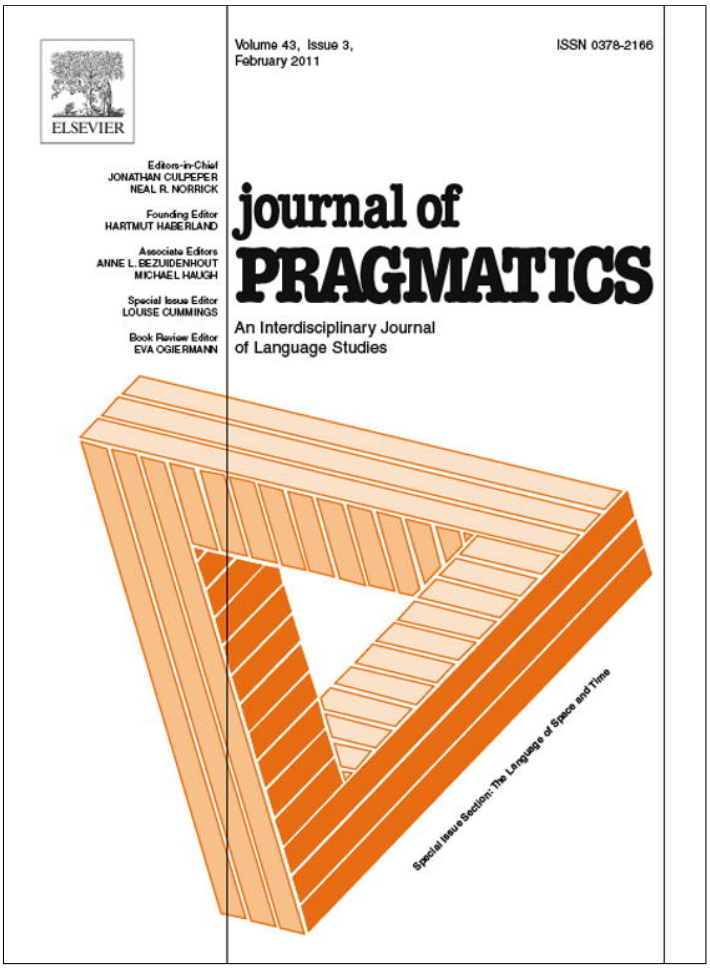

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Pitch range, gestural information, and perceived politeness in Catalan

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ABSTRACT

It is known that certain prosodic aspects of speech play a role in the expression of paralinguistic meaning, yet the concrete mechanisms of how this is implemented have not yet been fleshed out. The present article attempts to explore the contribution of pitch range to the expression of politeness in information-seeking yes–no questions in Catalan. Two perception experiments were carried out with stimuli that contained a gradual increase and decrease of the pitch range at the end of two target intonation contours (rising and falling). The results of the first experiment revealed that, for both contours, increasing the pitch range of the final part of the utterance tone resulted in a decrease of perceived politeness, whereas decreasing the pitch range had no effect. The second perception experiment showed that adding contextual (gestural) information reversed the tendency. Taken together, these results point to the complex interaction between prosodic cues and contextual information (specifically, facial gestures). There is nothing intrinsically polite about using an increased pitch range, unless it is accompanied by consistent contextual information. In sum, when assessing the degree of perceived politeness of an utterance, attention has to be paid to various prosodic aspects together with contextual and gestural information.

1. Introduction

It is widely acknowledged that prosody (intonation or use of pitch,[1] rate of speech, voice quality, among other elements) has the potential of contributing to the perception of politeness in different languages. In the seminal work by Brown and Levinson (1987), one of their positive politeness strategies (strategy 2) consisted in the exaggeration of "interest, approval, sympathy with H[earer]", which is "often done with exaggerated intonation, stress, and other aspects of prosodics, as well as with intensifying modifiers." (p. 104). Perhaps one of the most robust tonal correlates of perceived politeness that have been highlighted in the literature is that of tonal pitch range, or pitch span between the lowest and the highest f0 values (a valley and a peak, respectively) observed in an utterance: as Brown and Levinson mentioned, an increase in pitch range (what they

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[1] Throughout the paper, terms such as "pitch", "pitch height", "pitch scaling", and "pitch range" will be used. A brief definition is provided here for those concepts. Rate of vibration of the vocal folds determines pitch, "the auditory sensation of tonal height" (Gussenhoven, 2004:1). Higher frequency of vibration of the vocal folds (higher f0 or fundamental frequency) results in higher pitch, and it is expressed in hertz (Hz). "Pitch height" is, then, determined by vocal fold vibration. "Pitch scaling" refers to changes in pitch height. "Pitch range" refers to the distance or span between the lowest and the highest f0 values (a valley and a peak, respectively) observed in an utterance. Pitch range is automatically modified when pitch height increases or decreases at one point in the utterance but remains unchanged in the rest. None of the studies reviewed in this paper manipulate "register". By varying register, a whole contour is raised or lowered in the f0 space. This will not be examined here. For more information on these concepts, see Gussenhoven (2004) and Prieto (2002a,b).

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call "exaggerated intonation") can trigger an impression of a higher degree of politeness. As we will see below, cross-linguistic studies of the expression of politeness have also noted that an increase in pitch range in certain parts of the intonation contour conveys a higher degree in perceived politeness (see Álvarez and Blondet, 2003, for Venezuelan Spanish; Chen et al., 2004, and Chen, 2005, for British English and Dutch; Estrella-Santos, 2007, for Ecuadorian Spanish; Orozco, 2008, 2010, for Mexican Spanish).

Interestingly, some authors have endorsed the biological nature of (at least, part of) this relationship between pitch height and certain types of intonational meanings. Ohala (1983, 1984, 1996) suggested the existence of a cross-species phylogenetic use of f0, which he labeled the "frequency code". According to his view, the current use of pitch in human languages has evolved from a primitive code which relates high f0 and low f0 to basic meanings of "smallness" and "bigness" respectively and to secondary social meanings of "subordination, submission, lack of threat or confidence, politeness" and "dominance, threat, authority, aggression, assertiveness" respectively.[2] According to Gussenhoven (2002), "affective interpretations of the frequency code are rather numerous. Submissiveness, or 'feminine' values, and its opposite, dominance, or 'masculine' values, constitute one obvious dimension. Meanings that are associated with this dimension are (for higher pitch) 'friendliness' and 'politeness'". As Ohala (1984:2) put it, "although the evidence is not as extensive as that concerned with the use of f0 to mark sentence types, it seems safe to conclude that such 'social' messages as deference, politeness, submission, lack of confidence, are signaled by high and/or rising f0 whereas assertiveness, authority, aggression, confidence, threat, are conveyed by low and/or falling f0" (see also Bolinger, 1978).[3] High pitch has commonly led to high scores on semantic scales for "polite", "non-aggressive" and "friendly" in perception experiments involving intonation. As early as 1960, Uldall found that listeners associated high ending rises with both "submissiveness" and "pleasantness" (Uldall, 1964), whereas narrow pitch range was associated with meanings such as "unpleasantness" or "lack of interest" (Uldall, 1960). Chen et al. (2004) and Chen (2005) studied experimentally the perception of affective intonational meaning derived from Ohala's frequency code in Dutch and English, i.e., the perception of semantic scales such as "friendliness", "confidence" or "surprise" as conveyed by gradual changes in pitch range or peak alignment. Their findings showed that, even though there were differences in the fine-grained perception of English and Dutch listeners, stimuli with high pitch range tended to be perceived as more friendly. The strongest correlations were found between these scores and the mean fundamental frequency of the last quarter of the contour, suggesting that in both languages contour endings are more useful for this purpose than earlier portions.

