

# Question intonation contours as dynamic epistemic operators

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**Abstract** Although intonation has been traditionally claimed to be a strong indicator of the epistemic commitments of the participants in a discourse, very few empirical investigations have addressed specific semantic hypotheses related to the precise epistemic contribution of question intonation to utterance interpretation. The main aim of this paper is to test the claim that intonation in Catalan plays an important role in the specification of dynamic epistemic commitments in two complementary directions, i.e., speaker commitments to the speaker’s own proposition and speaker agreement with the addressee’s proposition. Following Krifka’s commitment space semantics (Krifka 2015, 2017), we will test the claim that question intonation in Catalan encodes different levels of ASSERT (commitment) and REJECT ((dis)agreement) epistemic operators. A total of 119 Central Catalan listeners participated in an acceptability judgment task and were asked to rate the perceived degree of acceptability between a set of interrogative utterances (variously produced with one of four intonational contours) and their previous discourse context (which was controlled for epistemic bias). Results showed that question intonation contours encode binary (and not degree) distinctions in speaker commitment and speaker agreement. That is, results showed that question intonation encodes fine-grained information about the epistemic stance of the speaker, not only in relation to the speaker’s own propositions but also in relation to the addressee’s propositions. From a crosslinguistic point

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of view, we argue that intonation closely parallels the function of modal markers in their encoding of speaker commitment and speaker agreement operators.

**Keywords** Intonation · Yes-no questions · Epistemic operators · Speaker commitment · Speaker agreement · Epistemicity

## 1 Introduction

Traditionally, prosodic studies have focused on intonational form, and the study of intonational meaning has been relatively neglected. Similarly, the fields of semantics and pragmatics have paid less attention to the pragmatic uses of intonation than to the pragmatic uses of lexical strategies. As a result, there is no firm agreement within the linguistic community on how to integrate the analysis of intonational meaning across languages into a unified prosodic, semantic, and pragmatic approach. This investigation addresses the debate in the literature about the phonology-semantics interface and presents an empirical investigation which has the goal of testing a specific semantic hypothesis related to the contribution of question intonation to utterance interpretation. More specifically, we will test the hypothesis that question intonation patterns can act as a system of *epistemic operators* encoding fine-grained distinctions related to a speaker's own *commitment* to the proposition expressed and to a speaker's *agreement* or disagreement with the addressee's propositions. This work thus represents a further step toward a fuller integration of prosody, semantics, and pragmatics.

### 1.1 Epistemic commitment

In this paper, *speaker epistemic commitment* will be regarded as equivalent to speaker epistemic stance, which includes interrelated but separate notions of epistemicity (or speaker certainty or belief about the proposition expressed) and evidentiality (or the source or evidence that the speaker has to back up the proposition expressed). The positional views on the relationship between evidentiality and epistemicity range from a total inclusion—where evidentiality is subsumed under epistemic modality—to a disjunction relation—where a clear distinction between the two is made. An in-between approach is that of overlap, where the two categories interrelate but do not conflate and are treated separately (see González et al. 2017 for a more extensive explanation of the different positions). In agreement with the last of these positional views, we understand the two notions as being independent (e.g., a speaker might have a strong belief in a proposition independently of the evidence s/he has for it), but also interrelated (e.g., typically, strong independent evidence in favor of a proposition leads to a speaker's strong belief in it). Many authors have provided thorough discussions of the points of encounter between epistemicity and evidentiality through the notions of epistemic stance, epistemological positioning, and legitimization strategies in discourse (see Cornillie 2009 for a review). Thus in this paper epistemic commitment will be understood as stancetaking, or epistemic stance, a term which has been widely dealt with in studies on critical discourse analysis, where knowledge is dynamically

co-constructed and speakers make use of interrelated epistemic and evidential forms to communicate their assertions and opinions.

Human languages can use a variety of linguistic strategies, including prosody, for the expression of the speakers' epistemic stance towards a proposition (e.g., Palmer 2001). Even though traditional studies on epistemicity and evidentiality have focused predominantly on how languages use morphosyntactic and discourse features to communicate epistemic stance, in the last decades work within the prosodic and semantic fields has regarded tunes as an important indicator of the epistemic commitment of various discourse participants (e.g., Pierrehumbert and Hirschberg 1990; Bartels 1999; Steedman 2007; Gunlogson 2001; Beyssade and Marandin 2006a, 2006b; Portes et al. 2014; Krifka 2015, 2017; see Prieto 2015 for a review). Despite this, little experimental work has been done on the specific epistemic contribution of intonation to sentence interpretation.

