

# OLD SOUNDS IN NEW CONTRASTS: L2 PRODUCTION OF THE ENGLISH TENSE-LAX VOWEL DISTINCTION

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## ABSTRACT

This paper examines the production of the English tense-lax contrast in high and mid front vowels by native speakers of Catalan. Despite the absence of temporal contrasts in the L1, Catalans have been found to rely on duration in their perception of English vowels. Some English vowels have been found to be perceived by Catalans as near identical to L1 vowels. This study explores this further by examining English speakers' perception of Catalan vowels. In addition, reliance on temporal and spectral cues is assessed in an L2 production experiment. Results indicate that learners implement a temporal contrast but mostly fail to produce a spectral contrast even when perceived similarity data predicted accurate L2 production.

**Keywords:** L2 production, vowel categorization, acoustic cues, perceptual similarity, duration.

## 1. INTRODUCTION

Adult second language (L2) learners tend to perceive non-native sounds in terms of their native categories. Recent theories link the ability to categorize L2 sounds accurately to the ability to discern differences between native and non-native sounds (e.g., [1], [8]). One question that arises is whether L1 categories that are very close or near identical to L2 categories can be used successfully to perceive and produce target L2 sounds. Non-native speakers may also fail to perceive and produce L2 sounds accurately if they differ from native speakers in their use of acoustic information, or cues, in the formation of target L2 sound categories. For example, McAllister et al. [13] found that success in learning the Swedish vowel duration contrast was related to the role of duration in the L1. This supported the Feature Hypothesis, which claims that an L2 contrastive category will be difficult to acquire if it is based on a non-L1 feature. A contrasting approach is Bohn's [2] Desensitization Hypothesis, which claims that late learners can detect temporal differences

between a pair of unfamiliar L2 vowels more readily than spectral differences. Supporting evidence comes from studies which show that L2 English speakers whose L1 does not make use of duration exploit temporal cues to a greater extent than spectral cues in differentiating between English /i/ and /ɪ/ ([4], [5], [10], [15]).

This paper examines the use of spectral and temporal cues in the production of the English tense-lax vowel contrast by Catalan speakers of English. This contrast is associated with variations in height and backness and a difference in vowel duration. Catalan has no lax-tense or temporal contrast [14]. English native speakers have been found to rely mostly on spectral cues in differentiating tense and lax vowels [11]. In a perception study, Catalan speakers were found to hear English /i e' ε/ as near identical to the acoustically closest L1 vowels (/i ei ε/), whereas English /ɪ/ was heard as a poor match to L1 /e/ [4]. The same study tested the perception of English /i/ and /ɪ/ by means of a synthetic /i/-/ɪ/-/ε/ vowel continuum varying in temporal and spectral steps. Unlike Canadian English speakers, Catalan learners of English tended to rely heavily on duration to distinguish between /i/ and /ɪ/. Given that Catalan has no temporal contrast, this was taken as evidence in support of Bohn's desensitization hypothesis [2]. The question that remained is why two target vowels that were equally judged as near identical to L1 vowels, English /i/ and /ε/, obtained different results in the perception test (/ε/ being more often correctly identified than /i/).

The goal of this paper is thus to explore the similarity relationships between Catalan and English vowels further by testing English-speaking listeners' perception of Catalan vowels, and to assess the use of temporal and spectral cues in the production of L2 English vowels.

## 2. PERCEPTUAL ASSIMILATION TASK

### 2.1. Participants and procedure

A group of 20 native Southern Ontario English speakers with no knowledge of Catalan performed a perceptual assimilation task. They were presented with the Catalan vowels /i e ei ε/ and the English vowels /i ɪ e' ε/ aurally and were asked to identify the stimuli as the vowel in 'beat,' 'bit,' 'bait' or 'bet', and provide a goodness rating on a 7-point scale ('7' = good exemplar of the selected vowel, '1' = poor exemplar). English vowel stimuli were elicited from male native English speakers in h+ vowel or h+ vowel+d sequences and Catalan vowels were elicited from male Catalan speakers in isolation. Data were digitized at a 10 kHz sampling rate and vowel portions were edited out to be presented in isolation so as to minimize the effect of neighbouring consonants. These same stimuli were used in the perceptual assimilation task performed by Catalan speakers in [4].

