



Research Article

Prosodic mitigation characterizes Catalan formal speech: The Frequency Code reassessed



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ABSTRACT

Research in the past few decades has claimed that high or rising fundamental frequency (F0) signals a set of meanings related to the expression of politeness (e.g., deference, submission or lack of confidence (Gussenhoven, 2004; Ohala, 1984)). In this regard, the Frequency Code has been proposed to explain the universal tendency for high pitch to be interpreted as related to politeness and other sociopragmatic meanings (Gussenhoven, 2004; Gussenhoven, Chen, & Rietveld, 2002; Ohala, 1984). Recently, however, some experimental research has questioned the universality of the Frequency Code and pointed to the importance of taking other prosodic parameters into account (e.g., Brown & Levinson, 1987; Grawunder, Oertel, & Schwarze, 2014; Winter & Grawunder, 2012). Clearly, further work is needed before the question of universal tendencies in the prosodic encoding of politeness can be conclusively settled. The present study attempts to help fill that gap. Twenty Catalan speakers participated in an oral discourse elicitation task designed to investigate the prosodic components of politeness in requests in formal register speech compared to informal speech by not only analysing F0 parameters but also taking into account other prosodic parameters such as duration, voice quality and intensity, and controlling for the use of phonological intonational patterns. Results showed that subjects exhibited a slower speech rate, a lower mean pitch, less intensity, less shimmer and less jitter and an increase in H1–H2 in the formal condition. Thus, contrary to previous claims, the Frequency Code appears not to hold for this language. Rather, our results support the idea that Catalan speakers use a phonetic mitigation strategy involving various prosodic correlates. After comparing our findings with the results reported in previous literature for other languages, we entertain the hypothesis that prosodic mitigation may well play a strong role in marking politeness cross-linguistically.

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1. Introduction

When communicating, interlocutors constantly position themselves in relation to the ongoing social interaction. Depending on whether a person is interacting with a senior or peer, the socio-pragmatic level of their speech will be adapted in one way or another. This relationship between formal speech and its use with superiors has kindled the idea that it might be associated with Ohala's Frequency Code (see Gussenhoven, 2004, chap. 5). The Frequency Code proposed that using low pitch speech (characterized by low F0) to signal dominance and high pitch speech to signal subdominance is

universal. By proposing a relation between the vocal expression of subdominance (a speaker making him/herself smaller) in situations of unequal power requiring politeness, it has been suggested that there is a clear association between high pitch and polite speech (e.g., Chen, Gussenhoven, & Rietveld, 2004; Orozco, 2010; Tsuji, 2004).

Until recently the Frequency Code has been assumed to be a well-established biological code in regard to its affective interpretation. However, in the past few years, evidence has emerged which contradicts its supposed universality (e.g., Winter & Grawunder, 2012). Furthermore, other research has also found that other acoustic cues besides F0 such as duration, intensity and voice quality also seem to play an important role in the expression of sociopragmatic meanings such as politeness. Following up on recent evidence against the

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universality of the Frequency Code and its applicability to formal speech, the present study analyses a corpus of semispontaneous requests elicited in status-symmetrical and status-asymmetrical situations. On the basis of our findings, we attempt to characterise an acoustic profile in Catalan formal and informal register speech, similar to Winter and Grawunder (2012), but we additionally consider intonational phonology and set out to discuss our results in relation to the Frequency Code in a more comprehensive way.

1.1. Politeness and the Frequency Code

In the field of pragmatics, making a request has been regarded as an example par excellence of a face-threatening speech act since it intrinsically threatens the hearer's face (Brown & Levinson, 1987). The so-called extent of the threat in a request is typically assessed according to three variables: the social distance between the interlocutors, their relative power and the cost to the speaker of imposing him or herself on the addressee. Thus, importantly, depending on whether a person is making a request of a senior or peer, the socio-pragmatic level of speech is adapted accordingly to minimize the threat. This is accomplished through mitigation devices. Caffi (2007) defined mitigation as a cover term for a set of strategies that are designed to soften, attenuate or alleviate one or several aspects of a person's speech. In Brown and Levinson's (1987) classical model of politeness the term mitigation is used co-extensively with the term politeness, referring to a set of strategies that is used by speakers to attenuate the potential impact of what the authors call 'face-threatening acts'. Since both terms frequently co-occur, they have often been considered synonyms in the literature (Fraser, 1990; Holmes, 1984; etc.). However, while politeness-related effects belong to an important group of pragmatic effects that mitigation can have, not every case of mitigation is necessarily related to politeness (Albelda, 2007; Held, 1989; Hernández-Flores, 2004; Holmes, 1984; Maiz-Arévalo, 2012; Rees-Miller, 2011). Mitigation can also be used more generally by a speaker out of uncertainty, caution or consideration (Caffi, 2007). Since formal speech is used when addressing a status superior, it has often been analysed as one type of politeness (e.g., Ide, 1989; Winter & Grawunder, 2012). While in Korean honorifics (informally referred to as politeness markers) are morphemes that are part and parcel of formal speech, politeness used in formal register speech is not limited to languages with explicit honorific systems or "discernment cultures", as claimed by Watts (1989). It is this notion of mitigating potential impact when addressing a superior that connects formality in speech and the Frequency Code. The Frequency Code itself is grounded in size asymmetries and physical dominance. These associations are based on the observation that animal (and human) voices with high pitch are biologically associated with smaller size, since small animals tend to have small larynxes that produce higher-pitched sounds. As mentioned above, the Frequency Code proposes that, on the one hand, rising or high F0 is universally associated with a range of social messages, such as submission, politeness, deference and lack of confidence, while falling and low pitch is associated with opposing social messages such as confidence, threat, aggression, assertiveness and authority. On the linguistic level, low

pitch is associated with speech acts involving high certainty, such as asserting, while high pitch is associated with speech acts involving uncertainty, such as asking questions (Gussenhoven, 2002; Ohala, 1984).

Gussenhoven (2002) brought together research on additional factors affecting intonational form, leading to further claims of a universal form-function relationship. He claimed that this form-function relationship is based on three biological codes: the Frequency Code, the Effort Code and the Production Code.¹ While these biological codes can be classed as affective (signalling attributes of the speaker) vs. informational (signalling attributes of the message), and while the meanings are universally available to all humans, the universal meanings deriving from different codes might be mutually incompatible and thus displayed in different ways depending on the language. The Frequency Code as originally proposed by Ohala (1984) constitutes the first of Gussenhoven's biological codes. It is based on the fact that the larynx varies in size across speakers, which leads to intrinsic pitch differences between children, women and men, and thus both larynx size and also vibration rate can be exploited to signal power or also smallness. The informational interpretations of these differences include uncertainty for higher pitch and certainty for lower pitch. Also as pointed out by Ohala, the affective interpretations of higher pitch are equated with submissive, friendly, polite, etc. and lower pitch with dominant, confident, aggressive, etc. Regarding these informational interpretations, Gussenhoven (2002, p. 55) points out that "(w)hen the form-function relations become grammaticalised, there is no longer any guarantee that they are maintained, since they are subject to the forces of phonological change", as in the case of question and statement intonation.

1.2. Typological evidence for and against the Frequency Code. The role of pitch modulations in conveying politeness

Some cross-linguistic research conducted on the contribution of F0 to the expression of politeness has endorsed the positive relationship between pitch range² and certain types of intonational meanings, such as friendliness and politeness. Chen et al. (2004) conducted an experiment on Dutch and British English in which they analysed the perception of affective intonational meaning by applying semantic scales for 'friendliness' or 'surprise' depending on gradual changes in pitch range. In general they found the Frequency Code to be valid in these two languages in that increasing the pitch range led to greater perceived friendliness. Yet, more specifically they found that friendliness and emphasis were interpreted in different ways by English and Dutch listeners. While English listeners associated higher register with more friendliness and with less

¹ The *Effort Code* describes the notion that putting in more effort leads not only to more precise articulatory movements but also to a higher number of canonical movements and more pitch movements. Thus, the effort code describes the fact that, when speaking to a superior, people will generally use increased precision of articulation and a wider overall pitch range. The *Production Code* is bound to the exhalation phase in breathing. During vocalization, air is used and as a result the subglottal pressure drops and the pitch seems to drop over time. In this code, high pitch is associated with the beginning of utterances and low pitch with the end. Also, new information is signalled by high pitch, and older information by low pitch.

