added difficulty of this contrast expressing a structural mismatch between its categories at the phonetic/phonological level in Spanish/Catalan and English (see section 2.2).

The mean percentages of correct discrimination reported in Table 2 generally support our hypothesis that lexical knowledge conditions the perception of nonnative phonemic contrasts so that they are easier to perceive in known words than in unknown words. These mean percentages, however, do not accurately show lexical knowledge effects on nonnative speakers' discrimination ability because (a) some of the real words may actually be unknown to the subjects and could more accurately be treated as nonwords for them, and (b) some of the nonwords, which have so far been assumed to be necessarily "unknown" to subjects, might actually be "mistakenly known" (due to phonetic similarity).

Table 3: Perceived contrasts in minimal-pair types

Lexical Knowledge	S1			S2		
	M	*SD*	*Sig.*	*M*	*SD*	*Sig.*
Type 3	1.18	.09	.000	1.21	.11	.000
Type 2	1.27	.15		1.19	.12	
Type 1	1.23	.18		1.24	.09	
Wilcoxon	S1			S2		
	Sig.	z		Sig.	z	
T3 vs. T1	.000	-4.955		.012	-2.506	
T3 vs. T2	.000	-5.013		.034	-2.122	
T2 vs. T1	.114	-1.581		.000	-3.968	

The subjects' responses in the two sections of the lexical post-test seem to confirm the lexical bias already observed in the AX discrimination task (see Table 3). Friedman's tests show that the mean scores are significantly closer to the "1" value (i.e. "perceived" phonemic contrast) for Type 3 minimal pairs (both words are known) than for Type 1 minimal pairs (both words are unknown), which obtain higher mean values ("2": "not perceived" phonemic contrast). Further Wilcoxon signed rank tests were carried out to identify statistically significant differences between the mean scores the subjects obtained in Type 1, Type 2 and Type 3 minimal pairs. The statistical analyses reveal significant differences in both sections of the lexical post-test between Type 3 minimal pairs and Type 1 minimal pairs, which suggest that lexical knowledge does have an effect on the perception of nonnative phonemic contrasts for advanced learners of English.

4. Conclusions

An analysis of the scores on an AX discrimination task and a lexical knowledge post-test revealed that advanced learners of English were more successful in perceiving non-native phonemic contrasts in minimal pairs with known words than in minimal pairs with unknown words and nonwords. It was mainly with those phonemic contrasts that were harder to perceive, however, that the subjects' scores on the auditory discrimination task produced statistically significant differences between known words and nonwords. These results suggest that lexical knowledge is a significant factor conditioning the perception of non-native phonemic contrasts, a factor to be taken into account when assessing learners' perceptual ability in the L2.

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