Cross-linguistic research conducted on the contribution of prosody to the expression of politeness has shown that prosody has the potential to express politeness both through phonological choice, e.g., the use of distinct pitch accents and boundary tones, as well as by exploiting more gradient pitch features or rhythmic features, including pitch range, overall pitch height, slower or faster tempo.[4] In the Japanese culture, politeness expressed both linguistically and attitudinally is considered of utmost importance (see, for example, Ide, 1982). For that language, Ofuka et al. (2000) found that the degree of politeness correlated positively with slower speech rate and total duration of the utterance. Maekawa (1999) noted that the degree of politeness varied as a function of pitch peak alignment and direction of the final boundary tone[5] in another variety of Japanese. In Venezuelan Spanish, more f0 variability was observed in polite questions than in impolite ones (Álvarez and Blondet, 2003). Orozco (2008, 2010) investigated the realization of polite utterances in Mexican Spanish. She presented 12 participants with 8 unpunctuated written sentences (requests) and asked them to pronounce them in neutral and polite styles. When comparing those renditions, she observed that the nuclear configuration was typically characterized by an expanded pitch range (especially for women) in the polite utterances. While there were no outstanding differences in the choice of the nuclear pitch accent between conditions, the polite style favored a rising boundary tone more than the neutral style did (72% vs. 64.4% of rising boundary tones in each condition respectively). Regarding the prenuclear material, accents could be realized with a wider pitch range in the polite style, but the differences were not significant. Finally, another difference found between neutral and polite utterances was the use of a high initial boundary tone in the latter (64%) more commonly than in the former (36%). On a different note, Estrella-Santos's work (2007) showed a case of borrowing of pitch contour and morphological structure from Quechua into Ecuadorian Andean Spanish. This structure, which was found to be considered more polite than the native Spanish one in this variety, is characterized by the presence of an extremely high initial rising pitch accent, extreme vocalic lengthening of the first accented syllable and a lengthening effect throughout the whole sentence. For Catalan, Payà (2003) examined how the perception of politeness was affected by conflicting or non-conflicting prosodic elements (choice of pitch contour type and speed of delivery) and non-prosodic ones (lexical and morphological choice). She observed that the presence of an impolite cue, of whatever type, overrode the rest.

[2] "The frequency code is a cross-species sound/meaning correlation whereby vocalizations consisting of high frequencies signal the vocalizer's apparent smallness and, by extension, his nonthreatening, submissive, or subordinate attitude and by which low-frequency vocalizations signal apparent largeness and thus threat, dominance, self-confidence. [...] The frequency code explains the similarities in cross-language and cross-cultural use of pitch of voice to mark questions versus non-questions, to signal different social attitudes (dominance, submission, assertiveness, politeness), and to refer to things small and large using sound symbolic vocabulary." (Ohala, 1983:15).

[3] Culpeper et al. (2003) and Nilsenova (2006) have endorsed in part Ohala's views that the meanings conveyed by prosody can be "iconic or physiological in origin". They associate high pitch to "small, child" whereas low pitch is linked to "large, adult". This dichotomy can be extended such that high pitch is associated with deference ("behaving in a 'small' way"). Moreover, Nilsenova (2006) adds the question of age in relation to the frequency code: higher pitch signals that the speaker is either very young or very old, hinting again at a situation of unequal power relations.

[4] The study of how emotions are conveyed by prosodic elements is of utmost interest in the fields of speech technologies and mental health. Understanding how humans convey emotion and attitude prosodically may help develop human to machine interaction, as well as refine clinical skills for mental health diagnosis (Johnson et al., 1986).

[5] A boundary tone is a tone that is associated with the edge of a prosodic domain.

Based on previous observations, Wichmann (2000, in press) pointed out that the "polite" fall in British English is a high fall, while the "deliberate" fall is a low fall. She mentioned that the difference in perceived politeness between the two contours could be linked to the difference in perceived finality between a high and low fall: a high fall has been found to signal "more to come", and a low fall greater finality (cf. Wichmann, 2000). The latter could thus signal "the last word" and appear to close off the interaction. Leaving the interaction open, on the other hand, could easily allow an inference of face concern and hence politeness.

Even though there is a general view that prosodic cues tend to convey systematic and inherent meanings, for decades intonation studies have failed to find reliable links between elements of prosody and emotional or attitudinal meanings (e.g., Crystal, 1975; Pierrehumbert and Hirschberg, 1990; among others). Crucially, the importance of contextual factors in prosodic interpretation has been increasingly recognized (e.g., Crystal, 1975; Cauldwell, 2000; Wichmann, 2000; Wichmann and Cauldwell, 2003). For example, Wichmann (2000) contended that a high falling nucleus in British English is not inherently "polite", but as with most such attitudinal labels becomes so only in context. Cauldwell (2000) observed that the attitudinal meaning conveyed by an utterance (a wh-question) in isolation was absent when the utterance was heard in its original conversational context. He asked students to decide whether that wh-question was perceived as being said by somebody who was "angry/irritated" or not. When that excerpt was presented in isolation, most people thought the speaker was "angry/irritated", whereas, when the excerpt was played in its context, almost nobody did. Similarly, Wichmann and Cauldwell (2003) asked students to use their own labels to describe the attitudinal or affective meanings conveyed by a series of sentences, first out of context and later in context. Participants' perception changed drastically when sentences were embedded in their context. Crucially, sentences in isolation were typically regarded as negative, whereas, when inserted in a context, they received more positive ratings. Both studies showed the crucial importance of factoring in contextual knowledge into the descriptions of associations between prosody and meaning.

One of the clearest examples of the important role that contextual information plays in the interpretation of prosody is the investigation of the relationship between prosody (and pitch range) in conveying impoliteness.[6] Culpeper et al. (2003) showed that prosody was involved in the expression of impoliteness in different ways: by choosing a specific nuclear contour (which determines the illocutionary force of the utterance), by allowing the conversation to continue or blocking it (by using rising or falling contours respectively), or by using extreme loudness or high pitch in order to invade the hearer's auditory space. In a study of (theoretically fake) impoliteness as entertainment (as exhibited in the quiz show "The weakest link"), Culpeper (2005) confirmed that prosody plays an important role. In his example, the expression of what is considered a polite farewell ("goodbye") was perceived as rude by virtue of its being accompanied by means of "faster tempo, tense articulation and [...] much higher pitch average" (Culpeper, 2005:53). When analyzing another utterance from that show, Culpeper (2005) noted that compressing the pitch range at the end brought about a sense of finality as well as of deflation, an effect opposite to that of being polite. Culpeper et al. (2003:1575) examined a threat by an officer to a client at an appeals tribunal. They noted that "increased emotional involvement [...] usually involves a widening of pitch range. A narrowing of range in this situation may suggest to the listener a degree of restraint, which is often more threatening than uncontrolled anger. In addition to the positive impoliteness of prosodically denying common ground, we also have a verbal threat intensified by low pitch, constituting negative impoliteness." All in all, impoliteness studies have shown that the prosodic expression of impoliteness uses similar prosodic features to the ones used for the expression of politeness (such as intonational contour choice, speech rate, pitch variation, pitch peak alignment, pitch height, and pitch range, among others).