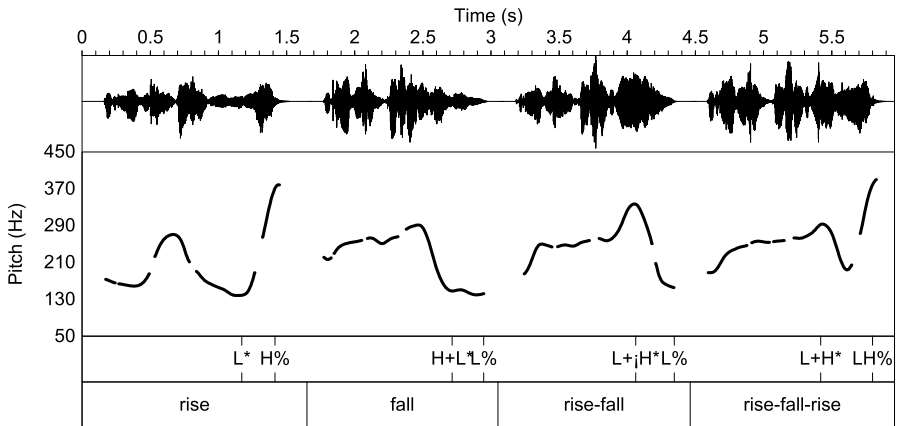
## 1.2 Intonational tunes and polar questions

In the domain of *question marking*, linguists agree that intonation is profusely used as a grammatical encoder of questionhood crosslinguistically (see, e.g., Gussenhoven 2004; Ladd 2008; see also Borràs-Comes et al. 2014 for a recent comparative analysis of Catalan and Dutch). Prosodic studies have documented that polar questions, for example, can be produced with a myriad of pitch contours within and across languages. Catalan speakers can use up to four different intonation contours for the expression of polar questions, including contours ending in a final low-rise ( $L^* H\%$ ), a high fall ( $H+L^* L\%$ ), a rise-fall ( $L+;H^* L\%$ ), and a rise-fall-rise ( $L+H^* LH\%$ ) (see Fig. 1; for a detailed analysis of the intonational phonology of Catalan, see Prieto et al. 2015). In this paper, the term “question intonation contour” will refer to pure prosodic forms which contribute specific semantic meanings associated with discourse questions.

We are aware that, depending on the language, intonational tunes interact in various ways with morphosyntactic structures. For example, Gunlogson's examples in (1) below show how the syntactic word order and intonation contour choice in English contribute together to the utterance interpretation (e.g., SV inversion in information-seeking yes-no questions *Are you a member of the CP?* or declarative word order in declarative/disbelief questions such as *You're a member of the CP?*). In Catalan we also find certain restrictions on the co-occurrence of intonation with question particles and word order. For example, in certain dialects an optional *que* particle can appear at the beginning of yes-no questions. Also, SV inversion is common in non-disbelief questions, while declarative syntax is used in disbelief questions (for more information, see Prieto and Rigau 2007).<sup>1</sup>

Aside from the interaction between intonation and syntactic patterns, many languages have also been shown to use a variety of polar question intonation contours (see Gunlogson 2001 for American English and Escandell-Vidal 1998; Hualde and Prieto 2015 for Spanish, among others). However, these question tunes

<sup>1</sup>As we will see below, in order to control for potential confounding effects of morphosyntactic marking, none of the sentences included in our experiment involved the use of *que* particles or the use of explicit subjects (e.g., *Tens gana?* ‘Are (you) hungry?’; see Sect. 2.2 below).



**Fig. 1** F0 contours and waveforms for the four main intonation contours found in Central Catalan yes-no questions, applied to the same sentence *Parlaves amb ta germana?*, ‘Were you talking to your sister?’. From left to right: final rise (L\* H%), final fall (H+L\*L%), rise-fall (L+<sub>i</sub>H\*L%), and rise-fall-rise (L+H\* LH%)

have been vaguely described as information-seeking, confirmation-seeking, and echo or incredulity questions, and to our knowledge there are no empirical investigations on the detailed characterization of these tunes from a semantic and pragmatic point of view. In general, not many studies have empirically addressed the issue of the types of pragmatic meanings encoded by intonation in questions from an integrated semantic, pragmatic, and prosodic perspective (see references below).

