A scaling contrast in Majorcan Catalan interrogatives

Maria del Mar Vanrell Bosch

Department of Catalan Philology
Universitat Autònoma de Barcelona
MariaDelMar.Vanrell@uab.es

Abstract

This paper reports the application of the Categorical Perception Paradigm (CP) to a pith height contrast in Majorcan Catalan. The first hypothesis is that pitch height is the primary perceptual cue in distinguishing yes-no questions from wh-questions in Majorcan Catalan. The second hypothesis predicts that, as in previous studies, the application of the CP involves the presence of order of presentation effects in the results of the discrimination task. The results show that the primary perceptual cue is the presence of upstep in yes-no questions and confirm the existence of an order of presentation effect that deserves further investigation.

1. Introduction

In Majorcan Catalan, yes-no questions and wh-questions are characterized by a falling nuclear accent H+L*, that is, an H leading tone aligned with the pretonic syllable and a L* tone associated with last stressed syllable. Typically, yes-no questions are headed by the unaccented interrogative particle *que*[1] (Fig. 1, top panel), and this can be compared with wh-questions headed by the accented wh-particle *què* (Fig. 1, bottom panel). Results from a previous study [2], a Map-Task recording [3], and my own speech suggested that in yes-no questions the leading tone H is upstepped (Fig. 1, above panel).

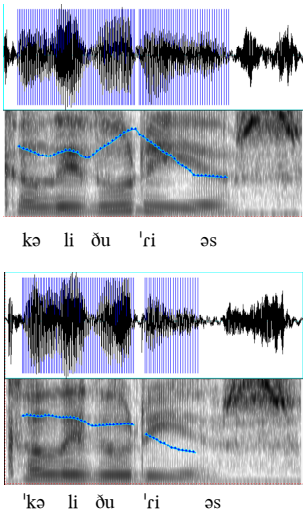

Figure 1. *Waveforms and fundamental frequency contours of yes-no question Que l'hi duries? (Would you take it to him?) (above panel) and Què li duries? (What would you take him?) (bottom panel).*

[1] See [1] for a syntactic and prosodic description of Catalan yes-no questions headed by interrogative marker *que*.

Although pitch range variation is assumed to be paralinguistic by the standard AM model, some studies have shown that the difference in pitch height can also trigger categorical effects [4], [5], [6], [7], [8].

The paradigm of CP has been applied to differences in peak alignment [9], [10]; to boundary tones [11], [12]; and to a scaling contrast [7]. Order of presentation effects have been reported in the application of the CP in vowel perception [13] and in the perception of musical intervals [14]. Accordingly, two hypotheses were tested. We hypothesized that listeners make categorical linguistic use of F0 scaling differences in perceiving yes-no questions as opposed to wh-questions in Majorcan Catalan. It was predicted that if listeners' perception of differences in pitch height is categorical, that would mean that pitch scaling is the primary perceptual cue to distinguish yes-no questions from wh-questions in Majorcan Catalan. However, it is also possible that differences in pitch height are not perceived as categorical. Therefore, that would mean that pitch height is not the primary cue and that other cues, like the presence or absence of accent in the interrogative particle, play an important role in distinguishing yes-no question from wh-questions in Majorcan Catalan.

Considering that asymmetries (order of presentation effects) have been reported repeatedly in the literature, the second hypothesis was that there would be order of presentation effects. It was predicted that these effects occur such that it would be easier to discriminate a stimuli pair when the direction of change is upwards than when it is downwards [7].

2. Method

The categorical perception paradigm was applied in order to determine whether listeners make categorical linguistic use of F0 scaling differences when perceiving yes-no questions as opposed to wh-questions in Majorcan Catalan.

One token of the yes-no question *Que l'hi duries?* (Would you take it to him/her?) and one token of the wh-question *Què li duries?* (What would you take him/her?) were produced by a native female speaker of Majorcan Catalan. Both tokens are homophonic at the segmental level. (Fig. 1).

In the yes-no question token the leading tone was at 263 Hz while in the wh-question token it was at 203 Hz. A linear stylization of the rising-falling movement was carried out. Three points were interpolated: a point at rising onset L1, a point at the peak H, and a point at the falling offset L2. L1 was aligned in both tokens at the onset of the syllable DU, H at the offset of the vocal of the syllable DU, and L2 at the offset of

the vocal of the syllable RI. From these two base tokens, ten stimuli were created by means of PSOLA synthesis. Five stimuli were created by shifting the peak downwards from the yes-no question token (Fig. 4, top panel) and five more stimuli by shifting the peak upwards from the wh-question token (Fig. 4, bottom panel) in four steps of 15 Hz.