The present study aims at exploring in an experimental way the pragmatic contribution of pitch range in the perception of politeness by manipulating this prosodic correlate in the speech materials. We chose to examine this particular pitch feature (pitch scaling or pitch range) because it has been singled out as one of the most important in conveying politeness differences (e.g., Ohala, 1983, 1984, 1996; Brown and Levinson, 1987; Gussenhoven, 2002; Payà, 2003; Orozco, 2008, 2010, among others). Specifically, we seek to determine how differences in pitch range in the last portion of the utterance affect the perception of politeness of interrogative requests in Catalan in two perceptual experiments, given that some reports have proposed that pitch height can be used to convey nuances (other than emphasis) such as "politeness" or "submission" (see Prieto and Cabré, 2008). In the first experiment, we manipulated the pitch range properties of two types of interrogative contours in Catalan. In the second experiment, we tested the effects of pitch range on the perception of politeness when an important contextual feature is added to the same experimental materials, i.e., an image of the speaker's smiling or neutral face while the utterance is being played. This allowed us to test whether having access to more contextual information (and specifically, to visual cues) changes the way in which we interpret prosodic cues such as pitch range.

Two different hypotheses will be entertained based on the studies just reviewed. On the one hand, pitch range differences in the last portion of the intonation contour are expected to correlate positively with degree of politeness in both experiments. This is sustained both in studies on the biological use of pitch (Ohala, 1983, 1984, 1996; Gussenhoven, 2002; Chen, 2005, among others) and also in some cross-linguistic experimental studies reviewed in the introduction (Álvarez and Blondet, 2003; Maekawa, 1999; Orozco, 2008, 2010, among others). In these studies, use of a higher pitch range was found to correlate positively with politeness. On the other hand, following Cauldwell (2000), Wichmann and Cauldwell (2003) and Culpeper (2005), pitch range differences should not be expected to have a systematic effect on listeners. They could even correlate negatively with the perception of politeness when other contextual cues (i.e., facial gestural information) are

[6] It is important to understand that impoliteness is not simply absent or failed politeness. Impoliteness constitutes a deliberate attempt to damage the hearer's face, according to Culpeper (2005) and Culpeper et al. (2003).

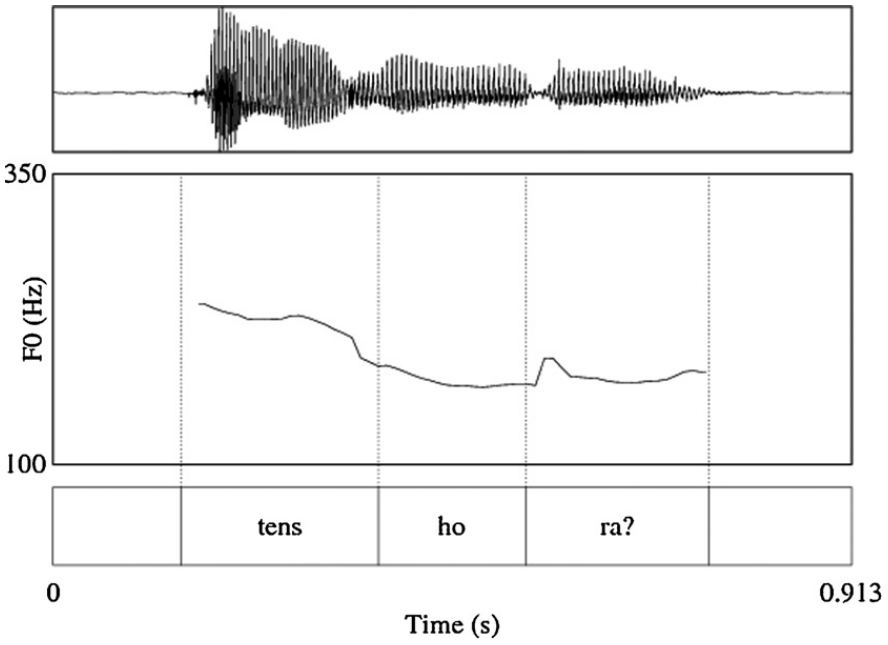

Fig. 1. Example of a falling yes–no question (*Tens hora?* "Do you have the time?"; literally, "have-[2nd person singular] time?").

present in the experimental stimuli. It is expected that in some experimental circumstances (i.e., high pitch with a neutral face), Catalan listeners are able to associate higher pitch with impoliteness.

The rest of the article is organized as follows. Section 2 presents the methodology section, including a description of the two most common pitch contours found in Catalan yes–no interrogatives. It also describes the preparation of stimuli and test administration. Section 3 presents the results and discussion for each experiment individually. Finally, section 4 deals with the general discussion and conclusions.

2. Methodology

Our main research question is whether pitch scaling modifies the degree of politeness perceived in both falling and rising information-seeking interrogatives in Catalan. This goal, originally motivated by the observation that higher boundary tones seem to be perceived as conveying a higher degree of politeness (Prieto and Cabré, 2008), ties in well with studies on the biologically-determined use of pitch and its signification (Ohala, 1983, 1984, 1996; Gussenhoven, 2002; Nilsenova, 2006, among others) and cross-linguistic studies on the effects of prosody on the perception of (im)politeness (Maekawa, 1999; Ofuka et al., 2000; Álvarez and Blondet, 2003; Culpeper et al., 2003; Payà, 2003; Culpeper, 2005; Estrella-Santos, 2007; Orozco, 2008, 2010).

To investigate whether we can pinpoint pitch range as being a systematic cue for conveying politeness in Catalan, we carried out two perception experiments in which the same acoustic stimuli were used. We created 18 synthetic stimuli by increasing and decreasing the pitch scaling of the final boundary tone of two types of yes–no questions (rising and falling contours) in equidistant steps. This resulted in f0 contours with varying degrees of sentence-final rising and falling pitch movements. Each of the two base questions displayed one of the two possible contours in Catalan: one of the questions ended in a rising boundary tone, whereas the other one ended in a falling boundary tone. In the first experiment, native speakers of Catalan were asked to judge which of two modified stimuli presented one after the other was the most polite in a given situation in a comparison task. They were also asked to rate the degree to which individual stimuli seemed polite or appropriate to a specific situation on a five-point scale. Based on claims that the interpretation of prosodic cues is dependent on contextual factors (Cauldwell, 2000; Wichmann and Cauldwell, 2003), we carried out a second perception experiment in which we added visual (gestural) information to the basic auditory stimuli.