### 1.3 Commitment and agreement in polar questions

Researchers have shown that intonational tunes in polar questions can encode a variety of pragmatic meanings (also called pragmatic biases) across languages. One of the well-researched expressions of epistemic disposition in both statements and questions is *speaker epistemic stance*, or the expression of the *degree of commitment* of the speaker towards the proposition expressed. From a conversational analysis point of view, Heritage (2012) has related different gradients of speaker certainty (in his words, gradients of epistemic stance) to a difference between declaratives (e.g., *You’re married*, where the speaker commits himself to his proposition), tag questions (e.g., *You’re married, aren’t you?*, where the speaker expresses a mid-level commitment), and questions (e.g., *Are you married?*, where the speaker expresses a low-level commitment; see also Escandell-Vidal 1998). Intonation has been shown to encode a distinction between pure information-seeking questions (i.e., questions where the speaker shows no particular commitment to his/her proposition) and confirmation-seeking questions (e.g., questions with a higher level of commitment to the proposition; see Escandell-Vidal 1998; Armstrong 2017, and Armstrong and Prieto 2015 for Spanish; Gravano et al. 2008 for English; Savino and Grice 2011 for Italian; Vanrell et al. 2013 and Roseano et al. 2016 for Catalan, among others). Recently, Vanrell et al. (2017) have shown that a specific type of polar question intonation in Majorcan Catalan signals the speaker’s sensory access to direct evidential information, which

in turn encodes a high degree of speaker commitment (or speaker certainty) about the proposition expressed.

Probably the best-studied case of *biased questions* is the so-called *declarative question* (e.g., *France is a monarchy?* vs. *Is France a monarchy?*). Gunlogson (2001) was one of the first authors to analyze the semantics of declarative questions in American English within a dynamic model of discourse and dialogue. She concluded that declarative questions ending in a rising pitch movement (a) convey a clear semantic bias and (b) are subject to contextual restrictions that do not apply to their interrogative counterparts. The example in (1b) shows that declarative questions, as opposed to neutral questions (1a), are not appropriate in situations where the questioner is assumed to be impartial, as in a courtroom or committee hearing. In our view, declarative questions can be interpreted as an expression of the epistemic difference (or *disagreement*) between speaker and addressee in terms of commitment to the proposition expressed (or belief/disbelief based on contextual evidence that has just become available to them). Similarly, assertions like (1c) are not felicitous in this context, since they show an inappropriate commitment of the speaker to the truth of the proposition.

- (1) [at a committee hearing]
- a. Are you a member of the Communist party? H%
  - b. #You're a member of the Communist party? H%
  - c. #You're a member of the Communist party. L%

From Gunlogson (2001: 2)

Speaker disbelief or incredulity, or speaker contradiction and disagreement with the addressee, has been experimentally shown to be signaled by intonation contours (alongside or independently of syntactic information) in a variety of languages, both in statements (Espinal and Prieto 2011 and Tubau et al. 2015 for Catalan; Portes et al. 2014 and Portes and Reyle 2014 for French; Sichel-Bazin 2015 for Occitan and French) and in questions (Crespo-Sendra et al. 2014; Armstrong and Prieto 2015 for Spanish).

#### 1.4 Integration into dynamic models of meaning

In this paper, we would like to highlight the need to take into account an interactive dimension of meaning in intonation, a double dimension that reflects not only the speaker's own commitment to the proposition expressed but also the speaker's agreement or disagreement with the addressee's proposition, from a dynamic perspective. Proposals for *dynamic models of meaning* stem from Stalnaker's proposal from the 1970s that sentences should be regarded not as isolated propositions but rather as interactional and dynamic updates and contributors to discourse context (see Stalnaker 1978). This perspective has generated a variety of models, such as Discourse Representation Theory, a theory of the interlocutor's ongoing discourse record, which is changed and updated with each new utterance (see McNally 2013 for a review). In this context, theories of speech act dynamics have proposed that speech acts create commitments by the interlocutors and may also introduce changes in commitments that can be analyzed as transitions between commitment spaces in a conversational game (Hamblin 1971, who was the first to analyze speech acts in terms of

commitments; Asher and Reese 2007; Beyssade and Marandin 2006a, 2006b; Krifka 2015, 2017; Malamud and Stephenson 2014). Some of these models have analyzed several dynamic dimensions in the interpretation of biased questions and assessed the conditions that restrict their appearance in discourse. For example, Asher and Reese (2007) analyzed confirmation questions as complex speech acts involving both an assertion and a question. Similarly, Beyssade and Marandin (2006b) dealt with biased confirmation questions and imperative questions. The latter have been interpreted as complex speech acts in which the speaker commits to a proposition and simultaneously calls on the addressee to commit to the same proposition, giving the question a volitional aspect. However, to our knowledge no previous investigation has dealt with the potential distinction in the commitment space (not the volitional space) between a speaker's commitment to their own propositions and their commitment to the propositions of others. In this paper, we will experimentally test whether these two complementary epistemic dimensions of meaning in questions (i.e., *speaker commitment* and *speaker agreement*) behave as independent dimensions when speakers interpret intonational tunes in conversation. This paper thus touches upon several ways in which intonational tunes affect discourse function and investigates fine-grained semantic distinctions in the commitment spaces, specifically in the domain of biased epistemic questions.