### 2.2. Results

The Catalan vowels /i e ei/ were identified as the English /i e e'/ on most occasions (98-100%) and were given high goodness ratings (5.6, 5.2 and 5.7, respectively). Importantly, these identification and goodness rating scores were comparable to those obtained by the English vowels. The Catalan vowel /ε/ obtained lower identification scores and goodness ratings (64% and 4.3). These results mirror the pattern of assimilation of English to Catalan vowels in [4]. Taken together, the results indicate that English /i, ε, e'/ and Catalan /i, ε, ei/ are perceived as near identical categories suggesting that the use of L1 categories by Catalan speakers of English may go unnoticed by English listeners. In order to produce English /ɪ/ successfully, however, learners will need to create a new, non-L1, category.

## 3. L2 PRODUCTION

### 3.1. Participants and procedure

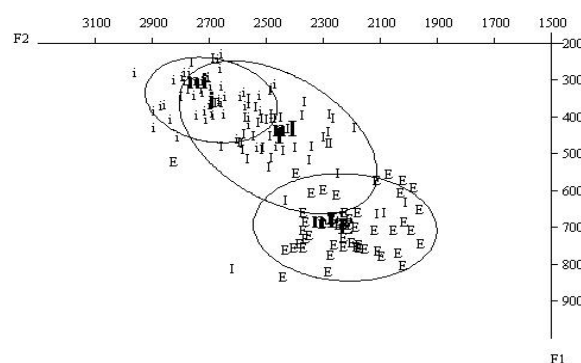
The participants were 30 L1-Catalan L2-English speakers who were English-major undergraduate students in Barcelona, Spain, and had participated in the perception experiment in [4]. Four native Canadian English speakers also participated for

control purposes. The task was a repetition and vowel insertion task. Subjects heard and then repeated an h\_d word and then produced new sets of words by inserting the vowel in the h\_d word into the nonsense word frame h\_b (e.g., 'head' - 'heb'). This method was used to avoid orthographic and word frequency effects and to minimize C to V and V to C tongue coarticulation. Data were digitized at a 10 kHz sampling rate. Production of the English vowels in the h\_b words was examined by means of acoustic measurements (formant values and duration), and listening tests.

### 3.2. Acoustic analysis

The steady-state F1 and F2 frequencies of the Catalans' production are plotted in Figure 1, excluding /e'/, which was characterized by greater formant movement. The Catalans' mean values were very close to the native English values. However, there was great variability in vowel quality as illustrated by the size and overlapping areas of the vowels' acoustic space, especially in the case of the large /ɪ/-/i/ overlap. This indicated that most Catalans failed to produce a spectral contrast between these two vowels. Vowel /ε/ was more clearly differentiated spectrally.

**Figure 1.** Catalan speakers' F1 and F2 values for English /i/, /ɪ/ and /ε/.



Mean durations are given in Table 1. Duration differences reached significance in a one-way analysis of variance ( $F(3,84) = 60.39, p < .001$ ). This pattern of vowel differences is consistent with results for native English speakers in this and other studies (e.g., [11]), indicating a target-like use of duration by Catalan learners of English. As the perception results in [4], this finding is consistent with the Desensitization Hypothesis [2].

**Table 1.** Mean durations in ms for each English vowel and mean tense/lax vowel duration ratios in the L2 data (SDs are given in parentheses).

/i/	/ɪ/	/i/-/ɪ/ ratio	/e'/	/ɛ/	/e'/-/ɛ/ ratio
243	153	1.62	257	183	1.44
(64)	(33)		(45)	(36)	

### 3.3. Listening tests

The L2 productions were assessed for accuracy by means of a vowel identification task and a goodness rating task.

#### 3.3.1. Stimulus preparation

Stimuli consisted of the vowel portions edited out from each h\_b test word so as to minimize the effect of consonant properties that might create an impression of a foreign accent. The vowel portion comprised from the first to the last positive peak in the periodic portion of the signal as indicated by an increase/decrease in overall amplitude and waveform complexity.

#### 3.3.2. Procedure

The first task was a forced-choice vowel identification task. Listeners were asked to identify the randomized vowels they heard as the vowel in 'had,' 'heed,' 'hid,' 'hayed,' 'head' or 'hub'. In the goodness rating task, stimuli were grouped in blocks of the same intended vowel and indicated with the corresponding IPA phonetic symbol. Listeners were asked to provide a goodness rating using a 7-point scale: '1' = poor exemplar of the target vowel, '7' = good English-sounding vowel.

#### 3.3.3. Listeners

Eight native Canadian English speakers participated in the vowel identification task. A different set of eight listeners participated in the goodness rating task. In this case, the listeners were Linguistics students and staff at the University of Toronto.