2.1. Basic materials: Catalan information-seeking yes–no questions

As Bonet (1984), Payà (2003), and Prieto (2001, 2002a) pointed out, Central Catalan information-seeking yes–no questions allow two different intonational realizations: the falling (Fig. 1) and rising (Fig. 2) contours. Prieto (2001) describes them in the following terms. The falling contour (Fig. 1) initiates at a high level tone that is associated with the first stressed syllable. After this, a low pitch accent is anchored to the last stressed syllable and the contour continues with a falling tone until the end of the utterance. Typically, a slight increase in pitch is observable in the syllable prior to the beginning of the decline (Prieto, 2001, 2002a). In Central Catalan, this type of yes–no questions may be introduced by the question particle *que*

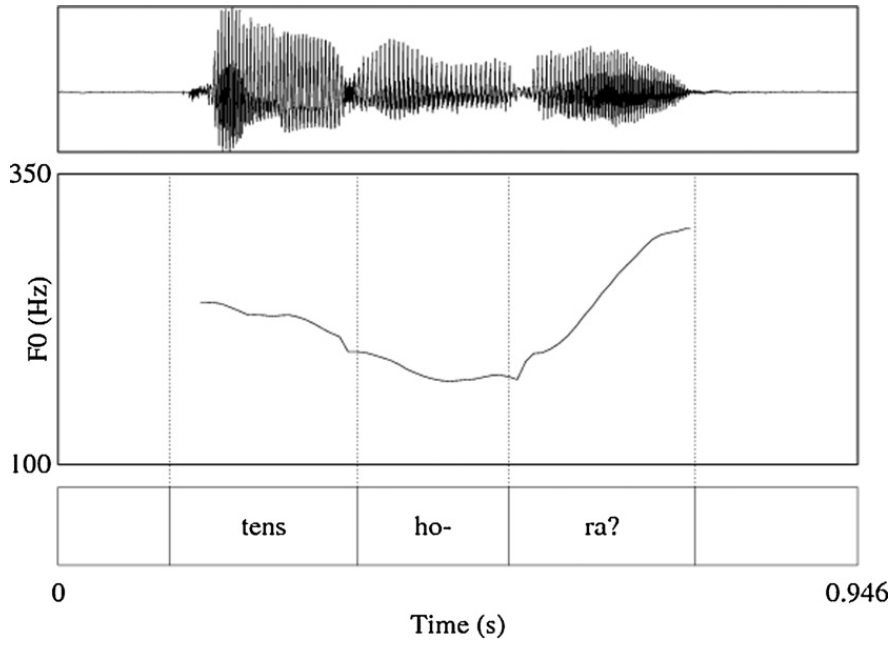

Fig. 2. Example of a rising yes–no question (*Tens hora?* "Do you have the time?"; literally, "have-[2nd person singular] time?").

"that" (Prieto, 2001; Prieto and Rigau, 2007). Following the notation described for Cat_ToBI[7] (Prieto et al., 2009; for an introduction in English, see Aguilar et al., 2009; Prieto, in press), the nuclear configuration of the falling pattern is transcribed as H + L * L%.

The other type of yes–no questions exhibits a rising contour (Fig. 2). This contour initiates at a high tone that is associated with the first stressed syllable "tens". A falling movement is associated with the last stressed syllable, where a low pitch accent is anchored. Finally, the contour concludes in a rising melody. The nuclear configuration of this contour, transcribed as L*HH%, is incompatible with the presence of *que*. For a more comprehensive approach to interrogatives, see Prieto (2001, a dialectological approach to interrogatives, 2002a, 2002b, in press), and Prieto et al. (2009).

In Payà's (2003) paper, the falling contour is described as the most polite. Payrató (2002) and Prieto (2001) claim that both patterns are adequate when the speaker's attitudes are neutral and when the aim of the interrogative is simply to elicit unknown information. However, when the action conveyed in the utterance implies a high benefit for the speaker and a high cost for the hearer, the falling pattern is perceived as less polite or formal than the other. They claim that the rising contour is preferred in those cases.

Natural productions of both the rising and the falling question intonation contours served as the source utterances for the stimuli in our perception experiments.

2.2. Acoustic stimulus preparation

The same acoustic materials were used in both perception experiments. Two interrogative utterances, one with the falling contour and the other one with the rising contour, were recorded by a young female native speaker of Central Catalan in a sound-proof booth. The content of the sentence was *Tens hora?* ("Do you have the time?"; literally, "have-[2nd person singular] time?") and it was selected so that it remained as semantically neutral as possible (following Ofuka et al., 2000; Orozco, 2010): at least in a Catalan environment, asking what time it is is a frequent situation and is not perceived as imposing a high cost on the hearer. This was done in order to prevent the form of the text from biasing participants' responses. For the same reason, no politeness markers (such as "please") or polite forms of address were included.

Both interrogatives were manipulated and synthesized using the PSOLA technique in the Praat software (Boersma and Weenink, 2009). Each original utterance was modified so that eight new different versions of each were produced by increasing or decreasing the pitch height of the boundary tone by 6 Hz in each manipulation. For the falling interrogative, the modification of the boundary tone involved modification of the pitch range of the nuclear pitch accent, because manipulating the boundary tone alone would have resulted in a complex contour which is not characteristic of the falling contour (see section 2.1). For both contours, the progressive increase and decrease of the boundary tone by 6 Hz in fact means modifying the pitch range of the final boundary movement. The stimuli thus represent varying degrees of falling and rising f0 movements; in other words, stimuli had progressively wider or more compressed pitch ranges.

[7] The ToBI system (*Tones and Break Indices*) is a method of prosodic transcription, based on the Autosegmental-Metrical model of intonational phonology. Cat_ToBI is the system developed for the transcription of prosody in Catalan within this framework (see Aguilar et al., 2009 for the online training materials).

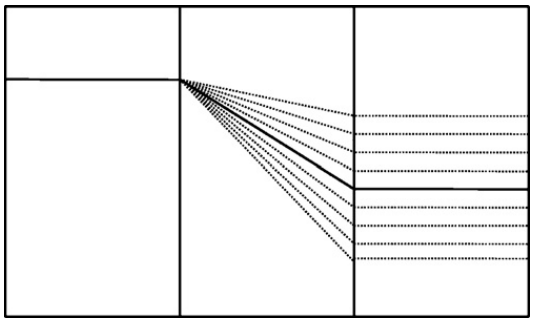

Fig. 3. Schematic representation of the falling yes–no question continuum for the interrogative sentence "Tens hora?". The solid line represents the original stimulus; whereas the dotted lines represent the manipulations of the final tone in steps of 6 Hz.

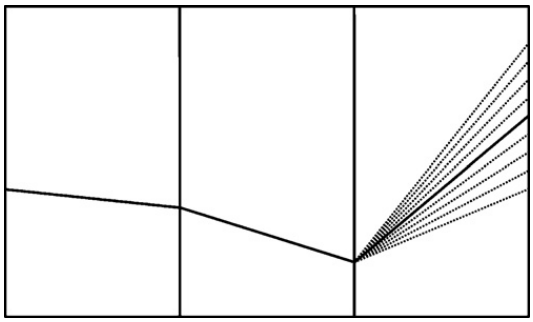

Fig. 4. Schematic representation of the rising yes–no question continuum for the interrogative sentence "Tens hora?". The solid line represents the original stimulus; whereas the dotted lines represent the manipulations of the final tone in steps of 6 Hz.

The total number of stimuli was 18 (16 new modified ones and the two original ones, which were also synthesized). Figs. 3 and 4 show schematic representations of the different stimuli created.

2.3. Experiment 1

Experiment 1 consisted of four tasks, two comparison tasks and two rating tasks, one for each type of intonation contour.

2.3.1. Participants

20 participants took part in this experiment (7 men, 13 women). All participants were native speakers of Catalan living in Catalan-speaking areas, aged 18–44 (mean age: 30). None reported any known hearing impairment.

2.3.2. Stimuli

The acoustic stimuli used were the same in all experiments (see section 2.2). The total number of stimuli was 18 (16 new modified ones and the two original ones, which were also synthesized). See Figs. 3 and 4 for an schematic representation of the different stimuli created.

2.3.3. Test administration

The test was administered by means of the DmDx Display Software (Forster, 2007). Participants were seated at a laptop wearing headphones. All the instructions were printed on the screen in Catalan and participants were allowed to read them at their own pace.