We will articulate our proposal involving these two epistemic dimensions in questions, e.g., speaker commitment and speaker agreement, within the model of commitment semantics put forth by Krifka (2015, 2017). As mentioned, in this model the basic function of a speech act is to change a commitment state, typically by adding new commitments. For example, for the interpretation of an assertion  $\varphi$ , the model posits the following two steps: (a) a syntactic operator ASSERT expresses the commitment to the proposition, and then (b) a second commitment (i.e., add  $\varphi$  to the common ground) is expressed by means of the intonation H\*.<sup>2</sup> In order to semantically interpret reactions to assertions, Krifka proposes the operators ACCEPT and REJECT, which encode either an agreement or a disagreement with the proposed commitment change (see Krifka 2017 for more details on the abovementioned operators). In Krifka's model, ASSERT has several functions, namely (a) to express a commitment of the interlocutor to the proposition, (b) at the same time to call on the addressee to be committed to that proposition, with the result that the proposition becomes part of the common ground. When dealing with the specific reactions to an assertion, Krifka (2017: Sect. 5) states that the addressee can decide to either "accept" or "reject" the interlocutor's proposition. At this point he proposes the ACCEPT and REJECT speech act operations, which encode the two possible reactions by the addressee. While ACCEPT is defined as an operation that expresses that the addressee takes on the obligation proposed by the speaker (e.g., agrees with the proposed commitment change), REJECT is defined as an operation that expresses that

<sup>2</sup>This is represented as follows: [<sub>FORCE</sub>P ASSERT [<sub>TP</sub>  $\varphi$ ] H\*] (see Krifka 2017:11). It is important to point out that semantic operators can be expressed through different grammatical means in different languages. For example, the FOCUS operator can be expressed crosslinguistically (a) by means of intonation, (b) via syntactic movement optionally combined with prosodic mechanisms to ensure prominence, or (c) by using specific morphemes also optionally combined with syntactic displacement, prosodic marking, or a combination of both (Elordieta 2007).

the addressee does not accept the commitment change proposed by the speaker (see Krifka 2017: 5). Moreover, in this paper Krifka tries to provide a detailed account of how these speech act operators can be combined with questions. In the present paper, we test the hypothesis that certain intonation patterns can be seen as encoders of different degrees of the REJECT and ASSERT epistemic operators in questions. Crucially, the operator ASSERT would directly contribute degrees of speaker commitment to the proposition and REJECT would be responsible for contributing degrees of speaker agreement. And depending on the language, REJECT and ASSERT operations can be encoded exclusively through intonation (or through intonation together with other morphosyntactic and discourse marking devices).

In the case of biased questions, the main goal of this paper is to experimentally test the claim that different levels of the *epistemic* ASSERT and REJECT speech act operators can be used. First, along the lines of Asher and Reese (2007), we will postulate that the two steps that are involved in the production (and interpretation) of a confirmation question can be implemented as the combination of two speech acts. First, by means of the interrogative clause syntax (the syntactic operator REQUEST)<sup>3</sup> the speaker will express the interrogative speech act. A second commitment will be due to prosody, and in particular a specific nuclear configuration will carry out the operator ASSERT. A stronger interpretation of the ASSERT operator could be added to a question to convert it into an evidential question conveying a high degree of certainty (see Sect. 2.2.2 below). Second, a REJECT speech act is one by which a speaker opposes the commitment suggested by the interlocutor, and forces a change of commitment. A REJECT operator can be added to an assertion to express contradiction or to a polar question to express incredulity. We will test the hypothesis that certain intonation contours encode a milder interpretation of the REJECT operator to express surprise about a proposed commitment change (see Sect. 2.2.2 below). Previous work dealing with rejecting answers to negative questions in Catalan and other languages exemplifies the use of the REJECT operator in statements (see Tubau et al. 2015; González-Fuente et al. 2015; Li et al. 2016). Tubau et al. (2015) empirically showed that the answer *sí* ‘yes’ produced with neutral declarative intonation L+H\* L% (as in (2b)) to questions with low negation in Catalan does not sound felicitous. By contrast, the answer *sí* ‘yes’ produced with the so-called contradiction contour is totally appropriate (see (2a)).