² "Pitch range" refers to the distance or span between the lowest and 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.

emphasis, Dutch listeners showed inconsistent answers by rating higher register for friendliness but associating it at the same time with more emphasis. These findings thus highlight that there are different ways in which physiological effect can be associated with paralinguistic meanings and underline that there might be differences between the possible connection established in each speech community. In addition, without explicitly making reference to the Frequency Code, some results from production studies in different languages seem to corroborate a positive relation between higher pitch and greater politeness. For example, results reported for Venezuelan Spanish by (Álvarez & Blondet, 2003) showed that politeness in interrogative utterances was marked not only through rising tone but also through more marked F0 height and F0 modulations. In another production experiment, these authors compared the intonation of two Venezuelan Spanish interrogatives, an informational wh-question and a more 'polite' indirect command expressed through a yes–no question. The results showed that the polite yes–no question displayed more F0 variability compared with the relatively flat wh-question. The yes–no question was also found to be higher in pitch than the wh-question. With regard to Peninsular Spanish, phonetic analyses of the VALESCO corpus³ have shown that polite interrogative sentences maintain a generally higher F0 level across the utterance than neutral questions (Hidalgo & Folch, 2011). In another study, Orozco (2008, 2010) asked 12 speakers of Mexican Spanish to produce eight unpunctuated written requests in first a neutral then a polite style. The results showed that Mexican Spanish speakers preferred to use not only a high final boundary tone but also a high initial tone when producing polite requests (Orozco, 2008, 2010). Herraiz and Serena (2014) analysed the melodic properties of politeness attenuators in Catalan in a spontaneous speech corpus and demonstrated, by focusing both on production and perception, that some of the most successful melodic characteristics of politeness attenuators for Catalan were the use of high and suspended final and internal pitch inflections as opposed to low final F0 movements.

However, not all studies endorse the universalist view on the use of high fundamental frequency patterns to mark politeness. There is increasing evidence that the overall mean pitch height of target utterances does not seem to be a consistent crosslinguistic marker of politeness. For example, Tsuji (2004) compared the pitch levels used by English and Japanese speakers during read and spontaneous speech and role-plays to assess whether high pitch was consistently used by both groups in particular situations and whether variations in such use were related to the sociopragmatic meaning, to the speaker's age or to cultural differences. The authors found that high pitch was used differently in the two languages: while in English it was used to mark friendliness in informal speech, in Japanese it was used to signal deference or politeness in formal register (and it was found to be more marked in the speech of female speakers). Also Winter and Grawunder (2012) investigated the issue in Korean by applying a set of discourse elicitation tasks to evoke *contaymal* (informal speech) and *panmal* (formal speech) in different types of speech acts (such as requests, apologies and compliments), and then measured the overall mean F0 and median F0 used.

Their results showed that rather low pitch compared to high pitch was used to mark polite register when addressing a person of superior status or age. Furthermore, two experiments focusing on perception by Brown, Winter, Idemaru, and Grawunder (2014) investigated first whether native speakers of Korean could detect the formality level of Korean utterances without any explicit verbal markers and second whether English listeners without any knowledge of Korean could do the same. It was found that when subjects were asked to judge the intended formality expressed by different voices, the overall accuracies were low for both groups of speakers. However, when subjects were asked to distinguish between honorific and non-honorific speech as uttered by a single voice, accuracies significantly increased for Korean listeners, showing that prosodic cues play an important role in detecting politeness. Further evidence against the reliability of high F0 as a marker of politeness has recently been found for German. Grawunder et al. (2014) investigated two varieties of German, Austrian and German spoken in Germany, applying a research methodology similar to that used in Winter and Grawunder (2012), and found that even though there seem to be individual differences among speakers, average F0 measures seem to be lower in the formal register condition. Other research has found that in Spanish too occasionally the use of a low F0 can have a polite mitigating effect (Hidalgo & Folch, 2011).

In relation to the abovementioned results, high pitch has also been shown to express *impoliteness* meanings in various languages (Culpeper, 2005, 2011; Culpeper, Bousfield, & Wichmann, 2003). For example, Stader (2007) showed that in German and New Zealand English high pitch was used to express aggression. Similarly, Goodwin, Goodwin, and Yaeger-Dror (2002) demonstrated that Latin American and African American elementary school girls use pitch leaps from their normal range of 250–350 Hz to around 600 Hz when producing disagreement turns in games of hopscotch. By the same token, experimental evidence from Catalan shows that increasing the final pitch height of yes–no questions leads to more *impoliteness* ratings, rather than *politeness* ratings, unless utterances are accompanied by a smiling face (Nadeu & Prieto, 2011). All in all, the above-outlined studies show that the relationship between F0 and politeness is far from straightforward. It seems that the Frequency Code may be universally applicable to neither all languages nor all modes of politeness. It is clear, therefore, that further work is needed to assess the role of F0 in the encoding of politeness across languages, not least because variation in the results across studies could also be due to the elicitation procedure employed (e.g., read speech vs. natural or semispontaneous speech) or the type of speech act (e.g., requests vs. apologies) or pitch contour (e.g., questions vs. statements) being analysed.

1.3. Is the Frequency Code applicable to Catalan?

A few studies have focused on the prosodic correlates governed by politeness in Catalan, with contradictory results. On the one hand, contrary to the Frequency Code prediction, Nadeu and Prieto (2011) found that a higher F0 level of the boundary tone of the yes–no questions was not interpreted as more polite. On the other hand, more recently, Herraiz

³ See <http://www.uv.es/corpusvalesco/>.

and Serena (2014), investigating mitigation contours in Catalan, found that some of the most effective melodic characteristics of politeness attenuators for Catalan were high and suspended final and internal pitch inflections. However, analysis was based on material collected from a TV show in which they centered their focus on the typically displayed F0 patterns in polite discourse, without measuring mean F0 or pitch range, it is not possible to make any strong claims about whether the Frequency Code holds in Catalan.

A recent production study on Catalan requests and offers (Astruc, Vanrell, & Prieto, 2016) highlighted how sociopragmatic factors such as social distance and the cost of the requested action restrict the choice of question intonation patterns in this language. They found that rising pitch patterns were more frequently used in high-cost offers and requests, and falling patterns were more frequently used in offers. Their intonational labelling was carried out following the Cat_ToBI framework (Prieto, 2014), which is in line with the Autosegmental-Metrical model of intonation. This model proposes that intonation contours are composed of a sequence of pitch accents followed by boundary tones. In accordance with the findings of Astruc et al. (2016), Borràs-Comes, Sichel-Bazin, and Prieto (2015) showed that the choice of vocative intonation contour in Catalan is regulated by situational and social politeness factors. It is thus clear that sociopragmatic factors as well as prosodic features must be taken into account when intonation choices are being described.

1.4. Other prosodic correlates found to be relevant for the conveyance of politeness

Though earlier studies on the phonetic aspects of politeness typically focused on pitch measures, more recent studies have shown that prosodic features such as duration, voice quality and intensity also play an important role when speakers adjust their speech style to polite registers (Venezuelan Spanish: Álvarez & Blondet, 2003; general overview: Brown & Prieto, 2017; Taiwan Mandarin: Lin, Kwock-Ping, & Fon, 2006; Japanese: Ofuka, McKeown, Waterman, & Roach, 2000; Korean: Winter & Grawunder, 2012). In general, formal speech tends to be produced more slowly and with more pauses, as shown by various studies analysing speech rate, absolute and relative syllable duration patterns, and pause duration. Winter and Grawunder (2012) found for Korean that speech rate was faster in informal than in formal speech. They also found that informal speech was characterized by fewer filled pauses (though that was not the case for silent pauses). Furthermore, Lin et al. (2006, p. 176) reported that female Taiwan Mandarin speakers modulated the final duration of phrases according to the degree of familiarity with their conversational partners, with longer duration occurring in formal register, phrase-final duration thereby indexing the social relationship between interlocutors. Ofuka et al. (2000) observed that, in Japanese, politeness can be achieved by accommodating to the interlocutor's pitch range. In their study, the duration of the final vowel had a great impact on the tonal impression of the utterance, that is, the longer the duration of the final vowel, the more polite the sentence was perceived to be. Additionally, Japanese speakers rated final rising

contours to be more polite than final falling contours. Similarly, Álvarez and Blondet (2003) showed a positive correlation between the perception of an utterance as being polite and vowel and syllable lengthening in Venezuelan Spanish. Similar results were found by Ruiz Santabalbina (2013) for Castilian Spanish. Also, Grawunder et al. (2014) demonstrated for two varieties of German (Austrian German and German spoken in Germany) that polite speech is characterized by slower speech rate and a higher number of filled pauses.