Experiment 1 consisted of four parts: two comparison tasks and two rating tasks. Each task contained only rising or falling stimuli. In the comparison tasks, participants were presented with two stimuli separated by a 1.2 second pause. They had to decide which of the two was the most polite by pressing a key in the keyboard ("1" if the first stimulus was perceived as the most polite; "2" if the second one was the most polite). Each pair was formed by combining every other stimulus in the continuum (e.g., stimulus 1 and stimulus 3; stimulus 2 and stimulus 4, and so on). This yielded 14 pairs of stimuli (seven groupings × two orders), presented five times each (14 pairs × five repetitions = 70 trials in each comparison task). The order of presentation of pairs was randomized for each participant.

The rating task consisted in the presentation of isolated stimuli, whose degree of politeness participants had to rate on a five-point scale ("1" meant "not very polite", "3" was "adequate", and "5" corresponded to "very polite"). In Watts's (2003) terms, "3" would correspond to *politic behavior*, i.e., behavior that is adequate to the ongoing social interaction. There were nine stimuli presented five times each (nine stimuli × five repetitions = 45 stimuli in each rating task). As in the comparison

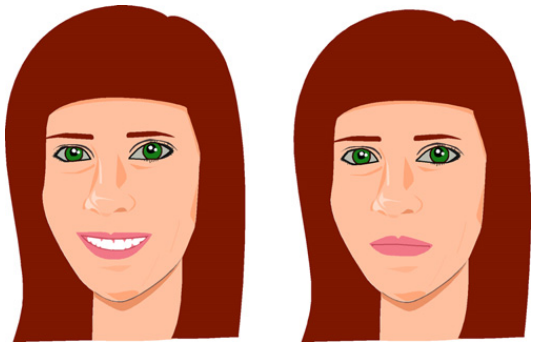

Fig. 5. Faces used in Experiment 2. The face on the left is the smiling face; that on the right is the non-smiling (neutral) face.

tasks, stimuli were presented in a randomized order for each speaker. In all the tasks, the following context was printed on the screen: "Imagine you are walking in the street. A stranger approaches you and after greeting you, she asks: 'do you have the time?'".

Before completing these tasks, participants were asked to sign a consent form and fill in a language background questionnaire. Participants then completed one of the comparison tasks followed by the rating task with the same set of stimuli. The two other tasks were presented in the same order after a short break. Some participants were exposed to falling stimuli first, while others heard rising items first. The total duration of the testing session was approximately 45 min.

2.4. Experiment 2

Experiment 2 consisted of two rating tasks, one for each type of intonational contour. In this experiment, listeners had facial information available (in the form of either a smiling or a non-smiling face) while they were rating the stimuli. This experimental setup allowed us to test the joint effect of contextual information (more specifically, visual cues) and prosodic information on the perception of politeness.

2.4.1. Participants

20 participants took part in this experiment (10 men, 10 women). All participants were native speakers of Catalan living in Catalan-speaking areas, aged 19–45 (mean age: 28.65). None reported any known hearing impairment. Participants were compensated with a 10€ gift card.

2.4.2. Stimuli

The two acoustic continua prepared for Experiment 1 were used for Experiment 2 with no further manipulation. In this experiment, the acoustic stimuli were accompanied by visual information. Two different visual stimuli were created for this task. The two images (shown in Fig. 5) represented the face of a young female (to match the voice of the acoustic stimuli) in two different conditions: smiling and neutral (non-smiling). The figures were created using Macromedia® Freehand® MX.

2.4.3. Test administration

The conditions under which participants took the test were the same as those for Experiment 1, and the same software was used. Participants were exposed to the same context and instructions and were also asked to look at the computer screen throughout the experiment. Only the rating tasks were used and stimuli were not presented completely in isolation, but with one of two faces: a smiling face and a non-smiling face (see Fig. 5). Each stimulus occurred a total of 10 times (it appeared with the smiling face five times, and the other five times with the neutral face). There were nine stimuli presented five times each with two different faces (nine stimuli × five repetitions × two faces = 90 stimuli in each rating task). Stimuli were presented in a different randomized order to each speaker. The order in which participants performed the tasks was also alternated. The total duration of the experiment was 18 min.

3. Results

3.1. Experiment 1

3.1.1. Rating tasks

Fig. 6 presents mean ratings for each of the stimuli in the two continua. Average ratings obtained by stimuli from both continua are very similar. Within each continuum, the degree of politeness perceived seems to decline as pitch height of the final boundary tone increases, especially for stimuli whose boundary tone had been increased rather than decreased. Analyses by participant revealed different patterns (for some participants, the degree of politeness correlated positively with the height of the final boundary tone).

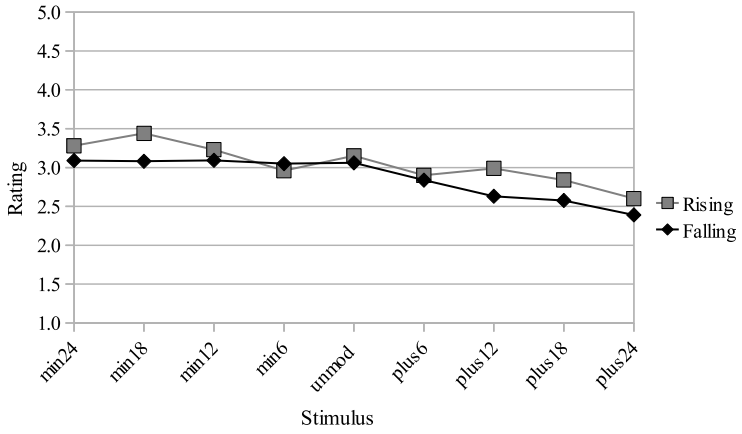

Fig. 6. Mean ratings for each of the stimuli in the rising and falling continua.

Two multiple-sample Friedman tests were performed, one on each set of stimuli, and showed significant differences in both continua (for rising stimuli: $\chi^2 = 51.439$, df = 8, $p < .001$; for falling stimuli: $\chi^2 = 64.186$, df = 8, $p < .001$). Wilcoxon two-sample tests were performed taking pairs of contiguous stimuli in the continuum. The difference between the extremes, and that between the unmodified stimulus and each of the extremes were also submitted to statistical analysis. Because multiple comparisons were tested using the same set of data, Bonferroni correction was applied to the p values resulting from the Wilcoxon tests to reduce falsely significant results. This type of correction consists in dividing the α level (set at .05) by the number of comparisons (.05/11 = .0045). The new significance level is set at .0045.

For both continua, significant differences were observed between the stimulus minus24 and plus24 (rising continuum: $z = -3.787$, $p < .001$, $r = -.27$; falling continuum: $z = -3.018$, $p = .003$, $r = -.21$), as well as between the unmodified stimulus and the plus24 (rising continuum: $z = -3.684$, $p < .001$, $r = -.26$; falling continuum: $z = -3.887$, $p < .001$, $r = -.27$). Other comparisons did not reach significance.

3.1.2. Comparison tasks

Figs. 7 and 8 show the results of the comparison tasks separately for rising and falling stimuli. The grey line represents the answers obtained by pairs formed by the lowest stimulus followed by the highest one (LH order); the black line represents the same stimuli in the reverse order (the highest stimulus first, HL order). Responses were coded so that "0" means that the lowest stimulus in the pair was considered the most polite, whereas "1" means the opposite (i.e., the highest stimulus was regarded as the most polite).