- (2) S1 to S2: No prens cafè? ‘Don’t you drink coffee?’  
 a. S2 to S1: Sí! L+H\* L!H% ‘Yes (I drink coffee).’  
 b. S2 to S1: #Sí. L+H\* L% ‘Yes.’ From Tubau et al. (2015)

The need for the specific intonational contour to be present in (2a) is due to the fact that rejecting answers to negative questions need to be composed of an ASSERT( $\varphi$ ) operator (encoded through the positive word *yes*, where  $\varphi$  is the propositional discourse referent) plus a REJECT operator (encoded with the L+H\* L!H% intonation pattern in Catalan). In (3b) and (3b’) we present the speech act dynamic analysis (separated into the syntactic analysis and the interpretation analysis) of the rejecting

<sup>3</sup>Remember that Catalan, similarly to English, also uses SV inversion in non-disbelief questions and declarative syntax in disbelief questions (see Prieto and Rigau 2007 for more information).

answer in (2a). By answering *sí* the speaker is asserting a specific proposition, which in order not to be in contradiction with the lexical contents of the particle must be a positive proposition which corresponds to the TP of the discourse polar question (or  $\phi$ ). By means of the marked intonation pattern L+H\* L!H% the speaker S2 is expressing REJECT against the negative assumption of the negative question.

- (3b) S2 to S1: Sí! <sub>L+H\* L!H%</sub>  
 [FORCEP REJECT: L+H\* L!H% [FORCEP ASSERT sí [TP ~~prens café~~]]  
 ‘Yes (I drink coffee).’

The semantic analysis of (3b) is represented in (3b’). The response is asserting a commitment to the truth of the proposition corresponding to the TP of the discourse polar question, that is,  $\phi$ , and at the same time rejecting it. The next interpretation move is that S2 expects that S1 will incorporate  $\phi$  to the common ground.

- (3b’) (... , C) REJECT <sub>S1,S2</sub> + ASSERT [S2:  $\phi$ ] + [ $\phi \in CG$ ]

Crucially, the lack of a REJECT operation (expressed with the unmarked L+H\* L% intonation pattern, see (2b)) would render the response in (3b) inappropriate. It is interesting to note that the German modal particle *doch* and French *si* (which serve to deny a denial) are used to lexically express both REJECT and ASSERT operations. For a more detailed analysis of the function of the REJECT operator in this data, see Tubau et al. (2015), González-Fuente et al. (2015), and Li et al. (2016); see also Krifka (2013) and Krifka (2017:18) for a treatment of the German particle *doch* in terms of REJECT plus ASSERT( $\phi$ ) operations.

To our knowledge, Portes et al. (2014) is the only experimental study addressing the contribution of intonation to sentence interpretation from a dynamic semantics perspective. They showed that intonational contours in French encode information about speaker commitment and attitude attribution to the addressee. In a forced-choice interpretation task, participants had to choose among four possible reactions (‘I get it,’ ‘I’ve no idea,’ ‘I guess you’re right,’ ‘No, really, it’s true’) after hearing sentences spoken with one of four contour types, namely a fall L\* L%, a rise H\* H%, a rise-fall H\* L%, and a rise-fall-rise H+!H\* H%. The results showed that L\* L% was consistently associated with ‘I get it,’ both H\* H% and H\* L% with ‘I’ve no idea,’ and H+!H\* H% with ‘No, really, it’s true.’ They claim that intonation contours encode both information about the commitment of the speaker to the proposition expressed (‘I have no idea,’ ‘I get it’) and also dialogical meaning that attributes attitudes to the interlocutor (‘No, really, it’s true,’ ‘I guess you’re right’). In this paper, we investigate a set of tunes in Catalan that encode different types of dialogical meanings such as disagreement with the interlocutor (e.g., a REJECT operation). Our main goal is to test the hypothesis that question intonation contours in Catalan encode fine-grained information about dynamic epistemic commitments in polar questions, in two complementary directions, namely (a) *different levels of speaker commitment* to the speaker’s own propositions (i.e., different levels of the operator ASSERT), and (b) *different levels of speaker agreement* with the addressee’s propositions (i.e., different levels of the operator REJECT). We hypothesize that these two independent epistemic operations (speaker commitment and speaker agreement)



will significantly affect the selection of question intonation contours by Catalan listeners.

## 2 Methodology

We designed an acceptability judgment task to assess whether different question intonation contours in Catalan encode fine-grained distinctions in degree of speaker commitment and agreement. Participants were asked to rate the degree of acceptability between a sentence produced with a given pitch contour and its preceding discourse context. As in Portes et al. (2014), acceptability judgment tasks have been shown to be especially useful to tap into the characterization of the pragmatic meaning of intonation, because measures of acceptability can be obtained between different types of intonation contours and pragmatically controlled discourse contexts.

### 2.1 Participants

A total of 119 native Catalan speakers completed the task (32 males and 87 females; mean age 38.18, SD 11.19). Participants reported a mean daily usage of Catalan of 85.07% (SD 25.89%).