Voice quality, which refers to the 'characteristic auditory colouring' of a speaker's voice (Laver, 1980), has also been shown to mark politeness. In the last few decades it has been recognized that voice quality not only is a physical parameter that characterizes speech voice but can also be used to shape meaning (see Van Leeuwen, 2008 for an outline). Changes in the action of supralaryngeal articulators can prompt a nasalized, dentalized or velarized voice. In addition, different vocal fold configurations induce different phonation types, such as whispery, creaky, breathy or harsh voices. These phonation types can be characterized through acoustic parameters such as jitter (which analyses the % of change in the duration of pitch period), shimmer (which analyses the % of change in speech amplitude between pitch periods) and H2–H1 (the difference in amplitude between first and second harmonics). The perceptual correlates of jitter and shimmer are related to vocal stability, since excessive amounts of either jitter or shimmer can be perceived as hoarseness. H2–H1 has been seen as a possible index of breathiness (e.g., Hillenbrand & Houde, 1996; Shrivastav & Sapienza, 2003). Ito (2004) found an association between perturbation of aspiration noise and politeness in Japanese. She recorded seven male speakers from Tokyo as they performed a map task in which they alternated between giving instructions and taking instructions. Afterwards, a selection of their utterances was presented to Tokyo Japanese native speakers who had to rate the formality level and then make a forced choice judgment on the degree of distance between speaker and addressee. The results showed that shimmer observed in the F3 region was involved in judging the relative status of addressee; however, the results from the forced choice judgment task did not show a significant difference between the acoustic correlates responsible for decreasing or increasing the degree of formality. Ito therefore concluded that although shimmer seems to play a significant role in the judgment of politeness, it was clearly not the only factor involved. Along the same lines, in a study based on a single speaker of Japanese, Campbell (2004) found that when the speaker spoke to strangers he applied a more breathy phonation than when he spoke to family members. By contrast, for Korean, Winter and Grawunder (2012) found that overall participants in their study used relatively more breathy-sounding voice in informal speech than in formal speech.

Intensity (i.e., perceived loudness) is another prosodic correlate that has been shown to be related to politeness marking. Winter and Grawunder (2012) and Brown et al. (2014) reported for Korean, Japanese and German that formal speech is generally less intense (i.e., quieter) than informal speech, though in fact the intensity effect was seen in German spoken in Germany but not Austrian German.

1.5. Goals and hypotheses

The goal of the present study is to assess the role of various prosodic parameters, namely mean F₀, duration, intensity and voice quality, in the production of informal vs. formal requests in Catalan, and in line with current trends in politeness speech research (see Winter & Grawunder, 2012), we will investigate whether there are any other prosodic correlates typically used in shaping politeness in this language.

The present study will look at both the phonetic and phonological features of speech. Similar to Winter and Grawunder (2012) we will analyse a complete set of phonetic measurements, with the goal of testing whether Catalan displays clear prosodic markers in formal register which could be regarded as having a hedging function in this context and thus serve to mitigate the face-threat. Additionally, by applying Cat_ToBI labelling procedure (see Prieto, 2014) to our data, we will examine whether Catalan speakers make a more frequent use of final high and mid boundary tones in the formal register condition. However, unlike Winter and Grawunder (2012), we will restrict ourselves to only one type of speech act, requests, in order to obtain a homogenous pragmatic sample of semispontaneous speech in which pragmatic factors such as social distance have been controlled for.

Two competing hypotheses will be tested, based on the results reported by the studies reviewed above. On the one hand, overall higher pitch is expected to correlate positively with formal register, as evidenced by studies on the biological use of pitch (Ohala, 1984; Gussenhoven, 2002; Gussenhoven, Chen, & Rietveld, 2002; Chen et al., 2004) and also by other studies which have corroborated a positive relationship between increased pitch height and the expression of politeness (Hidalgo & Folch, 2011; Orozco, 2008, 2010; Tsuji, 2004; Álvarez & Blondet, 2003). On the other hand, following Winter and Grawunder (2012) and Grawunder et al. (2014), we do not rule out the possibility that an increased pitch height may instead signal informal rather than formal register. Finally, given that various studies (Lin et al., 2006; Ofuka et al., 2000; Winter & Grawunder, 2012; Álvarez & Blondet, 2003) have found that duration, voice quality and intensity can play an important role as mitigation devices to mark politeness, we will not simply confine ourselves to the question of pitch but also explore the behaviour of a full set of prosodic features. More particularly, the significance of this paper lies in the amount of speech data analysed and the more controlled nature of the stimuli (cf. Winter & Grawunder, 2012, who used a mixed bag of scenarios), and importantly, we make use of a complete prosodic analysis of our data.

2. Methodology

2.1. Participants

Twenty female Catalan-speakers (mean age = 21.00; SD = 3.72) volunteered to participate in this experimental task. They were all students at the Universitat Pompeu Fabra in Barcelona. All were native speakers of Catalan, and they all considered Catalan to be their dominant language relative to Spanish (mean percentage of Catalan in total daily language use = 75.83%; SD = 13.62). Each participant received a token payment for her participation.

2.2. Materials

In order to obtain a homogeneous pragmatic sample, we focused on one type of speech act, namely requests. The elicitation method consisted of an oral version of the Discourse Completion Task (DCT), which has been used successfully in intercultural pragmatics and prosody research (Billmyer & Varghese, 2000; Blum-Kulka, House, & Kasper, 1989; Félix-Brasdefer, 2010; Vanrell, Feldhausen, & Astruc, in press). The elicitation procedure used was also directly comparable to that used in Winter and Grawunder (2012). DCTs provide participants with a situational prompt designed to elicit a response while controlling for a set of contextual factors. As a result, DCTs provide comparable, systematic and quantifiable data. Although spontaneous, naturally-occurring data would be ideal, when recording spontaneously-produced speech data it is very difficult to control for social variables such as gender, age, social distance and power and create fully comparable situations. Thus DCTs are very helpful to examine the patterns of pragmatic strategies used in speech, in a controlled way.

The DCT questionnaire consisted of six formal contexts and six informal contexts which served as a basis for initiating requests (see Appendix for full scripts in Catalan and English translations). In order to produce data sets that would be comparable across formal and informal registers, we controlled for the following three pragmatic factors: (a) social distance between interlocutors (e.g., talking to a friend vs. a stranger), (b) power difference between interlocutors (e.g., talking to a classmate vs. a boss), and (c) the cost of the action being requested within the discourse context (e.g., asking for directions vs. asking to borrow a car). As mentioned above, Brown and Levinson's (1987) politeness theory hypothesizes that the degree of face-threat in any act can be measured in terms of these three variables, namely social distance, relative power and the cost of imposition.

By way of illustration, in the formal register prompt below (1) a student has to request a letter of recommendation from a professor, and in the informal register prompt (2) a student has to request help from a friend for a short Portuguese translation.

(1) Formal situation

Vols demanar una feina de professor ajudant a Anglaterra entre el teu grau i el màster, pel que necessites una referència laboral per poder inscriure-t'hi. Què li diries a la teva cap de grup (catedràtica d'uns 50 anys) perquè et fes aquest favor?

You're applying for a teaching assistant job in England between doing your Bachelor's and Master's degrees, and you need a letter of reference from your tutor, a 50-year-old full professor. What would you say to her?

(2) Informal situation

Estàs estudiant portuguès. Encara no el domines del tot, i tens un text curt que hauries d'entendre bé fos com fos. Demana-li a la teva amiga si te'l pot traduir.

You are studying Portuguese. Your mastery of it is still quite limited, however, and you have a short text in Portuguese which you would like to understand fully. Ask your friend if she would translate it for you.

The context descriptions were written with the cultural background of the participating students in mind so that their responses would be as appropriate and natural as possible. Each description was printed on a card above a picture depict-

ing the location where the interaction described was supposed to be taking place, such as a professor's office or a university hallway. The image thus offered additional cues to the social distance between and relative power of the two interlocutors (This approach is based on Winter and Grawunder (2012)).

In order to check that our target contextual situations leading to requests in the formal and the informal conditions differed substantially in the perception of social distance, relative power and imposition cost, the 12 target situations were rated independently by six native Catalan-speakers. For each context, they were asked to rate Social Distance from 1 (e.g., close friends) to 3 (e.g., strangers) and relative Power from 1 (no power difference, e.g., peer talking to peer) to 3 (high difference, e.g., subordinate talking to superior). The Power ratings were consistent across raters, with informal conditions being given a score of 2 by all raters, and formal conditions being given a score 3 by all raters (so there was no need for inferential statistics to show that this difference was significant). Regarding Social Distance, the mean rating for the 6 informal contexts was 1.002 (SE = 0.072), whereas the mean rating for the formal contexts was 2.311 (SE = 0.072). A Linear Mixed Model (LMM) was run, with perceived Social Distance as dependent variable, and Formality as a fixed factor. Both Rater and Item were set as random intercepts. The results showed that more Social Distance was found for the formal contexts compared with the informal ones ($\beta = 1.306$, $p < 0.001$). In conclusion, the ratings given by the six native speakers confirmed that the social distance and relative power conveyed by our contextual situations were different across formality conditions.

