Information-seeking questions and incredulity questions: gradient or categorical contrast?

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Abstract

This paper investigates the perceptual cues used by Catalan listeners to distinguish between information-seeking and incredulity yes/no questions. Two experiments examined the potential contribution of pitch height of the boundary tone and duration of the last syllable as primary cues in distinguishing sentence types. The results show that a difference in pitch scaling of the boundary tone HH% is the strongest cue for perceptually distinguishing between the two interpretations. Identification results and the absence of a consistent peak in Reaction Time measurements suggest that this perceptual contrast may be gradient rather than categorical in nature.

Index Terms: yes-no questions, incredulity questions, gradient contrast, categorical contrast, tonal perception, Catalan language.

1. Introduction

In English, the contrast between an information-seeking question and a presumptive yes/no question (also called antiexpectational questions or incredulity declarative questions) can be conveyed through a change in the order of constituents. English incredulity questions are also called 'declarative yes-no questions' because they use the same form as a statement. By contrast, a Romance language like Catalan cannot resort to this syntactic strategy and both question types are syntactically identical. The examples below show the syntactic difference between English and Catalan in expressing this contrast:

	Information-seeking questions	**Incredulity Questions**
English	*Are you going by plane*?	*You're going by plane*!?
Catalan	*Vas en avió*?	*Vas en avió*!?

In Central Catalan, neutral and incredulity yes-no questions have the same intonational contour, that is, the first stressed syllable is realized with a low tone followed by a rising movement, and the last stressed syllable is produced with a low tone followed by a sharp rise, as reported in [1][2][3]. According to these studies, what distinguishes these two types of yes-no questions is the expanded pitch range that characterizes incredulity contours. Figure 1 illustrates the prosodic characteristics of the information-seeking question *Tens gana?* ('Are you hungry?', upper panel) and the incredulity question *Tens gana!?* ('You're hungry!?', lower panel).

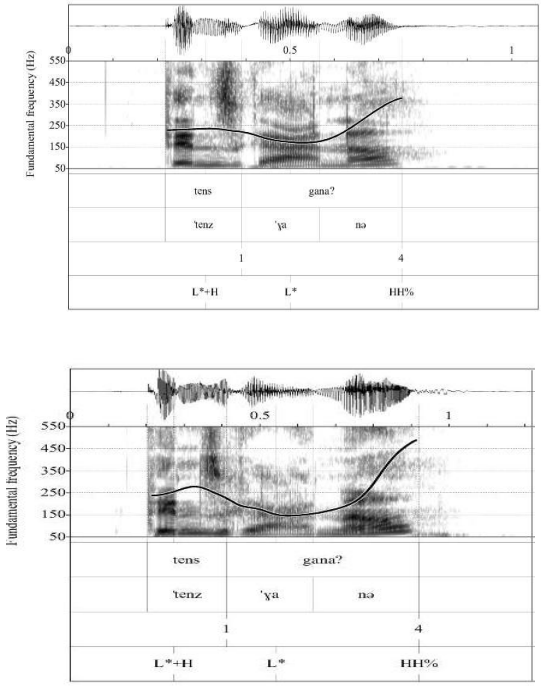

Figure 1. *Waveforms, f0 contours, and Cat_ToBI transcription of the utterance Tens gana? 'Are you hungry' produced with a neutral statement meaning (upper panel) and yes-no incredulity question Tens gana!? 'You are hungry!?'(lower panel).*

Recent crosslinguistic studies have shown that speakers can signal the difference between information-seeking questions and presumptive questions intonationally [4][5][6]. Some studies have found a gradient contrast between the two types of questions, while other studies indicate that the contrast is expressed categorically. For instance, Lee et al. [5] analyzed the production differences between information-seeking and presumptive yes/no questions in Buenos Aires Spanish. They concluded that the presumptive questions have a wider global pitch range than information-seeking questions, and also an expanded tonal range in the nuclear peak. However, Grice & Savino [4]'s study of Bari Italian revealed that variations in pitch range were used by listeners to separate the two interpretations of L*+H LH% in a categorical fashion (see also [6]).

The goal of this study is to investigate the contribution of various prosodic features to intonational meaning and to analyze whether the height of the boundary tone and duration of the last syllable -or a combination the two- signal perceptually the contrast between neutral and incredulity yes/no questions in Central Catalan.