### 2.2 Materials

#### 2.2.1 Target sentences

A total of 12 target sentences were used in the experiment. They contained only predicates in focus position (e.g., *Tens gana?* ‘Are you hungry?’, *Teniu mandarines?* ‘Do you have tangerines’), with no post-focal material or explicit subjects. These 12 sentences were each recorded four times as spoken by the first author of this study, an expert in the intonation of Central Catalan and native speaker of this variety, under the guidance of the second author. Each of the four instances exemplified one of the four most common types of nuclear configuration found for Central Catalan yes-no questions (a final rise  $L^* H\%$ , a final fall  $H+L^* L\%$ , a rise-fall  $L+\downarrow H^* L\%$ , and a rise-fall-rise  $L+H^* LH\%$ ; see Fig. 1 above). This yielded a total of 48 sentence tokens (12 sentences  $\times$  4 intonation contours).

#### 2.2.2 Pragmatic conditions

A total of 12 discourse context – utterance pairs were designed conveying clear epistemic biases (see Table 2 below for a set of examples). Six of these contexts encoded three different levels of strength of *speaker commitment*, or degree of epistemic disposition about the propositional content of the proposition in the question (low, mid, and high). The other six discourse contexts encoded three levels of strength of *speaker agreement*, or the speaker’s acceptance of the addressee’s proposition (low, mid, and high). Within Krifka’s commitment space semantics, different levels of speaker commitment will correspond to different levels of the ASSERT operator, and similarly

**Table 1** Pragmatic conditions analyzed in the study

Relationship	Degree	Schematic situation
Commitment	Low C.	I have no information
	Mid C.	I think X
	High C.	I just see X (direct evidential)
Agreement	High A.	I have no information; my interlocutor says Y
	Mid A.	I think X; my interlocutor says Y; I am surprised
	Low A.	I think X; my interlocutor says Y; I don't believe it

different levels of (dis)agreement will correspond to different levels of the REJECT operator. Table 1 summarizes the six different types of pragmatic contexts used in the experiment; the first column indicates the type of relationship established between the speaker and the propositional content of the sentence, the second column indicates the degree of this relationship (low, mid, or high), and the third column presents a schematic situation explaining each subtype of relationship.

In essence, the three levels of speaker commitment to the expressed proposition roughly correspond to information questions (low commitment), confirmation questions (mid commitment), and evidential questions (high commitment). As mentioned in Sect. 1, what we call polar evidential questions (e.g., those based on visual evidence) constitute a high-commitment type of confirmation-seeking question. In fact, the distinction made here between epistemic knowledge (*I think*) vs. evidential knowledge (*I see*) is ultimately related to the concepts of direct and indirect evidence as discussed by Plungian (2001). Whereas direct evidence is related to knowledge obtained in person through the senses, indirect evidence is related to that obtained by means of hearsay and inference. Moreover, a recent study on Majorcan Catalan (Vanrell et al. 2017) suggests that this distinction is especially relevant in the field of polar questions since such questions are recurrently produced by means of different intonation patterns and syntactic structures in this variety. It is thus expected that these three commitment states will be triggered by the discourse contexts we created. The example for the low commitment context (see Table 2 below, Low C) crucially relies on the information that the speaker moved ‘very recently’ into a new neighborhood and thus has no way of knowing whether the street parade will go by his or her house. Thus raters expect that the question *Passaran per sota de casa?* ‘Will they go by our house?’ will express no knowledge about the truth of the propositional content of the question. In the mid commitment context (Table 2, Mid C), the context is clearly indicating that the speaker has previous knowledge that tangerines have been available at the grocery during the month of November, so s/he assumes that they will probably have some available. Thus raters in this context will expect that the question *Teniu mandarines?* ‘Do you have tangerines?’ will be biased towards a confirmation question. Finally, in the high commitment context (Table 2, High C), the speaker has received the direct sensory evidence of a stomach’s growl from his/her office partner, which is directly related to hunger given that it is lunch time. Thus the question *Tens gana?* ‘Are you hungry?’ contextually needs to be interpreted with a high degree of commitment.