The curves in both graphs indicate that the lowest stimulus in the pair was generally preferred when the two stimuli were presented in the LH order (that is, when the first one was lower than the second). The HL order of presentation (the highest stimulus first) seemed to elicit more ambiguous responses. For the rising stimuli, average answers are mostly situated around .5, showing that there was no clear preference for one of the stimuli over the other when presented in the HL order. For the falling stimuli, a similar tendency is observed. However, in the HL order, the highest stimulus is preferred in the first three pairs, whereas the lowest stimulus is preferred in the last three pairs (i.e., pairs formed by combining stimuli whose final boundary tone had been increased).

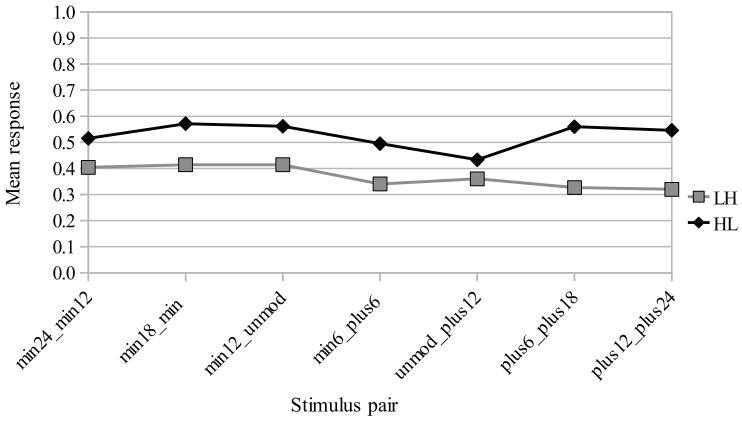

Fig. 7. Mean results of the comparison task for rising stimuli. 0 = the lowest stimulus is more polite; 1 = the highest stimulus is more polite.

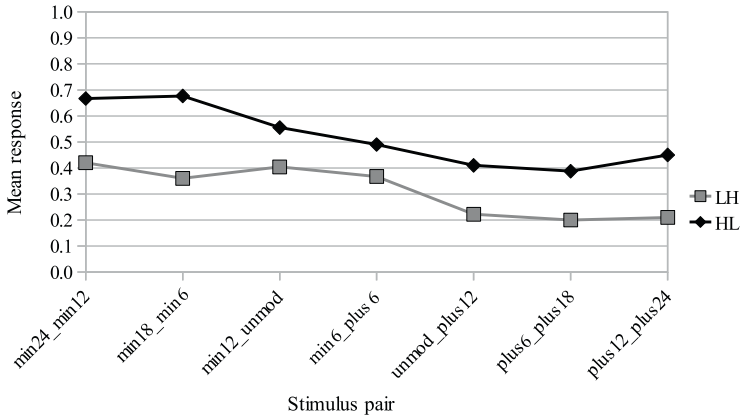

Fig. 8. Mean results of the comparison task for falling stimuli. 0 = the lowest stimulus is more polite; 1 = the highest stimulus is more polite.

An initial multiple-sample Friedman test revealed no significant differences for pairs of rising stimuli presented in the LH order ($\chi^2 = 8.525$, df = 6, $p = .202$) nor in the HL order ($\chi^2 = 7.508$, df = 6, $p = .276$). However, both Friedman tests for the comparison of pairs of falling stimuli in the LH order and in the HL order did return significant differences (LH order: $\chi^2 = 31.083$, df = 6, $p < .001$; HL order: $\chi^2 = 38.690$, df = 6, $p < .001$). Contiguous pairs of stimuli were submitted to Wilcoxon tests, but no significant differences between pairs were observed.

Order of presentation of stimuli was tested by means of a two-sample (LH vs. HL) Wilcoxon analysis testing general differences for all stimulus pairs. Fig. 9 plots the means for pairs of rising and falling stimuli presented in both orders (LH and HL). As can be seen, participants were more inclined to evaluate the lowest stimulus in the pair as the most polite when stimuli were presented in the LH order. In the HL order, average responses are close to .5, suggesting less ability to classify which stimulus was the most polite. These differences are significant (pairs of rising stimuli: $z = -5.305$, $p < .001$, $r = -.14$; pairs of falling stimuli: $z = -8.182$, $p < .001$, $r = -.22$). Thus, the order of presentation of stimuli in a pair did affect participants' judgments.

Further Wilcoxon tests were used to compare the pairings of the same stimuli in the two different orders of presentation. After applying Bonferroni correction, the significance level is set at .007 (.05/7). Two pairs in the rising continuum received significantly different ratings in the two orders, namely those formed by stimuli plus6 and plus18 ($z = -2.794$, $p = .005$, $r = -.20$), and plus12 and plus24 ($z = -2.889$, $p = .004$, $r = -.20$). The falling continuum behaves differently, since it presents more differences: the pairs min24–min12 ($z = -3.795$, $p < .001$, $r = -.27$), min18–min6 ($z = -4.522$, $p < .001$, $r = -.32$), unmodified–plus12 ($z = -2.777$, $p = .005$, $r = -.20$), plus6–plus18 ($z = -2.92$, $p = .004$, $r = -.21$), and plus12–plus24 ($z = -3.539$, $p < .001$, $r = -.25$), were rated differently depending on whether they were heard in the HL or in the LH order.

To sum up, in the rising continuum, participants rated stimuli plus6, plus18, plus12, and plus24 differently depending on the order in which they were presented. Lower stimuli (plus6 and plus12) were considered more polite when presented first, and the same is true for stimuli plus18 and plus24. In the falling continuum, most of the pairs were rated differently in the two orders. For pairs min24–min12 and min18–min6, again, the difference lay in the fact that the first stimulus of the pair

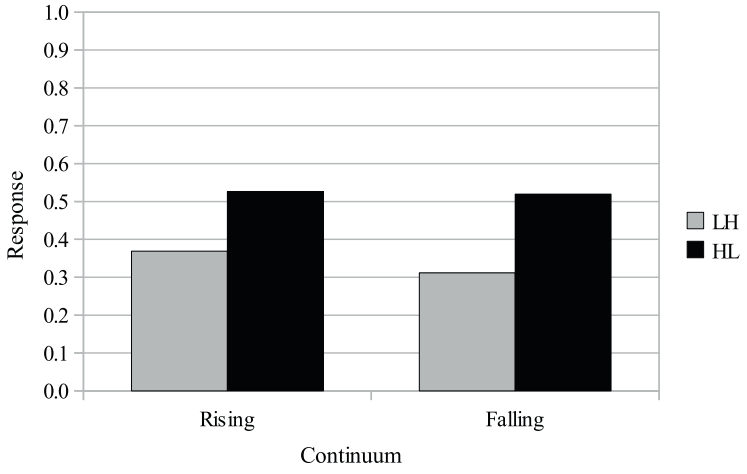

Fig. 9. Comparison of the mean responses of pairs of stimuli in the two orders of presentation. LH = the lowest one first; HL = the highest one first; 0 = the lowest stimuli was perceived as the most polite.

was always rated as more polite than the other, regardless of whether it was higher or lower than the other one. However, in the pairs unmodified–plus12, plus6–plus18, and plus12–plus24, the lowest stimulus was always preferred, although this effect was more evident in the LH order. It is precisely among stimuli with increased boundary tone that the lowest one is more clearly preferred, regardless of the order of presentation.