2.3. Procedure

The experiment took place in the Linguistics Laboratory at the Universitat Pompeu Fabra's Department of Translation and Language Sciences. Each participant performed the experiment individually. They first received instructions for

the task in written form. Then, after one of the researchers clarified the general procedure and answered any questions, the participants were presented with the 12 cards describing the prompt contexts, one at a time. They were given first the six informal contexts, in random order, and then the six formal contexts, again in random order. Once they had read and understood each card, they were asked to return it to the researcher and then deliver the request as spontaneously as possible facing a Panasonic 3MOS HD-AVCCAM video camera, which recorded them. Sound was captured by means of a small clip-on microphone. The sample rate was 44,100 Hz using 16-bit quantization. The whole session was carried out entirely in Catalan. All participants seemed to formulate the requests spontaneously and freely, and after the experiment they typically confirmed that the situations had seemed very natural to them (indeed many stated that they had encountered similar situations in their academic or professional life).

A total of 240 audiovisually recorded requests were thus obtained (6 situations \times 20 participants \times 2 conditions). Of this total, two requests had to be excluded. In one case, a request was excluded because the speaker had assumed that she should whisper given that the context provided was a library. This yielded inadequate auditory material. In the second case, one of the 12 situations was accidentally overlooked. The remaining 238 requests constituted altogether 3 h 31 min and 8 s of recorded speech.

2.4. Labeling procedure

Each video-recorded request was prosodically and pragmatically analysed by the first author of the study. The annotation scheme (see below) was defined and selectively reviewed by the other authors. Praat (Boersma & Weenink, 2017) was the annotation tool used for pragmatic and prosodic labelling.

Fig. 1 shows an example of the annotation scheme which was applied to the 238 requests. Text tiers below the phonetic imaging are explained in detail below.

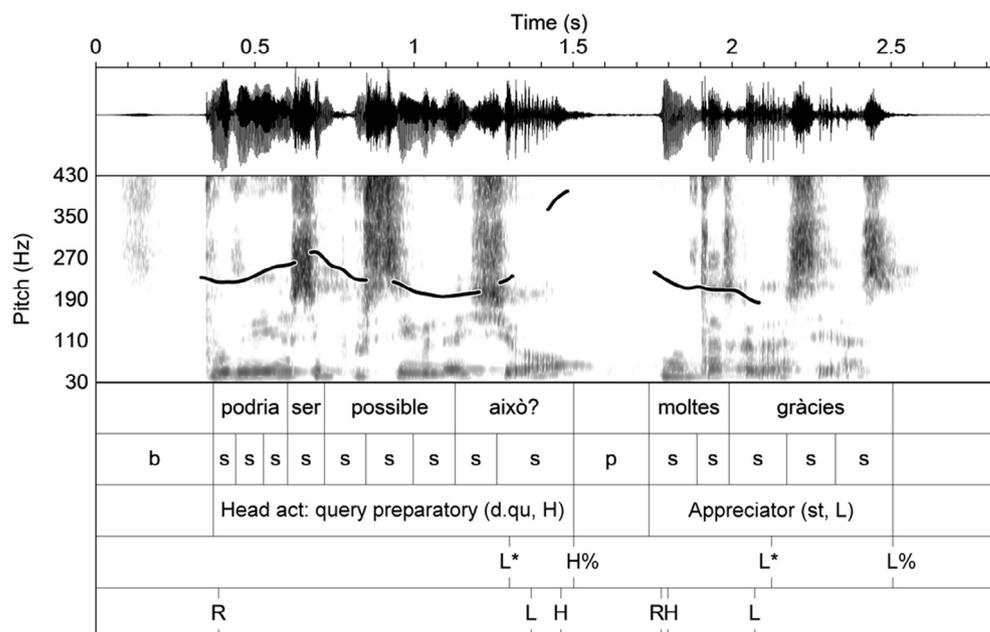


Fig. 1. Waveform, spectrogram and F0 contour of a condition 2 request (formal register) followed by orthographic, pragmatic and prosodic annotations (tiers 1–5).

Tier 1, words. The first tier contains the orthographic transcription of the target requests, separated by words.

Tier 2, syllables. In this tier, all target syllables were manually segmented in Praat, as were two types of pauses, namely filled pauses (which occurred due to breath intakes, marked with the letter “b”), and silent pauses (“p”). The syllables were marked as either regular syllables (s) or elongated syllables (*) (e.g., syllables containing hesitation). Other fillers such as ‘hm’, ‘mh’ etc. were included within the latter category. These markers allowed us subsequently to calculate the average syllable length, average length of elongated syllable and speech rate, measured in terms the number of words per second, number of syllables per second and number of fluent syllables per second (see Section 3.2., Results).

Tier 3, prosodic phrasing and pragmatics. Each intonational phrase (IP) was first annotated and characterized according to its pragmatic function, i.e., pertaining either to the head act, the nucleus of the speech act which might serve to realize the act independently of other elements (e.g., ‘can you pass me the bread’) or to other request-external strategies (preparators, precursors, reason, appreciator). In this paper, for some of the analyses we will distinguish between speech domains which belong to the head act and those that do not. This classification is an adaptation of Félix-Brasfeder’s (2005) coding scheme (adapted from Blum-Kulka et al., 1989). IPs and pragmatic strategies did not always show a one-to-one correspondence (i.e., sometimes a pragmatic strategy contained several IPs). Each IP was then classified as either a statement (st) or a question (d.qu = direct question/in.qu = indirect question), and finally labelled as ending with either a low (L) or high (H) boundary tone.

Tier 4, intonation. In this tier, each nuclear pitch configuration (e.g., pitch accent plus boundary tone) for each intonational phrase (IP) was annotated following the Cat_ToBI annotation system (Prieto, 2014).

Tier 5, F0 marks. In the last tier, the following measures were indicated manually for each IP: the reference line (= R, start time of the pitch contour within each intonational Phrase), the baseline (= L, lowest F0 point in the intonational Phrase) and the top line (= H, highest F0 point within the IP).

A series of phonetic measures were automatically extracted within each annotated syllable, namely, mean F0, mean intensity (in dBs), and mean jitter and shimmer. Furthermore, in order to assess the breathiness of the participants’ responses, the amplitude difference between the first and second harmonics (H1–H2) was also automatically obtained. Different measures concerning the duration of words and different types of syllables and pauses were also extracted in order to calculate the speech rate and the amount of hesitation in both registers.

2.5. Statistical analyses

All statistical analyses were carried out using IBM SPSS Statistics v24 software. More specifically, a series of Linear Mixed Models (LMMs) and Generalized Linear Mixed Models (GLMMs) were undertaken in order to compare the values found for the two levels of our fixed effect (informal register vs. formal register), taking the former as the reference category when reporting the results. The dependent variables were modelled according to the specific distribution shown (Linear

for continuous measures, Binomial for binary outputs, or Poisson for count data), some of them being previously transformed (in order to provide a better fit for their residuals and, subsequently, for their statistical analysis; Eddington, 2015). When errors occurred in the application of mixed models, such as no convergence, less complex models of analysis were carried out. The structure of random effects is specified below.

In Section 3.1, we analyse data related to lexical and morphological marking. These data were binomial in nature (i.e., a feature is either found or not in each of the utterances in the database), so our first attempt at analysing them consisted of a GLMM with a Binomial distribution. However, this yielded a series of errors such as non-convergence or non-positive definiteness of the Hessian matrix, which invalidated the models obtained (Eddington, 2015). Because of this, we organised the data into a new database containing the number of utterances in which a particular feature occurred, for each of the formality conditions. The data was then analysed using a GLMM with a Poisson distribution, but similar errors resulted (i.e., the final Hessian matrix or the estimated covariance matrix of the random effects were not positive definite). As a final resort, a series of *t*-tests for dependent samples were performed on this section’s data.

In Sections 3.2 and 3.4, we analyse pitch, voice quality and intensity measures (continuous data in all cases). A series of LMMs were applied to the data. Formality was set as fixed factor (with *informal* as the reference category). All models included a random effects block setting and a random slope for Speaker by Formality. In order to provide a better fit for jitter and H2–H1, they were previously transformed into their natural logarithm (ln).

In Section 3.3, we report on speech rate and hesitation markers. We specifically analysed different types of dependent variables: duration (of utterances, words, fluent syllables, elongated syllables and pauses), number of features per utterance (of words, elongated syllables and pauses), and the proportion of elongated syllables over the total number of syllables. Again, in order to provide a better fit for our data, duration measures were transformed into their natural logarithm (ln), and proportion data were first transformed into their natural logarithm and then the negative reciprocal was calculated, i.e., $-1/(\ln(\text{variable}))$. Duration and proportion data were analysed by means of a LMM; count data were analysed by means of a GLMM with a Poisson distribution. All models included a random slope for Speaker by Formality. Formality was set as fixed factor (with *informal* as the reference category).

Finally, in Section 3.5 we report a holistic-like analysis in which all continuous measures (previously presented in Sections 3.2–3.4) were analysed by means of a single statistical model. In order to provide a single score for all variables, they were previously z-scored. The model included a random intercept for Speaker. Formality, Measure and their paired interactions were set as fixed factors.