On the other hand, the three agreement levels correspond to so-called disbelief/incapability questions (low agreement), surprise questions (mid agreement), and understanding echo questions (high agreement). The term *understanding echo question* here refers to a type of reiterative question that in no way challenges the propositional content of the interlocutor's sentence but rather is used to seek clarification of something that the speaker simply did not hear or understand properly (see Noh 1995 for a classification of echo questions). The difference between disbelief/incapability questions (low agreement) and surprise questions (mid agreement) lies in the degree of speaker acceptance (or agreement) either of the propositional content of a sentence uttered by another discourse participant or of extralinguistic information that has been activated in the context (e.g., the fact that someone that was expected at a meeting is not coming). While in surprise questions the speaker accepts the proposition/extralinguistic information regardless of the fact that s/he is surprised about it, in disbelief questions the speaker asserts a clear opposition and non-acceptance of this information. In our materials, the low agreement context (see Table 2, Low A) encoded the fact that the speaker's direct evidence about the good weather clashes with the interlocutor's statement that they were caught in the rain. Thus raters in this case expected that the interrogative sentence *Se us ha posat a ploure?* 'You got caught in the rain?' should encode disbelief. In the mid agreement context (Table 2, Mid A), the speaker had been told that his friends would not come to the party, but his interlocutor tells him the contrary, that everyone is going to go the party. Crucially, since the speaker's knowledge is only based on hearsay information (i.e., indirect evidence), the speaker utters a sentence in which s/he exposes the mismatch between his/her presuppositions and the interlocutor's information (i.e., expresses surprise), but which in way challenges the possible truth of his/her interlocutor's intervention. Therefore, the speaker's reaction *Serem tots els de la colla?* 'We'll all be there?' is interpreted with a medium degree of agreement with the interlocutor's proposition. The high agreement context (Table 2, High A) merely makes clear that the speaker is uttering an echo question just to double-check whether the message s/he just heard is true, with no other nuance. Thus the interrogative sentence *Parlaves amb ta germana?* 'You were talking with your sister?' is understood in this context as an understanding echo question.

### 2.3 Experimental procedure

The experiment was set up through the online survey platform SurveyGizmo.<sup>4</sup> The 12 trials were randomly presented to the subjects in 12 separate slides. In all slides, the discourse context was presented both textually and in audio form. By clicking on buttons at the bottom of the discourse text, subjects could play the audio file corresponding to the target utterance spoken with one of the four intonation patterns (see Fig. 1). After listening to each prompt, participants were asked to rate its contextual appropriateness by clicking at some point on a horizontal bar representing a 0–100 scale (0 = totally inappropriate; 100 = totally appropriate). A total of 5,712 responses were obtained (119 participants × 12 contexts × 4 intonational contours).

<sup>4</sup>Website available at <https://www.surveygizmo.com>. Accessed 7 September 2017.

**Table 2** Example context-utterance pairs for the six pragmatic conditions analyzed in the study. The target interrogative sentences in Catalan appear in italics, followed by their English translations. Care was taken that all sentences had a comparable syntactic structure consisting of a verbal phrase followed by a noun phrase or a prepositional phrase. Avoiding explicit use of the subject in all sentences controls for potential effects of SV inversion in our materials. Notice that while the target interrogative sentences in the Commitment contexts appear immediately after the discourse context (S1, S2), the target interrogative sentences in the Agreement contexts represent a reaction to a move by another participant (S2, S1). The Catalan version for each discourse context is provided in the Appendix

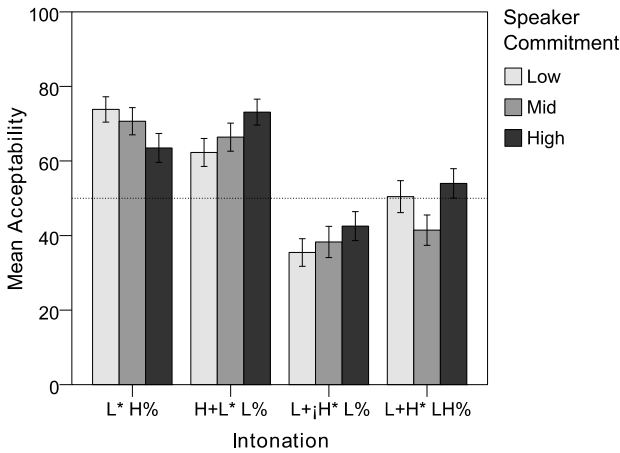
Type	Example context followed by target sentence
LC	Not long ago you moved to a new neighborhood. This week it is celebrating its annual fiesta. Tonight your neighbor tells you there is going to be a traditional street parade with dragons and fireworks, but you don't know what route it will take. — <i>Passaran per sota de casa?</i> 'Will they go by our house?'
MC	It's November, and tangerines have been available for a few weeks now. When you go out shopping, you stop by your local greengrocer's, assuming they'll have some. — <i>Teniu mandarines?</i> 'Do you have tangerines?'
HC	It's almost two in the afternoon and you and Sonia are together working at the office, as always. You're concentrating on your work, when all of a sudden you hear her stomach growl. — <i>Tens gana?</i> 'Are you hungry?'
HA	You've tried calling a friend a couple of times but without success. A second later he calls you, but you can't hear him very well and you don't know if you heard what he said clearly. —Sorry. I was talking with my sister. — <i>Parlaves amb ta germana?</i> 'You were talking with your sister?'
MA	It's fiesta time in the city and tonight they are going to do the traditional street parade with dragons and fireworks. You are planning to go see it with some friends. You already spoke to your friends Joan and Pau, but they told you that they were out of town and wouldn't be there tonight. Now you see Pere, another member of the group, and he tells you that in the end everyone will be able to come. —We'll all be there. — <i>Serem tots els de la colla?</i> 'We'll all be there?'
LA	Your roommate is a photographer. It's a gorgeous, sunny day out today, and she has gone to Salou to cover a wedding. When she gets back, she tells you that it started raining while she was there. You can't believe it because it has been such a gorgeous day. —So we got caught in the rain. — <i>Se us ha posat a ploure?</i> 'You got caught in the rain?'