3.1.3. Discussion

First, it is interesting to observe that stimuli in both continua received similar ratings. This may indicate that the two contours (rising and falling) do not differ in terms of the degree of politeness they convey and that they are, in fact, interchangeable in interactions that imply a low cost for the hearer, as Payrató (2002) and Prieto (2001) ventured.

Second, contrary to predictions based on the cross-species use of f0, politeness does not seem to systematically correlate with pitch height increase in Catalan. Results of the two rating tasks reveal that a different tendency is observed: stimuli whose final boundary tone had been modified by increasing the pitch were evaluated as less polite than the ones whose final boundary tone had been decreased in pitch. Most importantly, this tendency reached statistical significance in both continua. Yet, it is not true that participants rated lower stimuli as being more polite. When the pitch height of the final boundary tone was lowered there was simply no effect, although the general tendency appreciated in the graphs is that of an increase.

The results of the comparison tasks support those obtained in the rating tasks. Stimuli with lower final boundary tone were always preferred in the LH order, and in some cases in the HL order. Interestingly, it is in cases where the boundary tone was increased (in the falling interrogatives) that the lower one was always preferred, no matter what the order of presentation was. Therefore, the same effect is found in both the rating and the comparison tasks: participants tended to consider stimuli with increased boundary tones as less polite than the unmodified ones or those with a decreased boundary tone.

In the comparison tasks, an effect of the order of presentation of the stimuli was noted. Participants did not perform equally when stimuli were presented in the HL and the LH orders. In the LH order, participants tended to choose the lowest stimulus in the pair as the most polite. In the HL order, the effect was not that clear. It might well be that this effect is rooted in a well-attested asymmetry in tonal perception. It is known that discrimination of a tonal change presented as an increase (as in the order LH) is "easier" compared to the same change presented in the reverse direction, namely as HL. These asymmetries have been reported very often both in intonational languages (Ladd and Morton, 1997; Vanrell, 2007, among others) and in tonal languages (Francis and Ciocca, 2003). In our case, the stimuli with increased boundary tones might be more successfully discriminated (and perceived as less polite) than the stimuli with decreased boundary tones because the contrast is more salient when it is presented in this order.

Apparently, these results would conflict with most of the experimental studies described above. Yet it is evident that their results are hardly comparable to the ones presented here, since none of them make any predictions regarding the role of pitch height of the final boundary tone. Our experiment is different in that it is a perception experiment and it aims at isolating one specific prosodic cue.

Our results do, however, partially contradict the biological use of pitch height outlined in the "frequency code" (Ohala, 1983, 1984, 1996). It is important to note, though, that lower stimuli were not perceived as more polite than the unmodified one either. There was simply no difference between them. That is, the opposite tendency (i.e., the lower the pitch, the higher the degree of perceived politeness) does not hold. Our results may be due to the fact that we are manipulating one single parameter and keeping other prosodic cues constant, whereas in real interaction prosodic cues interact. Furthermore, a recent study by Crespo-Sendra et al. (2010) has shown that pitch scaling of the boundary tone in the rising yes–no question is a reliable cue for Catalan listeners to discriminate between a neutral information-seeking question and a presumptive question (uttered with incredulity). Therefore, this might be a confounding factor in our data.

In addition, even if we did include a context for the utterance to be evaluated, it may be that the context was not informational enough. The role of pitch range might be different when exploited in conjunction with duration or intensity or more contextual information (linguistic or extralinguistic). In previous studies (Cauldwell, 2000; Wichmann and Cauldwell, 2003), having access to the linguistic context in which an utterance was produced has been found to affect the way it is perceived and interpreted by listeners to a large extent. Although we included a description of a context in our experiment, it is possible that it was too limited. In the second experiment, we used the same stimuli while adding contextual information (i.e., access to the speaker's face) to determine whether the meanings conveyed by pitch height differed when more context was provided.

3.2. Experiment 2

Figs. 10 and 11 display mean ratings for each stimulus in the rising and falling continua respectively. The effect of the visual cues is evident in the graphs: participants assign higher ratings to those stimuli which are paired with a smiling face than to those presented with a neutral face for both continua. Two Wilcoxon tests revealed that these differences are significant (rising continuum: $z = -14.16$, $p < .001$, $r = -.33$; falling continuum: $z = -13.792$, $p < .001$, $r = -.33$).

As regards the comparison between stimuli, the graphs show that the higher the pitch of the boundary tone, the higher the degree of perceived politeness, especially for the falling interrogative continuum. For the rising continuum, two multiple-sample Friedman tests revealed significant differences in the continuum, both when the smiling face was

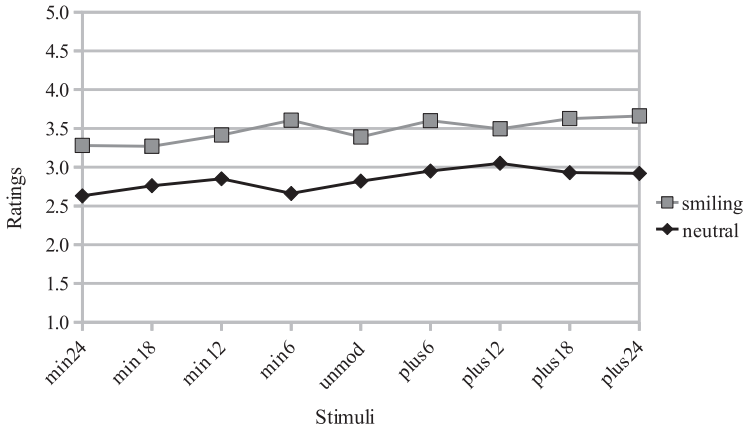

Fig. 10. Mean ratings for each of the stimuli in the rising continuum for the two conditions (happy vs. neutral).

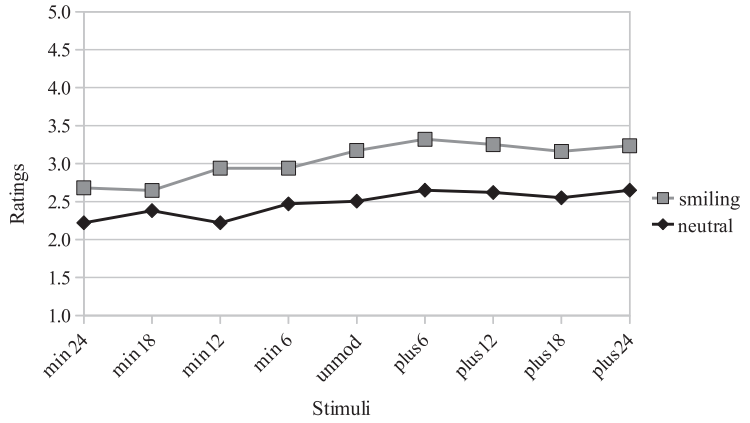

Fig. 11. Mean ratings for each of the stimuli in the falling continuum for the two conditions (happy vs. neutral).

presented ($\chi^2 = 35.026$, df = 8, $p < .001$) and when the neutral face was presented ($\chi^2 = 31.423$, df = 8, $p < .001$). To locate differences along the continuum, two-sample Wilcoxon tests were performed for contiguous stimuli, the highest and the lowest in the continuum, the highest and the unmodified, and the lowest and the unmodified stimulus (following the same analysis done in Experiment 1). No significant differences were observed for the rising continuum for any of the two conditions (smiling vs. neutral face).