3. Results

In this section, we first analyse data related to lexical and morphological marking (Section 3.1) in the formal and informal registers. Second, we analyse the pitch measures (Section 3.2). In Section 3.3, we report on speech rate and

hesitation measures, and in Section 3.4 we report on voice quality and intensity measures. Finally, in Section 3.5 we provide a holistic-like analysis in which all continuous measures (previously presented in Sections 3.2–3.4) are analysed by means of a single statistical model.

3.1. Lexical, morpho-syntactic and intonational marking

In Catalan, there is a set of well-known morphosyntactic and lexical differences between speech registers, which differ along a number of dimensions (see Payrató & Maria Cots, 2011). In order to check for those differences, we analysed those dimensions by extracting from the orthographic tier the relevant information about forms of address, verb forms and sentence types, and more specifically by using exclusively the head act domain (see Section 2.4). The number of head acts ($N = 263$) was higher than the total number of requests obtained in the DCT ($N = 238$), since occasionally participants chose to formulate more than one head act when producing a request.

The utterances were first inspected for their verbal person morphology, that is, the more informal 2nd person singular (e.g., [tu] vols 'you_[Informal] want'), or the more formal 3rd person singular (e.g., [vostè] vol 'you_[Formal] want'). Verb modality, and specifically the use of conditional forms (e.g., voldria 'you would want'), is also another clear indicator of politeness in Catalan. Four main conditions were identified in our database regarding mood, namely imperative, indicative, conditional-indicative and conditional-subjunctive. Head acts can be produced using different sentence types, which lead utterances to be understood with various degrees of imposition. The head acts in our database displayed four different sentence types: imperatives, direct questions (e.g., Pots mirar-te què li passa al meu ordenador? 'Can you take a look to see what's going on with my computer?'), declaratives and indirect questions (e.g., Et voldria preguntar si em podries ajudar 'I wanted to ask you whether you could help me'). In order to check whether the politeness condition (i.e., formal vs. informal register) had an effect on the phonological choice of intonation patterns, we also analysed the use of final pitch configurations in direct questions within the head acts in both conditions.⁴

Table 1 presents the mean number of utterances produced by each subject containing these lexical, morpho-syntactic and intonational markers. The table also includes the results of a series of *t*-tests for dependent samples in which *informal* was set as the reference category. Whereas 2nd person morphology was more frequent in informal conditions, 3rd person morphology was more frequent in formal ones. While informal register conditions displayed more imperative and indicative verbal moods, the two conditional verb forms were more often used in formal register conditions. While imperative sentences and direct interrogatives were more frequent in informal registers, indirect interrogatives were more frequent in formal registers. Whereas there was no statistical difference between formality conditions for the use of falling tunes (L* L% or H + L* L%), rising tunes (L* H%) were used more often in

informal registers. Finally, the two registers were statistically similar regarding the height of the final H% rising intonations.

All in all, the above results confirm that clear morphosyntactic markers characterize formal vs. informal register conditions in our speech data. On the one hand, informal register is characterized by a greater presence of 2nd person singular verbal morphology, verbs in imperative and indicative mood, and head acts produced as imperatives and direct-interrogative sentence types (which is also shown by a greater presence of rising tunes). On the other hand, formal register is characterized by a greater presence of 3rd person singular verbal morphology, verbs in conditional mood, and head acts produced as indirect-interrogative sentence types.

3.2. Pitch measures

Average pitch was extracted automatically from all regular syllables produced in the requests. Moreover, three other pitch measures were extracted by using manually placed specific points in each intonational phrase produced, namely the reference line, the top line and the baseline (see Section 2.4). Table 2 contains the results of the various LMMs applied plus the means estimated by the models. As can be seen in the table, all pitch measures except for the baseline show significantly lower pitch values in the formal condition. Unexpectedly, mean pitch values and also mean values of the reference and top lines were lower in the formal condition than in the informal condition.

3.3. Speech rate and hesitation markers

A series of measures were extracted in order to analyse the speech rate and hesitation behaviour of utterances. Concerning the former, we analysed the total duration of utterances, the number of words per utterance, the mean duration of words and the mean duration of fluent syllables. As can be seen in Table 3, formal utterances were longer and contained more words, and these words were also longer (all $p < 0.001$). However, we failed to find a reliable difference between the duration of fluent syllables across formality conditions ($p = 0.085$), which suggests that the duration of words increased due to hesitation strategies. These measures thus indicate an overall slower speech rate in the formal condition compared to the informal condition.

Concerning hesitation markers, we analysed different measures related to elongatedly-produced syllables and produced pauses, namely the proportion of elongated syllables over the total number of syllables, the number of elongated syllables per utterance, the mean duration of elongated syllables, the number of pauses per utterance and the mean duration of pauses. As can be seen in Table 4, formal utterances had a greater proportion of elongated syllables over the total number of syllables, a result which is also reflected in the greater absolute number of elongated syllables in formal utterances found (both $p < 0.001$). The results also show that these elongated syllables were longer in formal utterances ($p = 0.003$). Finally, the absolute number of pauses per utterance was greater in the formal condition ($p < 0.001$), though the duration of these pauses was found to be statistically similar between the two formality conditions ($p = 0.100$).

⁴ Direct questions (and not indirect questions) were used because the intonation of indirect questions typically corresponds to the intonation of broad focus declaratives, i.e., a falling intonation pattern (a low fall, realized as L* L% or H+L* L%).

Table 1

Mean number of utterances produced by each subject (and standard deviations) for different lexical, morpho-syntactic and intonational markers in the two formality conditions. The table also includes the results of a series of *t*-tests for dependent samples in which *informal* was set as the reference category. The degrees of freedom for the *t*-tests are 19 in all cases except in the last one, where they are 7.

Measure	Informal		Formal		<i>t</i> -Test results	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>p</i>
2nd person morphology	5.90	0.31	4.15	1.98	3.920	0.001
3rd person morphology	0.00	0.00	1.50	1.93	−3.470	0.003
Imperative	0.40	0.68	0.00	0.00	2.629	0.017
Indicative	2.55	1.57	0.90	1.29	4.355	0.000
Conditional-indicative	3.00	1.75	4.25	1.62	−2.918	0.009
Conditional-subjunctive	0.15	0.37	0.85	0.88	−3.036	0.007
Indirect questions	1.30	1.22	3.70	1.08	−7.931	0.000
Declaratives	0.55	0.60	1.10	1.12	−1.993	0.061
Direct questions	4.00	1.26	1.20	1.36	7.483	0.000
Imperatives	0.40	0.68	0.00	0.00	2.629	0.017
Falling intonation (L* L% or H + L* L%)	0.15	0.49	0.10	0.31	0.370	0.716
Rising-falling intonation (L* H%)	1.80	1.11	0.10	0.31	7.373	0.000
Boundary H height (Hz)	328.56	54.87	293.08	58.15	−1.434	0.195

Table 2

Mean F0 (in st) and standard errors for four pitch measures (overall pitch, reference line, baseline and top line) in the two formality conditions. The table also includes the results of a series of LMMs in which *informal* was set as the reference category.

Measure		Informal		Formal		LMM results	
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	β	<i>p</i>
Average pitch	(st)	13.27	0.352	12.79	0.351	−0.479	0.002
	(Hz)	218.69	4.35	212.67	4.34	−6.022	0.001
Reference line	(st)	14.68	0.298	13.98	0.290	−0.698	0.001
	(Hz)	236.19	4.02	226.56	3.92	−9.626	0.000
Top line	(st)	17.95	0.408	16.70	0.398	−1.286	0.000
	(Hz)	287.04	6.57	266.48	6.41	−20.564	0.000
Baseline	(st)	10.42	0.301	10.16	0.286	−0.256	0.264
	(Hz)	185.15	3.13	183.12	3.01	−2.028	0.319

Table 3

Averages and standard errors from a model run with no transformations over four speech rate dependent variables in the two formality conditions. The table also includes the results of a series of (G)LMMs in which *informal* was set as the reference category.

Measure	Informal		Formal		GLMM results	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	β	<i>p</i>
Total duration of utterances	13.25	2.06	21.41	2.06	0.467	0.000
Number of words per utterance	41.32	3.78	53.78	5.50	0.269	0.000
Mean duration of words	0.2613	0.0061	0.3072	0.0060	0.149	0.000
Mean duration of fluent syllables	0.1476	0.0034	0.1526	0.0034	0.025	0.066

Table 4

Averages and standard errors from a model run with no transformations over five hesitation-related dependent variables in the two formality conditions. The table also includes the results of a series of (G)LMMs in which *informal* was set as the reference category.