### 3 Results

#### 3.1 Speaker commitment

Figure 2 summarizes the results of the acceptability judgment task with regard to Speaker Commitment. While the rising contour (L\* H%) is preferred for the expression of low speaker commitment (low > mid > high), the falling contour (H+L\* L%) is preferred for high speaker commitment (high > mid > low). The other contours (L+<sub>i</sub>H\* L%, L+H\* LH%) receive low acceptability rates overall.

A Generalized Linear Mixed Model (GLMM) was performed in SPSS v22 with Acceptability (0–100) as the dependent variable. Speaker Commitment, Intonation,



**Fig. 2** Mean acceptability rates (error bars: 95% CI) of the different intonation contours (*x-axis*) when judged in each of the three levels of speaker commitment (*different color bars*)

and their interaction were set as fixed factors. Subject and Item were set as random factors. A main effect of Intonation was found to be significant,  $F(3, 2206) = 151.212, p < .001$ , and so was the interaction Speaker Commitment  $\times$  Intonation,  $F(6, 2206) = 10.807, p < .001$ .

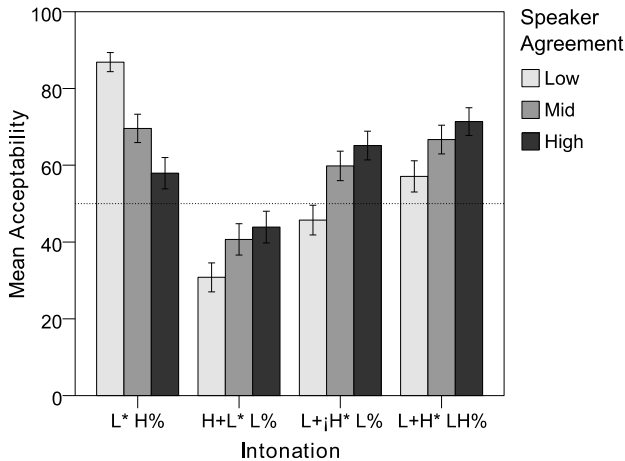
The main effect of Intonation can be interpreted as a general preference for using both L\* H% and H+L\* L% over L+H\* LH% and L+;H\* L%. The interaction Speaker Commitment  $\times$  Intonation can be read in the following way. Low commitment contexts showed a contour preference scale such that L\* H% > H+L\* L% > L+H\* LH% > L+;H\* L%. In mid commitment contexts, both L\* H% and H+L\* L% were preferred over the other two contours. Finally, in high commitment contexts, H+L\* L% was preferred over both L\* H% and L+H\* LH% ( $p = .458$  between them), and all three were also preferred over L+;H\* L%.

### 3.2 Speaker agreement

Figure 3 summarizes the results of the acceptability judgment task with regard to the independent variable Speaker Agreement. While the rising contour (L\* H%) is preferred for low speaker agreement (low > mid > high), the circumflex pitch contours (L+;H\* L%, L+H\* LH%) are preferred for higher levels of speaker agreement (high > mid > low). The falling contour (H+L\* L%) receives the lowest acceptance rates overall.

A second GLMM was performed with the same dependent variable and random factors described in the preceding section. Speaker Agreement, Intonation, and their interaction were now set as fixed factors. A main effect of Intonation was found to be significant,  $F(3, 2201) = 143.714, p < .001$ , and so was the interaction Speaker Agreement  $\times$  Intonation,  $F(6, 2201) = 41.941, p < .001$ .

The main effect of Intonation can be interpreted as an overall scale of contour preference, as follows: L\* H% > L+H\* LH% > L+;H\* L% > H+L\* L% ( $p = .023$



**Fig. 3** Mean acceptability rates (error bars: 95% CI) of the different intonation contours (*x-axis*) when judged in each of the three levels of speaker agreement (*different color bars*)

between L\* H% and L+H\* LH%;  $p < .001$  for all other comparisons). The interaction Speaker Agreement  $\times$  Intonation can be read in the following way. