

A reanalysis of Catalan devoicing

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Received 30th September 1986, and in revised form 21st December 1986

1. Introduction

Mascaró (this volume) offers a number of objections to Dinnsen & Charles-Luce (1984) in an effort to reject the empirical finding that word-final devoicing is non-neutralizing for at least some speakers of Catalan. While he offers no empirical support for his counter claim, he does raise two points that merit consideration. The first point criticizes our characterization of some of the underlying representations. The second point raises a methodological problem involving segmentation due to possible effects of gemination in certain contexts. This paper reanalyzes data from the original study considering only those items that: (1) are non-controversial in terms of underlying representations, and (2) are unaffected by gemination.

In accordance with Mascaró's analysis of the morphophonemic structure of our original 10 minimal pairs, we reanalyzed the data from two of the original five minimal pairs. These minimal pairs are: (1) *cap* /kap/ "head" and *cap* /kab/ "it fits" and (2) *sec* /sek/ "dry" and *sec* /seg/ "I sit down". There is evidently no controversy as to the underlying voicing of the word-final stops in these two minimal pairs. As in our original study, we performed analyses of variance on three temporal correlates of underlying voicing: (1) vowel duration preceding the final stop, (2) voicing into closure of the final stop, and (3) closure duration of the final stop.

For vowel duration and voicing into closure, 100% of the original data from these two minimal pairs were resubmitted to statistical reanalysis. However, because of the possible effects of long closure durations resulting from gemination of word-final velar stops and the following word-initial [k] environment of one of our carrier sentences, we selected a specific subset of the closure durations for both minimal pairs. Only those stops that were clearly released were submitted for reanalysis. In this way, we could be confident that closure duration as a correlate of voicing was not confounded with long geminate durations. Our selection criteria for determining whether a stop was released were as follows. For stops with a following vowel environment, a distinct perturbation of energy in the waveform occurred after the offset of voicing into closure and before the periodic onset of the vowel. For stops with a following consonant environment, two distinct perturbations of energy in the waveform occurred after the offset of voicing into closure. In this case, the first perturbation corresponded to the release of the final stop of the test word and the second perturbation corresponded to the release of the following consonant. Thus, in the environment of a following consonant, 64% of the original closure durations for the two minimal pairs were reanalyzed. In other words, 36% of the closure durations of the test words were not released. However, in the environment of

a following vowel, 100% of the original closure durations for the two minimal pairs were included in the reanalysis of closure duration.

A minor, but related, point raised by Mascaró (see his footnote 5) is that test words belonging to different lexical categories may be stressed differently in the carrier sentences depending on their particular category. Stress differences can certainly affect the durations of the temporal correlates we measured and, like gemination, confound the durations that may be correlated with underlying voicing. However, there are at least two reasons why stress probably did not significantly affect the overall results of the original study. First, the test sentences were read in a random order intermixed with 560 filler items. The random ordering and the large number of filler items reduced the speakers' focus on the experiment and, therefore, the test words embedded in the carrier sentences. Second, the two carrier sentences were neutral to all items. Thus, there was no syntactic or semantic biasing for any test word, and speakers should not need to use stress for signifying a particular meaning, which might otherwise be ambiguous. Nonetheless, the results are based on words that were clearly articulated. Thus, one might say that these words were stressed by all speakers.

2. Results

Table I gives mean values and standard deviations in milliseconds for the results collapsed across the five speakers and the two minimal pairs /kap/ - /kab/ and /sek/ - /seg/ when they occurred in a following vowel environment ($_ \# V$) and in a following consonant environment ($_ \# C$). The top panel shows the results for vowel duration

TABLE I. Mean values and standard deviations (SD) in milliseconds for underlying [- voice] and [+ voice] word-final stops in a following vowel environment ($_ \# V$) and a following consonant environment ($_ \# C$). The results for preceding vowel duration, closure duration, and voicing into closure are presented in the top, middle, and bottom panels, respectively

Vowel duration	$_ \# V$	$_ \# C$
[- voice]	76	70
SD	(14.3)	(17.6)
[+ voice]	76	69
SD	(15.0)	(17.9)
Closure duration	$_ \# V$	$_ \# C$
[- voice]	80	90
SD	(19.4)	(9.7)
[+ voice]	78	91
SD	(13.9)	(11.7)
Voicing into closure	$_ \# V$	$_ \# C$
[- voice]	23	23
SD	(4.1)	(4.5)
[+ voice]	24	24
SD	(3.6)	(4.9)

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the bottom shows the resul
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_C#C	
70	(17.6)
69	(17.9)
_#C	
90	(9.7)
91	(11.7)
_#C	
23	(4.5)
24	(4.9)

preceding final stops, the middle shows the results for closure duration of final stops, and the bottom shows the results for voicing into closure. As in the original study involving five minimal pairs, a 2(underlying voicing: voiced/voiceless) \times 2(environment: _#C and _#V) factorial design was used. Separate analyses of variance were performed on each of the three temporal correlates.

2.1. Vowel duration

No significant main effect of underlying voicing or any significant interaction involving underlying voicing was found. However, a significant main effect of environment was found [$F(1, 4) = 9.74; p < 0.04$]. Thus, vowels shorten by approximately 9% before word-final stops in the environment of a following word-initial consonant, relative to a word-initial vowel. The results for vowel duration are consistent with the original findings involving five minimal pairs.

2.2. Closure duration

Again replicating the original findings, no significant main effects of underlying voicing or environment and no interactions involving underlying voicing were found. Word-final stops in the environment of a following word-initial vowel show a similar shortening effect (relative to a following initial consonant) that was found in the original findings for closure duration.

2.3. Voicing into closure

A significant main effect of underlying voicing was found [$F(1, 4) = 10.10; p < 0.03$]. Although the magnitude of difference is small (only slightly more than a 4% difference), voicing into closure significantly distinguishes underlying voicing for the minimal pairs of /kap/ - /kab/ and /sek/ - /seg/ and distinguishes voicing in both following phonetic environments. No main effect of environment and no interactions involving underlying voicing were found.

3. Conclusion

It is especially interesting that the main effect of underlying voicing for voicing into closure obtained in the reanalysis when there were no main effects of underlying voicing for the group data in the original study. The conclusion that devoicing is non-neutralizing finds even greater support in the reanalysis of the group results. The original study was able to establish only that *some* individuals maintain the word-final voice contrast and, thus, do not neutralize. The results from the reanalysis show that the group as a whole maintain the contrast, at least in terms of voicing into closure. The fact that the reanalysis revealed this effect may well be attributable to a more accurate characterization of the underlying representations as suggested by Mascaró. Whatever the explanation is for such an effect, it should be noted that similar effects have been found for groups and individuals from different languages exhibiting the same phonological phenomenon, namely, Polish (Slowiaczek & Dinnsen, 1985) and German (Charles-Luce, 1985; Port & O'Dell, 1985).

Mascaró in his footnote 5, misrepresents our position in this Letter by stating that our