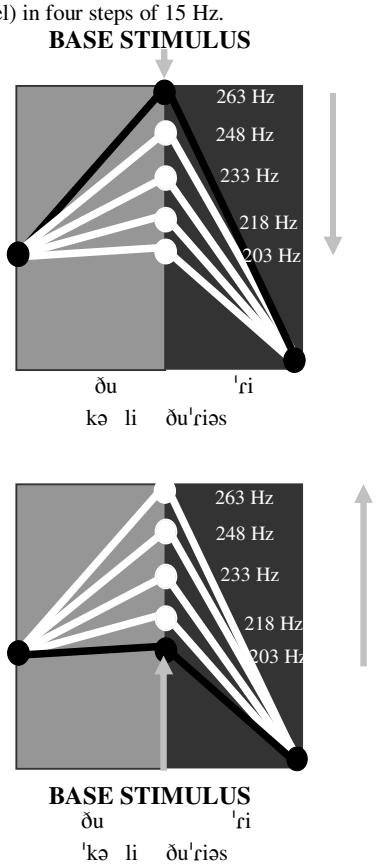

Figure 4. *Schematic creation of the stimuli from yes-no question base stimulus (top panel) and from wh-question base stimulus (bottom panel).*

In the identification task, these ten stimuli were repeated four times and were presented in blocks of ten in random order. Subjects were asked to respond after each stimulus as they would answer the question in a real situation. I.e.: *Que l'hi duries? –Sí* (Would you take it to him? –Yes), *Què li duries? – Això* (What would you take him? –That).

The materials for the discrimination task consisted of pairs of stimuli from the identification task. Eight pairs of stimuli were created in AB order (four from the yes-no question base stimulus and four from the wh-question base stimulus): step 1+2, step 2+3, etc.). Eight pairs of stimuli were created in BA order (four from yes-no question base stimulus and four from wh-questions base stimulus): step 2+1, step 3+2… Additionally, 10 control AA pairs were created which contained two identical stimuli (step 1+1, step 2+2, etc.). Two repetitions of these stimuli were randomized. Thus, subjects were offered a total of 52 stimuli presented in blocks of 13. Subjects were asked to decide whether they heard the pair of stimuli as "same" or "different". The perception test was conducted using Perceval, software for performing computerized auditory and visual perception experiments. The complete test lasted approximately 30 minutes.

Twenty native speakers of Majorcan Catalan (ten female speakers and ten male speakers), between 23 and 41 years old, participated in the experiment. They had to achieve a pre-established level of identification accuracy whereby 80% of the base stimuli had to be recognized. The responses of those listeners who didn't identify 80% of the base stimuli were rejected. The data from three subjects were discarded for that reason.

2. Results

2.1. Identification task

Fig. 5 shows the percentage of yes-no question responses along the continuum of stimuli created from the yes-no question base stimulus (stimulus 263 Hz). As we can see, the function presents an S-shape. Figure 5 also plots the standard error of the mean of the responses at each stimulus. Stimulus 1 (263 Hz) and stimulus 5 (203Hz) have low standard errors (± 2.65 for stimulus 1 and ± 2.01 for stimulus 5). That means that for stimulus 1 and 5 subjects agreed in their responses because these stimuli represent the canonical categories. On the other hand, stimulus 3, which represents the shift between the two categories, has a higher standard error of ± 6.06, which shows less agreement among listeners. It is worth noting that when the stimuli are near to the category shift the responses present a higher standard error (listeners hesitate when judging the stimulus). This confirms the existence of categorical perception.

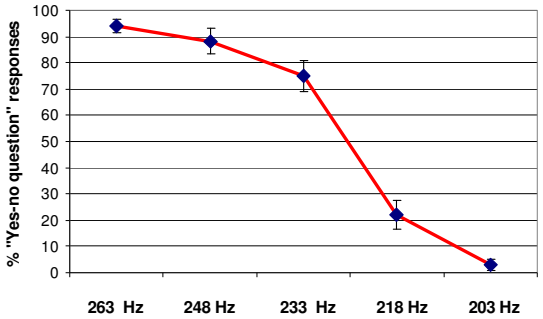

Figure 5: *Percent of yes-no questions responses at the continuum of stimuli created from the yes-no question base stimulus (stimulus 263 Hz).*

Fig. 6 shows the percentage of yes-no question responses at the continuum of stimuli created from wh-question base stimulus (stimulus 203 Hz). The curve again appears S-shaped. If we observe the standard errors of the mean of the responses, we will see that stimulus 1 again has a low standard error (± 2.01) but stimulus 5 presents a higher standard error (± 6.10)[2].

[2] This might be due to the responses of one particular participant whose mother tongue was Central Catalan. This participant met the pre-established level of identification accuracy and for that reason was not rejected, despite his unexpected responses.

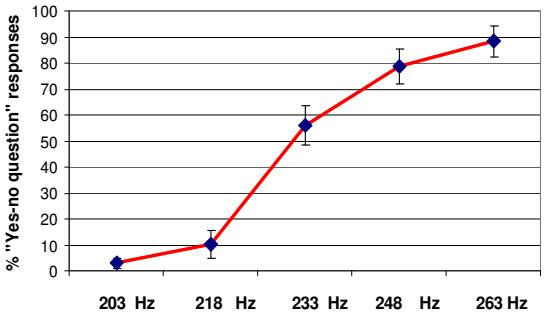

Figure 6. *Percent of yes-no questions responses at the continuum of stimuli created from the wh-question base stimulus (stimulus 203 Hz).*

2.2. Discrimination task

Results of the discrimination task are plotted in Figure 7. Stimuli were created from the yes-no question base stimulus. Different stimulus pairs (AA, AB, BA) are represented along the x axis in different colors. We find a discrimination peak at the interval 218-233 Hz (BA pairs), which is what one would expect from the identification function, given that there was a boundary shift effect at 233 Hz in both functions (the one from yes-no question base stimulus and the one from wh-question base stimulus). The most striking feature of these results has to do with the BA pairs. Note that the discrimination peak appears in the BA pairs in which the second stimulus has a higher peak than the first. These results suggest that listeners have trouble distinguishing between stimulus pairs presented in AB order (the pairs in which the second stimulus has a lower peak than the first). ANOVA Post hoc showed a significant difference between the responses to the stimulus 218-233 Hz relative to the responses at the other stimulus pairs ($p<0.01$). That is, the difference in the responses at this stimulus pair shows a significant order of presentation effect and the existence of a boundary at the crossover point between the categories.

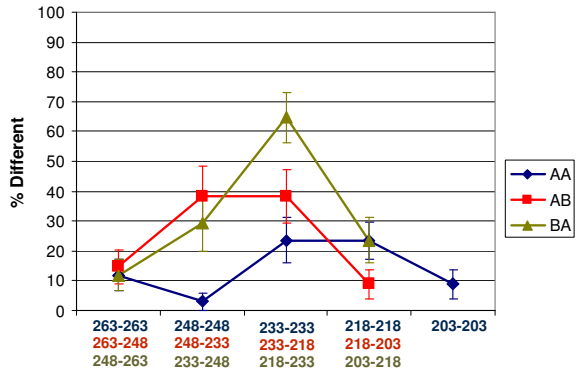

Figure 7. *Percent of "Different" responses (stimuli from yes-no question base stimulus).*

Results of the discrimination task (stimuli created from wh-questions) are shown in Fig. 8. Different stimulus pairs (AA, AB, BA) are represented along the x axis in different colors. We can see a prominent discrimination peak at the 218-233 interval (the percentage of responses reaches 70%), which agrees with the results of the identification task (where we detected the category shift at 233 Hz). Observe that there is hardly any difference between the rate for BA pairs (where the second stimulus has a lower peak than the first) and the rate for AA (identical) pairs. These results confirm the findings shown in Fig. 7, that is, it appears that subjects have difficulty distinguishing between the stimuli when the direction of change is downwards. ANOVA Post hoc showed a significant difference between the responses at the stimulus 218-233 Hz and the responses to all the other frequencies ($p<0.01$). That means that the difference between the responses at this stimulus pair show a major order of presentation effect and confirms the idea of a categorical distinction due to a difference in pitch height.

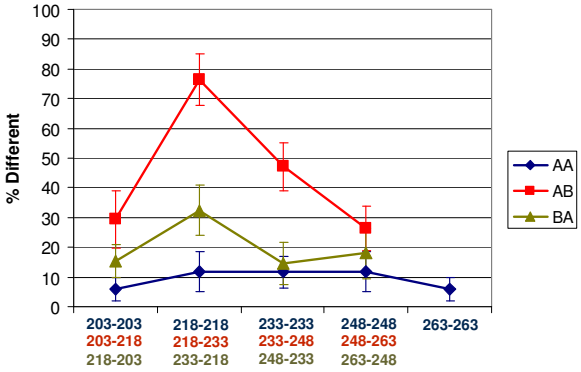

Figure 8. *Percent of "Different" responses (stimuli from wh-question base stimulus).*

3. Discussion

The results from the identification and discrimination experiments show that it is possible to switch the perceived category between yes-no question and wh-question simply manipulating the pitch height of the leading tone. We observed in Fig. 5 and in Fig. 6 that the presence of the accented wh-particle in the continuum created from yes-no question base stimulus and the presence of the unaccented interrogative particle in continuum created from wh-question base stimulus did not interfere in the categorical perception. Therefore, the results appear to confirm that the primary perceptual cue that Majorcan listeners use when distinguishing yes-no questions from wh-questions is the difference in pitch height of the leading tone.

However, it is worth noting that the percentage of yes-no question responses for stimulus 5 (the stimulus that represented the yes-no question category) in the identification function of the continuum whose stimuli had an accented wh-particle (Fig. 6) was as low as 88.23%. This might be due to the presence of one participant whose mother's language dad been Central Catalan. In fact, if we eliminate the responses of subject 8, the percentage of yes-no question responses at stimulus 5 changes from 88.23% to 93.75%.

With regard to the results from the discrimination task, stimuli created from the wh-question base stimulus (Fig. 8) yielded better results than stimuli created from the yes-no question stimulus (Fig. 7). We speculate that this could be because of

the order in which listeners performed the discrimination task. After the practice block, the first and third blocks were made up of stimuli from yes-no question base stimulus and the second and fourth of stimuli from the wh-question base stimulus. Thus, the subjects had become better trained in the discrimination task by the middle of the task, that is, from second or third block (bear in mind that they had to judge five blocks, one practice block and four test blocks). This could explain why the function of results from the second and fourth blocks (both blocks consisting of stimuli created from the wh-question base stimulus) plots better results.

Finally, it is worth trying to explain the order effect that our results show. [7] found an order effect that they explained as related to the findings of the "declination" experiments of [15], [16], [17]. Basing themselves on [15] and [16], [18] concludes that the fact for which subjects judge later peaks to be higher than earlier peaks, even though they have the same fundamental frequency, can be explained by the elapsed time between them. Therefore, listeners would assume some rate of declination when listening to speech. However, this explanation is harder to apply to our results because we have neither two-peak stimuli nor one-peak stimuli in which the peak is on either an early or a late word. Accordingly, we speculate that these asymmetries (order effects) could be explained by general auditory mechanisms. High tone plays an important role in the acquisition of tone in the case of tonal languages, which could explain why high tone serves as a reference point in a discrimination task. Furthermore, as in the case of asymmetries in vowel perception, the asymmetries in tonal perception [7], [19], (the present study), could reveal a language-universal perceptual bias that listeners bring to the task of tonal or intonational discrimination.

4. Conclusions

The results of this perception study confirm that the primary cue for distinguishing yes-no questions from wh-questions in Majorcan Catalan is pitch scaling. This phonological distinction is not considered by the ToBI system. I would claim that in order to account for scaling differences in Majorcan Catalan interrogatives, it is necessary to resort to upstep features.

The results also indicate that there are order of presentation effects that depend on the direction of change, it being easier to distinguish between the stimuli pair when the direction of change is upwards. These order effects deserve further study in order to find out the role that these asymmetries play in the general auditory mechanisms and the impact that the acquisition of tone or intonation may have on the size and shape of these asymmetries.

5. Acknowledgments

I am grateful to Pilar Prieto for guiding my work, to Francesc Felipe for help with computer and technical issues, to the subjects for participating in this experiment, to Marta Ortega and José Ignacio Hualde for their advices, to Laboratoire of Parole and Langage for Perceval software, to Mariapaola D'Imperio and Caterina Petrone for help with Perceval, to participants of PaPI preview and PaPI conference for comments and suggestions.

6. References

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