#### 3.3.4. Results

The results of the two listening tests are summarized in Table 2 below, which provides the mean identification scores and goodness ratings. The English control group obtained high identification and goodness ratings (87-96% and 5.5-5.7). Catalans' production of /e'/obtained the highest identification scores and goodness ratings, followed by /ɛ/, while /i/ and /ɪ/ obtained the

lowest scores. The more frequently identified vowels obtained the highest goodness ratings. There were significant correlations between identification scores and goodness ratings.

**Table 2.** Percentages of correct identification and goodness ratings of the L2 vowels produced by the Catalan subjects (SDs are given in parentheses).

Correct Identification				Goodness Rating			
/i/	/ɪ/	/e'/	/ɛ/	/i/	/ɪ/	/e'/	/ɛ/
73	71	99	86	4.5	3.9	5.5	5.2
(33)	(33)	(4)	(9)	(1.3)	(1.3)	(0.5)	(0.7)

An analysis of the acoustic characteristics of the production data indicated that /i/ tokens with longer duration, lower F1 and greater F2-F1 difference were better identified and rated, whereas in the case of vowel /ɪ/, better results in the listening tests corresponded to the opposite characteristics, that is, shorter vowel duration, higher F1, lower F2 and smaller F2-F1 difference (significant correlations were obtained at  $p < .01$  and  $p < .05$ ).

## 4. DISCUSSION

The perceived similarity data obtained from native English speakers indicates that Catalan /i/, /ɛ/ and /ei/ are heard as good instances of the acoustically closest English categories. Thus, it was predicted that the use of the L1 categories by Catalans in their production of English /i/, /ɛ/ and /e'/ may go unnoticed by English-speaking listeners. This appeared to be true for /ɛ/ and /e'/, which were found to be accurately produced. These results are in agreement with Flege and Best's models ([1], [8]), which allow for L2 vowels that are very close to L1 vowels, or 'near-identical' vowels, to pass as good instances of target L2 vowels. Similar cases of near-identity resulting in accurate L2 production have been reported for Dutch speakers' production of English /i/ and /ɪ/ [9], Spanish speakers' production of English /ɛ/ and Germans' production of English /i/ and /ɪ/ [7].

Catalans rely mostly on duration in producing the /i/-/ɪ/ contrast. This is consistent with the perception results in [4] and with Bohn's Desensitization hypothesis [2], and argues against the Feature Hypothesis [13]. Importantly, English /i/ was not produced as expected for a near

identical vowel (like /e/ and /ɛ/), but patterned with the dissimilar vowel /ɪ/. Similar results have been reported for Spanish speakers' production of English /i/ (similar) and /ɪ/ (new) [6]. The failure to produce the near identical vowel /i/ as accurately as the other two near identical vowels may result from the categorization of the /i/-/ɪ/ contrast as a temporal opposition and a subsequent reanalysis of the near identical L2 vowel as a temporal variant of /ɪ/. Learners may initially assimilate English /i/ to Catalan /i/ in view of the perceived similarity. As learners become aware of the temporal difference between /i/ and /ɪ/, the contrast may be implemented as a duration contrast. The gradual realization of the spectral characteristics of /ɪ/ may at first carry with it the deterioration of its tense (long) counterpart in the temporal contrast, i.e., /i/. Cases of deterioration of very similar sounds have been reported before. Major [12] found that Portuguese subjects' production of English /ɛ/ deteriorated as production of /æ/ improved. Similarly, Flege [9] observed that Dutch speakers' production of the similar English /u/ became worse as they gained proficiency. If the contrast is eventually analyzed as both a temporal and spectral contrast, a more accurate representation and production of /ɪ/ and /i/ may be achieved (see [5] for a proposal of acquisition stages).

## 5. CONCLUSION

A series of experiments have assessed the perceived distance between English and Catalan high and mid front vowels, and the use of spectral and temporal properties in the production of the English vowel contrast by Catalan learners of English. Importantly, the L2 learners appear to make use of the non-L1 duration cue in their production of English /i/ and /ɪ/, replicating perception results and lending support to Bohn's Desensitization Hypothesis [2]. A perceived similarity experiment involving English listeners and Catalan vowels correctly predicts accurate production of the near identical vowels /e/ and /ɛ/. Use of L1 categories goes unnoticed by English listeners. Failure to produce the also near identical vowel /i/ is explained by the categorization of this vowel in terms of a purely temporal contrast with the dissimilar vowel /ɪ/, resulting in a spectrally

merged category that prevents learners from simply using the L1 category, at least at some stage in the acquisition.

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