For the falling continuum, multiple-sample Friedman tests revealed differences along the continuum for both conditions (happy face: $\chi^2 = 79.025$, df = 8, $p < .001$; neutral face: $\chi^2 = 41.254$, df = 8, $p < .001$). Two-sample Wilcoxon tests also revealed significant differences (at $\alpha = .0045$, after Bonferroni adjustment) between stimuli minus12 and minus18 ($z = -2.965$, $p = .003$, $r = -.21$); plus24 and minus24 ($z = -3.318$, $p = .001$, $r = -.23$); and between the unmodified stimulus and minus24 ($z = -3.649$, $p < .001$, $r = -.26$), when presented with the smiling face. No significant differences were found when the neutral face was presented.

3.2.1. Discussion

The tendency observed in the first experiment was reversed when more contextual information was added to the test. The use of visual cues in the same rating experiment resulted in two different effects: on the one hand, the tendency in the second experiment was for the degree of politeness to increase as pitch height of the final boundary tone increased (and it was significant for both continua under the two conditions). On the other hand, this effect was not as robust as it was in Experiment 1. Although we observed overall differences, the only significant differences along points in the continua were found for the falling continuum under the smiling face condition. Those differences revealed that a higher boundary tone was generally perceived as more polite (except for the comparison between minus18 and minus12). Another difference that we observed was that stimuli in the falling continuum were consistently rated as being less polite than their corresponding rising stimuli. This also differed from what we observed in Experiment 1.

These results, together with the fact that stimuli presented with the smiling face were always perceived as more polite than the same stimuli presented with the neutral face, suggest that prosody is very much dependent on the context. In fact, what our results show is that the same stimuli with and without context can be perceived in very different ways by hearers (e.g., Cauldwell, 2000; Wichmann and Cauldwell, 2003).

4. General discussion and conclusions

The goal of the first experiment was to assess the contribution of varying degrees of sentence-final pitch range to the perception of politeness in two types of interrogative contours in Central Catalan: the rising and the falling patterns. Following Ohala (1983, 1984, 1996) and Gussenhoven's (2002) "frequency code" hypothesis, we first hypothesized that, for Catalan listeners, an increase in pitch height might bring about a nuance of politeness. Linguistic descriptions of Catalan intonation contours such as those found in Prieto and Cabré (2008), as well as other cross-linguistic work on the role of pitch range in the expression of paralinguistic meanings, also supported the hypothesis that higher f0 would be associated with higher degree of politeness. Yet, on the other hand, the context-based proposal of the relationship between prosodic cues and pragmatic meanings put forward by Cauldwell (2000), Wichmann and Cauldwell (2003), and by Culpeper et al. (2003), would predict that there is nothing inherently polite in the production of higher pitch height, and that the perception of politeness is necessarily dependent on the linguistic context.

The pattern of results obtained for both types of interrogatives (falling vs. rising intonation contours) is basically equivalent with respect to the potential effect of pitch range on perceived politeness. The results of the first task in the first perception experiment (the rating task) showed that increasing the pitch range of the final portion of the utterance, both for the rising and for the falling interrogative contours, resulted in a progressive decrease in the degree of perceived politeness; whereas a decreasing pitch range had no effect. These results agreed with those from the comparison task: when stimuli were presented in pairs, the one with lower pitch height in the final boundary tone was typically preferred, for both contours. That is, when Catalan listeners heard exclusively the target sentences in an auditory mode, they rated the one with lower pitch range at the end of the utterance as the most polite. These results were quite surprising, bearing in mind Ohala's (1983, 1984, 1996) frequency code proposal and previous results on the relationship between pitch range and perceived politeness (Álvarez and Blondet, 2003, Estrella-Santos, 2007, and Orozco, 2008, 2010, for Spanish; Chen et al., 2004, and Chen, 2005, for British English and Dutch). This surprising result might have been triggered by a certain lack of context due to the nature of the task. Cauldwell (2000) and Wichmann and Cauldwell (2003) stressed the importance of evaluating meanings conveyed by prosody in a larger context. Our context was a paragraph printed on the screen, and this is probably not as realistic as having a large chunk of the conversation or images of the situation. Moreover, because the context was the same in each trial, participants may have automated the process and failed to pay attention to the context while they were carrying out the tasks.

The results of the second perception experiment, which included the same auditory stimuli as the first experiment together with static visual cues with two types of faces (smiling face vs. neutral face), revealed a completely different pattern. The use of visual cues in the same rating experiment resulted in two different effects. First, the tendency was for an increased pitch height to be perceived as more polite than when it was decreased (it was significant for both continua and under the two face conditions). Since the acoustic stimuli were the same in both experiments, we can attribute this effect to the use of visual cues and, in general, to the inclusion of more contextual information in the test. Second, though overall differences were obtained, the only significant differences along points in the continua were found for the falling continuum under the smiling face condition. These results, together with the fact that stimuli presented with the smiling face were always perceived as more polite than the same stimuli presented with the neutral face, suggest that contextual information (and, in our case, cues to gestural information) interacts in very important ways with prosodic information in conveying politeness. It is more likely that it is the combination of several cues (prosodic as well as extralinguistic, e.g., visual) that brings about some paralinguistic nuances. The two perceptual experiments provided evidence in favor of the possibility that prosodic correlates are not unequivocally linked to pragmatic meanings.

In a pilot study, we gathered production data (105 yes–no questions) and found patterns that were in line with the findings reported here. In order to identify the prosodic cues that are used to convey a nuance of politeness or impoliteness, a production experiment was carried out. For each of seven contexts, five female speakers of Central Catalan (ages 26–54, mean age: 37.8) were shown a written sentence (a yes–no question) and they had to read it while expressing politeness, impoliteness or neutrality, depending on what the context dictated (they were not allowed to modify the semantic content of the sentence, they had to use prosodic features to convey the different meanings). Thus, we obtained three renditions of each sentence which only differed in their prosody. Importantly, analysis of the data showed that there was no unique way to employ the different correlates examined (namely, duration of the accented syllable and of the boundary tone, mean intensity of the utterance, and pitch range of the boundary tone as well as of the whole utterance), rather, each participant used them in different ways. Specifically, while some participants used a wider pitch range to convey impoliteness, others used it to signal politeness.

In sum, the results obtained in both perception experiments indicate that changes in pitch range at the end of the utterance can interfere with the degree of politeness conveyed by yes–no questions in Catalan. Our data show that the very same stimuli can be perceived as conveying more or less politeness depending on how much information about the context hearers possess. In absence of visual cues, participants tended to dislike stimuli whose boundary tone had been increased. When visual cues were brought into play, the tendency reversed. Based on the results obtained in the rating and comparison tasks, it can be concluded that pitch height does play a role in the perception of politeness, yet this role is highly dependent on the context (both linguistic and extralinguistic) in which utterances are embedded. The contribution of sentence-final pitch range is different when combined with static visual cues, and it is possible that varying other aspects of the signal (duration, intensity) and of the context would yield even different results.

Finally, it is important to stress the fact that no one-to-one relationship between prosody and pragmatic interpretation was found. The very same prosodic cues can be ambiguous between different interpretations and contextual information (such as the visual cues in our experiment) can help disambiguate. As other studies have demonstrated before, a description of politeness (whether of an abstract, theoretical, and universal nature or not) may benefit from the incorporation of prosody as well as context of utterance as decisive elements in the encoding of this percept.

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