Measure	Informal		Formal		GLMM results	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	β	<i>p</i>
Proportion of elongated syllables over the total number of syllables	0.0769	0.0071	0.1027	0.0070	0.051	0.000
Number of elongated syllables per utterance	4.40	0.78	8.70	1.43	0.686	0.000
Mean duration of elongated syllables	0.4079	0.0121	0.4429	0.0110	0.073	0.003
Number of pauses per utterance	3.11	0.41	5.96	0.71	0.650	0.000
Mean duration of pauses	0.3337	0.0165	0.3628	0.0149	0.061	0.100

3.4. Voice quality and intensity

The following measures of voice quality were automatically extracted for each syllable in our recordings: perturbation by amplitude (shimmer), perturbation by F0 period (jitter), the harmonic differential (the difference in amplitude between the first and second harmonics, H1–H2, in Hz), and intensity (in dBs). Readings of the first and second harmonic were extracted for each one of the non-hesitated syllables and the difference

between them was calculated. As can be seen in Table 5, there was a significant decrease in shimmer ($p = 0.002$) in the formal condition, a near-significant tendency for jitter and a nonsignificant tendency for the H2–H1 voice quality measure. Furthermore, intensity was found to be significantly lower in the formal speech condition than in the informal speech condition ($p = 0.047$). Given that intensity is the acoustic measure for loudness, this shows that participants adopted reduced loudness as a strategy in the formal condition.

Table 5
Mean and standard deviations and standard errors for the prosodic measures related to voice quality and intensity in the two formality conditions. The table also includes the results of a series of LMMs in which informal was set as the reference category.

Measure	Informal		Formal		LMM results	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	β	<i>p</i>
Jitter	0.0219	0.0007	0.0210	0.0007	-0.0531	0.017
Shimmer	0.1551	0.0022	0.1506	0.0022	-0.0045	0.002
H2-H1 (Hz)	527.07	14.90	540.14	14.84	0.0214	0.140
Intensity (dB)	76.69	0.45	76.22	0.45	-0.457	0.047

3.5. Holistic analysis and final remarks

We performed an additional LMM in order to compare all continuous measures presented in Sections 3.2–3.4 (17 in total). In order to provide a single metric for all variables, they were previously z-scored. Doing this allows these metrics to be displayed in a comparable metric and directly compared across formal and informal conditions, thus making it possible to determine which acoustic measures show the sharpest differences between the two conditions (see Fig. 2). The fixed effects results revealed a main effect for Measure, $F(16, 3942) = 6.491$, $p < 0.001$, but not for Formality, $F(1, 3942) = 0.298$, $p = 0.585$. Crucially, the interaction Formality \times Measure, whose pairwise contrasts are detailed below, was found to be significant, $F(16, 3942) = 182.305$, $p < 0.001$.

Table 6 includes the results of the pairwise contrasts of the Formality \times Measure interaction in our holistic analysis.

In this analysis, a significant effect was found for both the mean duration of pauses and the H2–H1 difference, which was not the case in the previous sections and may be a consequence of the fact that we are now working a single score for each of the 238 utterances obtained. Furthermore, except for the baseline pitch and the mean duration of fluent syllables,

all measures reached significance. As reported in the previous sections, speech rate markers (and the H2–H1 difference) provide greater values in the formal condition, whereas the majority of pitch and voice quality measures provide lesser values in the formal condition. Concerning pitch measures, top line pitch makes the greatest difference between conditions ($\beta = -0.611$, $p < 0.001$). Concerning duration measures, a number of effects go in the same direction, the most prominent one of which is the mean duration of words ($\beta = 0.935$, $p < 0.001$). Finally, concerning voice quality measures, shimmer is the most noteworthy ($\beta = -0.437$, $p < 0.001$). Among the three types of measures, the ones related to speech rate seem to provide the greatest coefficient values for the difference between the two formality conditions.

4. Discussion and conclusion

The present analysis has revealed two clearly different patterns of sociopragmatic speech cues in formal vs. informal request situations. In the formal situation, where speech was directed to people with more power, the power imbalance was marked through deference strategies that were

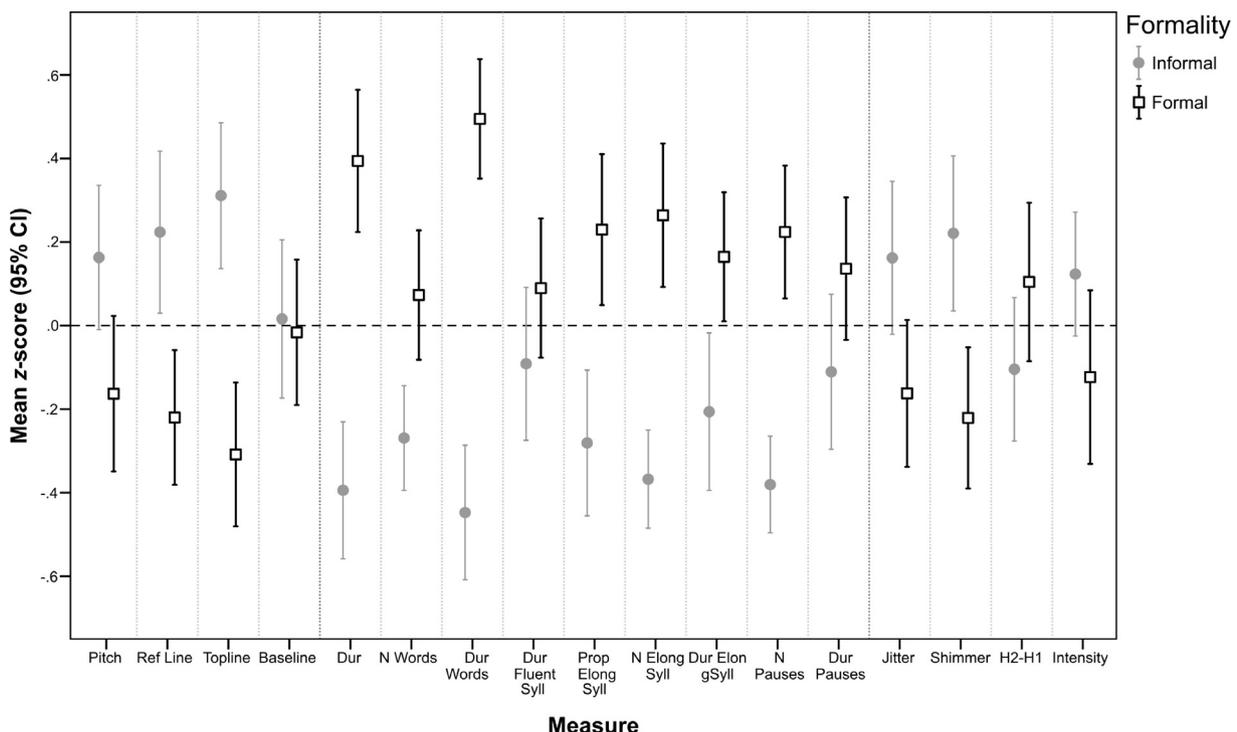


Fig. 2. Mean z-scores (and error bars depicting a 95 confidence interval) for the 17 prosodic measures analysed in this section, for the two formality conditions (dashed red = informal; solid black = formal).

Table 6

Mean z-scores and standard errors for the 17 prosodic measures analysed in this section, for the two formality conditions. The table also includes the results of the pairwise contrasts obtained for the interaction Formality \times Measure, in which informal was set as the reference category (so a negative value indicates a decrease in the formal condition).

Measure	Informal		Formal		Pairwise contrasts	
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	β	<i>p</i>
Average pitch (st)	0.163	0.198	-0.158	0.220	-0.321	0.000
Reference line (st)	0.223	0.191	-0.215	0.180	-0.438	0.000
Top line (st)	0.307	0.163	-0.304	0.177	-0.611	0.000
Baseline (st)	0.016	0.198	-0.011	0.191	-0.027	0.711
Total duration of utterances	-0.395	0.172	0.399	0.187	0.794	0.000
Number of words per utterance	-0.268	0.129	0.080	0.151	0.348	0.000
Mean duration of words	0.445	0.118	-0.490	0.120	0.935	0.000
Mean duration of fluent syllables	0.089	0.178	-0.087	0.152	-0.176	0.079
Proportion of elongated syllables over the total number of syllables	-0.292	0.131	0.228	0.157	0.520	0.000
Number of elongated syllables per utterance	-0.368	0.112	0.276	0.175	0.644	0.000
Mean duration of elongated syllables	-0.217	0.122	0.165	0.131	0.382	0.002
Number of pauses per utterance	-0.381	0.106	0.232	0.149	0.613	0.000
Mean duration of pauses	-0.141	0.139	0.141	0.127	0.282	0.002
Jitter	0.162	0.174	-0.158	0.187	-0.319	0.000
Shimmer	0.220	0.180	-0.216	0.179	-0.437	0.000
H2-H1 (Hz)	-0.105	0.185	0.109	0.209	0.214	0.029
Intensity (dB)	0.123	0.179	-0.119	0.255	-0.242	0.005

morphological, syntactical and lexical in nature, and also through clear prosodic mitigation devices.