2. Method

The present study we wished to investigate the contribution of f0 (related to the boundary tones) and the duration of the last syllable in an utterance (which was observed to be a potentially important cue in presumptive contours in [7] [3]) in distinguishing these two question types. To this end, two standard identification tasks (one of gradual response and other with dual response) were applied to this contrast. A 'problem' that has been highlighted by identification tasks is the fact that the Catagorical Perception paradigm assumes a binary distinction in intonational meaning. In an attempt to address this problem, [8] evaluated the suitability of three different scales for obtaining perceptual judgments of intonational meaning. They concluded that a visual analog scale was most suitable for obtaining perceptual judgments of semantic properties of intonation, and this scale does not decide a priori how many levels of meaning can be distinguished for a given attribute. A complementary goal of our research was to contribute to this discussion and test the convergence and degrees of appropriateness of the two experimental methods. Therefore we propose to compare the results we obtained from two different identification tasks, namely a binary response task and a gradient response task (involving a visual analog scale).

In addition, Reaction Time (RT) measurements were taken since some researchers have proposed the RT approach as a good alternative to the discrimination task in testing the hypothetical discreteness of a contrast [9][10]. Chen [10], claims that "short RTs for within-category identification and long mean RTs for across-category identification are essential properties of linguistically real identification categories".

The stimuli for the two identification tasks were recorded with a native speaker of Central Catalan. She responded to the following everyday situations:

-**Neutral question**: You ask your friend if he is hungry. (Recorded response: *Are you hungry?*)
-**Incredulity question**: You have just finished dinner with a friend and you see that he has stopped in front of a pastry shop and he says "I am hungry". Amazed—since he just ate a big meal—you ask him if he is still hungry. (Recorded response: *You're hungry!?*)

To create the stimuli, the f0 value at the end of the recorded sentence was manipulated using the resynthesis script in Praat [11]. The scaling of the prenuclear pitch accent of the base stimulus was neutralized, since some scaling differences were found in the original recordings[1]. The materials for the two identification tasks consisted of three continua in which three different parameters were manipulated using the neutral and incredulity interrogatives: as end points. These parameters were duration, tonal scaling and a combination of both prosodic features. Thus, in the duration continuum the duration of the last syllable was manipulated from 190 ms to 240 ms in 10 steps of 5.5 ms each; in the tonal scaling continuum the tonal scaling of the boundary tones was manipulated from a high to an extra-high pitch in 10 steps of 12.5 Hz each; and finally each of the ten steps of the duration continuum was combined the corresponding step on the tonal scaling continuum to create a third combined contiuum (see Figure 2).

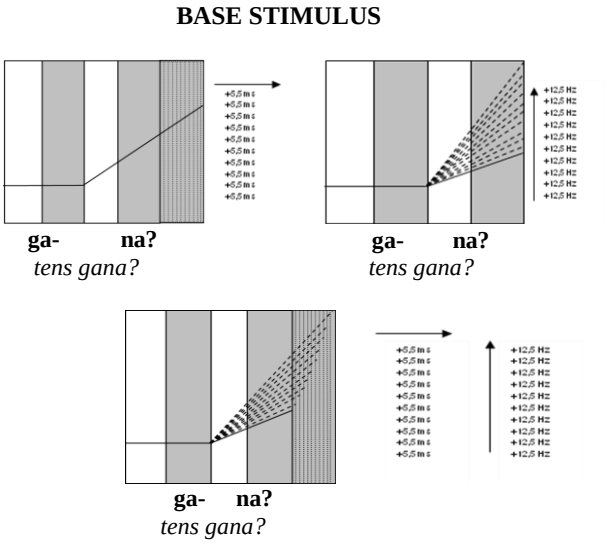

Figure 2. *Schematic diagrams of the three continua consisting of manipulated stimuli ranging from neutral to incredulity yes-no questions. Top left panel shows the duration manipulations, top right panel the scaling manipulations, and bottom panel the combined manipulation of both features.*

In the first identification task (binary response), the ten stimuli of each continua were presented in five blocks of ten in random order. Subjects were instructed to listen to each stimulus and immediately classify it (as either a neutral or incredulity yes-no question) by pressing a computer key as quickly as possible. In order to collect reaction time data, the experimental procedure was run using *E-Prime* [12]. Stimuli were auditorily presented through the computer, via headphones. Responses and the corresponding reaction times were registered through the computer keyboard.

In the second identification task (gradient response), the ten stimuli of each continua were repeated two times and presented in four blocks of ninety in random order. Subjects had to mark along a visual scale the degree of incredulity that they had herad (ranging from 0 to 1, from more neutral to more incredulity) –see Figure 3. The visual analogue scale perception test was played by means of PRAAT [11].

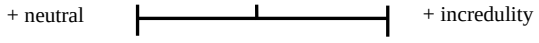

Figure 3. *Example of the Visual Analogue Scale*

Twenty native speakers of Central Catalan between 20 and 45 years old participated in both tasks of the experiment. Listeners were instructed to maintain their hands near the keyboard and press the keys as fast as they could. Subjects were seated at a laptop in a quiet room and the stimuli were played back through headphones. The full test lasted approximately 30 minutes.

[1] Currently, we are working in a gating experiment to prove if there are significant differences in the scaling of the prenuclear L*+H.

3. Results

3.1. Identification tasks

3.1.1. Binary response

3.1.1.1 Duration

The graph on the left in Fig. 4 shows the proportion of responses which identified each stimulus as an incredulity question along the continuum in which duration had been manipulated. As we can see, the function does not present an S-shape, revealing that this cue plays a very minor role in distinguishing the two types of yes-no questions. A Wilcoxon test analysis of identification results was applied to the data. The analysis did not reveal a significant main effect for any stimulus number. Furthermore, results for RTs (see Fig. 4, graph on the right) do not show a peak, confirming the absence of categorical contrast.

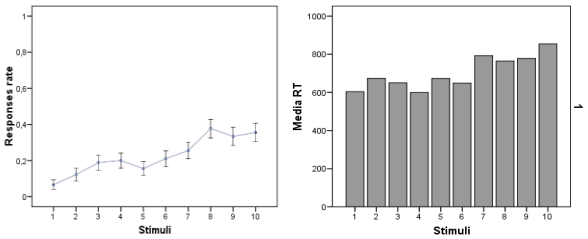

Figure 4. *The graph on the left shows proportion of identification as incredulity question (and standard error values) as a function of stimulus step number (averaged over subjects). The graph on the right shows mean Reaction Time in ms. for each stimulus.*

3.1.1.2. Scaling

The graph on the left in Fig. 5 shows the portion of responses that identified each stimulus as an incredulity question along the continuum in which scaling had been manipulated. As we can see, the function does not present the classic S-shape either. Yet there is an important effect between stimuli 2 to 4 (the mean jumps from .21 to .62 of mean), and Wilcoxon tests revealed a significant main effect of these stimulus numbers (at p<.001). Importantly, however, this hypothetical category switch is not supported by RT measurements, which do not show any clear peaks (see Fig. 5, the graph on the right).

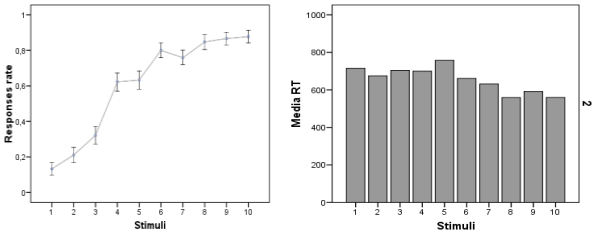

Figure 5. *The graph on the left shows proportion of identification as incredulity question (and standard error values) as a function of stimulus step number (averaged over subjects). The graph on the right shows mean Reaction Time in ms. for each stimulus.*

3.1.1.3. Duration and Scaling

The graph on the left in Fig. 6 shows the portion of responses that identified each stimulus as an incredulity question along the continuum in which both duration and scaling had been manipulated. As we can see, again the function does not present an S-shape. However, here there is a more pronounced rise from stimulus 2 to stimulus 4 (mean .16 to .69). Wilcoxon tests revealed a significant main effect of these stimulus numbers (at p<.001). However, again this hypothetical category change is not supported by any corresponding peak in RT measurements: from stimulus 2 to stimulus 3 p<.18; and from 3 to 4 p<.164 (see Fig. 5, panel on the right).

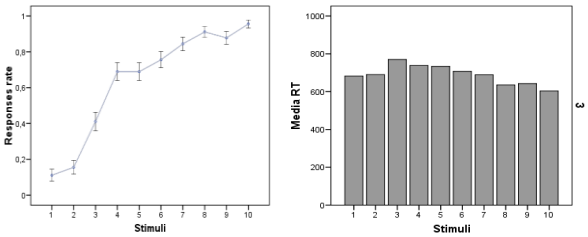

Figure 6. *The graph on the left shows proportion of identification as incredulity question (and standard error values) as a function of stimulus step number (averaged over subjects). The graph on the right shows mean Reaction Time in ms. for each stimulus.*

3.1.2 Gradient response task

3.1.2.1. Duration

Fig. 7 shows the percentage of responses along the continuum when duration is manipulated. Again, the function does not present an S-shape and is shallower than the corresponsding binary response task function. A Wilcoxon test analysis did not reveal a significant main effect for any stimulus number.

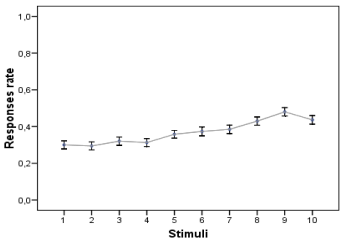

Figure 7. *The graph shows mean "incredulity" identification scores in the gradient response task, duration-based continuum.*

3.1.2.2. Scaling

Fig. 8 shows the mean score of responses that identified each stimulus as an incredulity question along the continuum in which scaling had been manipulated. Again, the function is shallower than that yielded by the corresponding binary identification task and does not show an S-shape (compare with Figure 5). Yet again there is an important effect from stimulus 3 to stimulus 4. However, a Wilcoxon test did not reveal a significant main effect for any stimulus number.

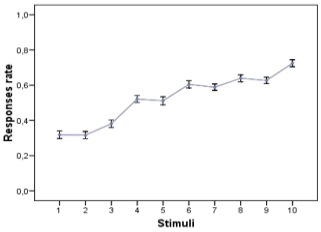

Figure 8. *The graph shows mean "incredulity" identification scores in the gradient response task, scaling-based continuum.*

3.1.2.3. Duration and Scaling

Fig. 9 shows the mean score of responses that identified each stimulus as an incredulity question along the continuum in which both duration and scaling had been manipulated. As we can see, the function shows a much shallower shape than in the corresponding binary identification task. Again, there is an important effect from stimulus 3 to stimulus 4, but it is not supported by Wilcoxon tests ($p<.06$).

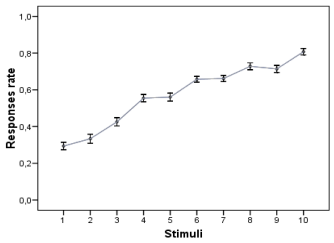

Figure 9. *The graph shows mean "incredulity" identification scores in the gradient response task, combined duration + scaling continuum.*

4. Conclusions

Our results show that a difference in pitch scaling of the boundary tone HH% is the primary factor that helps Catalan listeners to distinguish between an information-seeking vs. an incredulity interpretation. The contribution of duration is small, but consistent, and serves as a secondary cue to the contrast. Though this prosodic cue is not sufficient in itself to cause a difference in interpretation, when it appears combined with pitch range it appears to enhance the interpretation of meaning.

Thus, like in other languages such as Italian [4] and Spanish [5], the intonational meaning of incredulity in Central Catalan is primarily conveyed through differences in pitch range. Yet in contrast with Bari Italian [4], the identification results together with RT measurements prove that pitch scaling on the H boundary tone does not have a clear phonological character in distinguishing information-seeking from incredulity questions in Central Catalan.

The comparison between the results of two types of identification tasks (namely a binary response task and a gradient response task) reveal that, unsurprisingly, binary tasks tend to have more differentiated results because dichotomic responses force the speakers to choose between a binary distinction in meaning. As claimed by [10] and [4], in order to interpret the results of binary identification tasks it is crucial to analyze RT patterns. By this reasoning, an RT peak at the frontier between two categories the greater processing time required for the sorting of ambiguous stimuli into one of two categories. In our case, the absence of RT peaks suggests that such extra processing is not taking place and that therefore categorical perception is not present in this particular contrast (but cf. [4]). On the other hand, the results from our gradient response task reflect a more conservative pattern of responses in between the two extremes. Though this could be interpreted as an argument for the better suitability of the gradient response paradigm for investigating the phonological character of a given contrast, we would need to test the behavior of this paradigm in phonological contexts offering more clearcut categorical contrasts, and check our results against RT patterns.

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