4.1. F0 as a cue to politeness behaviour

With respect to the use of pitch, the results reported here for speakers of Catalan show that three of the four pitch parameters analysed (overall pitch, and reference line and top line measures) were significantly lower in the formal condition. This stands in contrast to Ohala's Frequency Code prediction regarding affective meaning and other previous work findings which seemed to corroborate the Frequency Code hypothesis. It therefore contradicts the idea that request speech acts directed to superiors should be associated with high F0. Perhaps the real question is whether biological codes such as the Frequency Code should automatically apply to Catalan formal language at all. First of all, Ohala (1984) predicted a universally applicable theory without taking into account descriptive results coming from a broad array of languages. Clearly, predicting a universal theory based on limited data is extremely speculative. Second, another empirical problem with the Frequency Code is that drawing a connection between physical dominance and a complex social phenomenon like politeness implies quite a conceptual leap. Generalizing biological characteristics to a social phenomenon might be a delicate thing to do.⁵

Furthermore, as pointed out by Winter and Grawunder (2012), most researchers interested in politeness-pitch associations have often failed to properly define what they mean by politeness. The literature on this social phenomenon is by no means straightforward, with several competing theories of politeness existing side by side, and the notion of politeness itself still lacks a stable definition within a widely shared acceptable theoretical framework (see, e.g., Culpeper, 2011). As a result, acoustic realizations of the pragmatic dimensions of speech have been given different interpretations in terms of politeness and methodological differences across compromise a strict comparison of the results across languages. For example, other studies have analysed the acoustic realizations

of other pragmatic dimensions of speech such as "friendly" and equated them with polite interpretations (see Chen et al., 2004). Furthermore, while some studies have used read speech (e.g., Orozco, 2008, 2010), others (like our own) have used semi-spontaneous speech elicited through a discourse completion task (e.g., Winter & Grawunder, 2012) and still others have used completely spontaneous speech (e.g., Hidalgo & Folch, 2011) to analyse the prosodic characteristics of politeness, all of which may well have had an influence on the results and certainly affects their comparability. Thus, our results are most directly comparable to the other studies which have applied as a method the Discourse Completion Task involving the elicitation of formal and informal requests. Our results for Catalan seem to clearly pattern with the findings for Korean in Winter and Grawunder (2012), where speakers also overall displayed a lower mean pitch in the *panmal* (formal speech) condition. Work using a similar methodology to compare typologically different languages like German, Japanese, Korean and Russian (Brown, Winter, Idemaru, & Grawunder, 2015) seemed to yield similar evidence of low F0 corresponding to formal register compared to informal register speech in some of those languages. Likewise, despite the non-homogeneous behaviour of subjects, findings from German spoken in Germany and Austrian German (Grawunder et al., 2014) also showed that F0 seems to be significantly lower in the formal condition in German spoken in Germany, while no significant differences surface between the two conditions in Austrian German. Moreover, evidence from psycholinguistics has shown that high F0 can be a correlate of animated speech. In various studies, emotions such as anger, fear and joy were all characterised by raised F0 and high intensity (Johnstone & Scherer, 2000; Pittam & Scherer, 1993; Scherer, 1986). If that is so, it is easy to argue that high F0 might be inconsistent with politeness-related meanings in the context of formality. When all is said and done, however, the choice of pitch height is most likely culture-dependent and languages may well have different underlying interpretations of what it means to be polite. For example, while in Korean, Catalan and Russian being calm might be valued as a sign of maturity and authority, in Japanese it may be viewed as being submissive (see Kaori, Winter, & Brown, 2016).

⁵ We thank Bodo Winter for these suggestions.

Similar to the Frequency Code prediction that overall high F0 will relate to increased politeness in formal register speech, some work on the interaction between prosody and politeness has highlighted the more frequent presence of H tones in the polite conditions statements and questions, pointing to differences in the choice of intonation pattern rather the overall rise or fall in the tone of voice. Looking at the intonational contours of the direct questions in our own data, we see a higher occurrence of rising pitch contours (L* H%) in the informal condition as compared to more falling contours (H + L* L%) in the formal condition. Generally, in regard to the linguistic functions of F0 for questions and statements the Frequency Code's universalist claims regarding not only sentence type marking (and in particular the patterns of polar questions) but also pitch seem unsupported by the evidence. In some languages, polar questions do not end in a final rise, but rather an accentual rise is produced, often followed by a fall (Grice, D'Imperio, Savino, & Avesani, 2010). A similar contour is also found in Romanian, Hungarian and Greek (Grice, Ladd, & Arvaniti, 2000) and Roermand Dutch (Gussenhoven, 2000).

Furthermore, the notion that there is a general tendency to find lower tones in statements and higher tones in questions does not seem to be clear either. There are several languages which display opposite patterns for yes–no questions, including Danish, Finnish, Western Arabic (Hirst & Di Cristo, 1998), Hawaiian Creole English, a number of Polynesian languages such as Hawaiian and a number of West Atlantic African languages (Rialland, 2007)⁶. Even English, one of the principal languages on which the Frequency Code is based, shows variation across dialects. For instance, in a number of northern British accents (Birmingham, Liverpool, etc.), rising pitch contours are systematically used in statements (Cruttenden, 1986). Furthermore, in different sociolects of American English (Jun, 2005) higher pitch or rising intonation can also be found in statements, in what has been called a high-rising terminal. By the same token, it has been found in Australian English that declaratives are not necessarily accompanied by falling pitch (Fletcher & Loackes, 2010).

To be fair, when Gussenhoven (2002) integrated the Frequency Code into his proposal, he mentioned the possibility that the biological codes need not be interpreted in a strictly categorical fashion, thus elaborating on Ohala's original proposal in which he did not distinguish between the paralinguistic and the structural level. For the paralinguistic meanings, the claim was that they were universally available and recognizable (see e.g., Gussenhoven & Chen, 2000). However, only at a later stage the 'competition between meanings' element was identified and a language specific component regarding the interpretation of the biological codes was proposed by Chen et al. (2004). The mitigation effect found for formal politeness in the present study might be similar to Chen et al.'s (2004) proposal on speech communities' different associations between physiological/anatomical effects and paralinguistic meanings, resulting in pitch having more variegated social meanings than previously thought. Yet, empirical studies on this issue are clearly lacking. In particular, further research is

needed to assess pitch behaviour in both its phonological and phonetic dimensions and their distribution relative to sociopragmatic factors such as politeness. Only if the intonational differences between phonological pitch contour choices are accounted for will we be in a good position to assess differences in the tone of voice used by speakers.

4.2. Non-F0 acoustic parameters: prosodic mitigation as a cue to politeness behaviour

The assessment of other acoustic parameters like duration, intensity and voice quality in our investigation of formal politeness patterns revealed that participants used a set of devices all of which can be argued to correspond to a **prosodic mitigation strategy**. One interesting prosodic phenomena is the occurrence of hesitation markers throughout our corpus. There was a significant increase in pauses, both silent and filled (breath intakes), as well as syllables including hesitations in formal speech. A decrease in speech rate as measured by mean syllable duration per second with politeness suggests that this measure also constitutes a very important and clear marker of hedging. This has certainly also been shown to be the case in Korean (Winter & Grawunder, 2012) and German (Grawunder et al., 2014), where slower speech rate and word rate appear along with these higher rates of filled pauses and hesitation markers in the formal (polite) condition. While in general the requests in the formal condition were significantly longer and the head act of the requests was accompanied by several request strategies such as explanation or preparation for the request, it cannot be ruled out that some of the pauses and hesitations might have been due to the increased difficulty in language planning. However, the increase in pauses and hesitations was more than slight and we thus consider the high amount of disfluencies to be a deliberately chosen strategy, the use of uncertainty and hesitation markers to attenuate a request in a situation of unequal power. Mitigation is by no means only restricted to requests addressed to superiors, but its occurrence seems to increase in settings of formal politeness.

Along with this increase in pauses and hesitations, we observed a decrease in intensity, another feature of politeness shared by Korean and German (at least as spoken in Germany, not Austria). In regard to voice quality, our participants displayed a more stable and clear voice in the formal condition. Our results partly correspond to those reported by Ito (2004), who demonstrated that shimmer seems to be significant in Japanese for judging the relative status of an interlocutor and thereby a possible cue for assessing politeness. Furthermore, tendencies for both jitter and shimmer values to play a significant role in the distinction between formal and informal registers have been found in both Korean (Winter & Grawunder, 2012) and German (Grawunder & Winter, 2014). In these languages a decrease in both jitter and shimmer has been detected in the formal register and this pattern has been shown to indicate higher degrees of politeness.

Interestingly, the prosodic characteristics of mitigation have also been documented to be markers of social anxiety. Galili, Amir, and Gilboa-Schechtman (2013) examined college students' vocal characteristics as a function of social anxiety by asking participants to read a set of neutral, command and

⁶ Gussenhoven (2016, p. 431) defended that "[the] final lax voice to mark interrogativity, as attested in many African languages (Rialland, 2007), indirectly supports the conception behind the Frequency Code by Ohala (1984), which holds that vocal features that express femininity may be used to express interrogativity."

request sentences. In contrast to neutral sentences, reading requests triggered a greater decrease in vocal intensity and overall slower speech rate. So even when reading utterances, participants seemed to clearly deploy expressive acoustic markers to convey social standing, which can be caused by social anxiety.

4.3. Conclusion

To sum up, our results on the one hand show that in Catalan the relation between the use of high pitch and polite register hypothesized by the Frequency Code does not seem to hold. On the other hand, our results add to the growing body of research showing that formal politeness affects many different prosodic parameters, ranging from intensity and pitch to speech rate and voice quality. We suggest that a prosodic mitigation profile characterizes formal speech in Catalan, and manifests itself through a set of more attenuated and softened prosodic correlates such as lower pitch, slower speech rate, lower intensity and a more breathy voice quality. Thus, overall, our results reinforce Winter and Grawunder's (2012) and Grawunder et al.'s (2014) findings, since also in Catalan there seems to be a trend for politeness displayed in formal register speech to be characterized by a subdued prosodic profile which clearly contrasts with that of informal speech. Although further work is needed that compares results across languages, we entertain the hypothesis that there is a cross-cultural tendency to mark deference in formal speech through mitigation.

One possible limitation of the present study is that the data set was produced only by women. It is conceivable that men tend to show somewhat different patterns or degrees of prosodic mitigation. Furthermore, the data was artificially elicited, not spontaneously produced. While it is assumed that participants will apply the same culturally acquired behavioural patterns in an elicited context as they would when speaking naturally, it might well be that the latter would evoke higher arousal levels and thus sharper differences between formal and informal speech. If future research could combine an experimental approach with spontaneous data and then check for overlap in the results, this would yield rich insights indeed. Finally, it should be noted that this study has examined only one speech act. Future research should investigate whether the trends observed in the prosodic signalling reported here is similar across all speech acts in Catalan. Other interesting topics opened up by this paper that merit future research include the relative strength of the different acoustic parameters in the expression of mitigation in formal speech and whether mitigation can also be reflected multimodally, though body and facial cues.

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Appendix A.

1. DCT Catalan version

	FORMAL	INFORMAL
C	Imagina't que vas per el passadís i t'hi trobes la teva cap (que és cap de secció i té uns 50 anys). Com que no et queda clara una cosa del treball, li demanes si podríeu fer una reunió demà a les 2pm a la seva oficina. Saluda-la i explica-li la situació i demana-li si li va bé l'hora	Imagina't que vas per un passadís de la facultat i t'hi trobes la teva amiga, que ahir no va venir a classe. Resulta que el professor us ha convocat a una reunió per a parlar del vostre treball i li heu de dir si us va bé l'hora. És dimecres a les 10.30. Saluda-la i explica-li la situació i demana-li si li va bé l'hora que us ha proposat el professor
1	Estàs sol·licitant una beca, i decideixes demanar-li a la teva professora (una catedràtica d'uns 50 anys) que et coneix bé com a tutora acadèmica que és que t'escrigui una carta de recomanació. Què li diries perquè et fes aquest favor?	El teu ordinador portàtil té algun problema; vas a veure a la teva amiga, que és molt bona amb els ordinadors, i li preguntes si l'hi pot fer un cop d'ull
2	Treballes en una empresa. La setmana passada, la teva cap (que és cap de secció i té uns 50 anys) et va demanar que escrivissis un PPT per a una presentació que tenia dimecres de la setmana vinent. El termini per lliurar-lo és avui a la nit (divendres) et sembla que necessitaràs uns dies més. Com li sol·licitaries al teu cap una extensió del termini?	A causa d'una grip estomacal, vas faltar a la darrera classe d'història de divendres passat, en què estàs matriculat. Així que decideixes demanar prestats els apunts a la teva companya de classe, per posar-te al dia amb la resta de classe. Què li diries, a la teva amiga, perquè et deixés els apunts de la classe que et vas perdre?
3	Vols demanar una feina de professor ajudant a Anglaterra entre el teu grau i el màster, pel que necessites una referència laboral per poder inscriure-t'hi. Què li diries a teva cap de grup (catedràtica d'uns 50 anys) perquè et fes aquest favor?	Estàs estudiant portuguès. Encara no el domines del tot, i tens un text curt que hauries d'entendre bé fos com fos. Demana-li a la teva amiga si te'l pot traduir
4	T'acabes d'assabentar que una de les teves millors amigues es casarà a Suècia d'aquí a tres mesos. Per descomptat que t'agradaria assistir al casament, però	El teu ordinador no funciona per culpa d'un virus, però demà has de lliurar un document important. Decideixes demanar-li a la teva companya d'habitació si

(continued on next page)

Appendix A. (continued)

FORMAL	INFORMAL
com que serà en dijous t'hauries de prendre com a mínim dos dies lliures per viatjar-hi i assistir a la boda i a la festa. Vas a veure a la teva cap (que és cap de secció i té uns 50 anys) i li demanes si pots agafar-te dos o tres dies de lliure disposició	et pot deixar el seu portàtil aquesta nit. Què li diries, a la teva companya, perquè et fes aquest favor?
5 Has de lliurar un treball final en un parell de dies i necessites urgentment un llibre en concret que no pots trobar a la biblioteca perquè algú altre ja el té en préstec de fa temps. Saps que la teva professora (catedràtic aduns 50 anys) en té una còpia en algun lloc, i com que necessites consultar aquest llibre vas a veure'l i li demanes si l'hi pots agafar prestat	Avui teniu una prova sobre una novel·la a les 11. Són les 10 i esteu al bar amb els companys i veus que la teva amiga ha portat la novel·la. Demana-li a la teva amiga si te la deixa fullejar una estona per a repassar

2. DCT English version

FORMAL	INFORMAL
C Imagine that you are walking down the corridor at your office and run into your 50-year-old boss. You'd like some clarification from her about something you are working on and would therefore like to set up a meeting with her tomorrow at 2PM in her office. Greet her, explain the situation, and find out if she'd be available at that time	Imagine you walk down the corridor at university and run into a classmate with whom you are working on a class project. This classmate wasn't in class yesterday when the professor told you that she wanted to meet with the two of you to talk about your work and asked whether you would be available on Wednesday at 10.30. Greet your classmate, tell her about the situation and ask her if the hour proposed by the professor suits her
1 You are applying for a scholarship and decide to ask your professor, who has gotten to know you well as your academic advisor, to write a recommendation letter for you. What would you say to get your professor to do this favour for you?	Your laptop has a problem. You go and see a friend who is really good with computers and ask her if she could take a look at your laptop
2 You work for a company. Last week your boss asked you to put together a PPT for a presentation that she has to give on Wednesday next week. The deadline is tonight (Friday) and you fear that you	Because of the stomach flu, you were absent from last Friday's history class that you are enrolled in. So you decide to borrow notes taken by a classmate, who is a close friend, to catch up with the

Appendix A. (continued)

FORMAL	INFORMAL
won't manage to finish it by tonight. How do you ask your boss for an extension of the deadline?	rest of the class. What do you say to get this friend to lend you her notes?
3 You are applying for a teaching assistant job in England between doing your Bachelor's and Master's degrees, and you need a letter of reference from your tutor, a 50-year-old full professor. What do you say to him/her?	You are studying Portuguese. Your mastery of it is still quite limited and you have a short text in Portuguese which is important for you to understand. Ask your friend whether she could translate it for you
4 You've just heard that one of your best friends is going to get married in Sweden in three months' time. Of course you would like to attend the wedding but since it takes place on a Thursday you would need to take at least two days off work to fly there and attend the wedding ceremony and party. You go to see your boss at work and ask whether it would be possible for you to take those two or three days off work	Your computer is out of order because it has been infected by a virus, but you have an important paper due tomorrow. You decide to ask your room mate whether you can borrow her computer tonight. What do you say to get your roommate to do this favour for you?
5 You have to hand in a term paper in a couple of days and you urgently need a particular book which you can't find in the library because someone else has already borrowed it some time ago. You know that your 50-year-old professor has a copy somewhere and since you would really like to consult this book you go and ask her whether you can borrow the book	Today you have a test about a novel at 11 am. It is 10 am and you are at a bar with friends and you see that your friend has brought along the novel. Ask your friend if you could browse through the book briefly to review before the exam

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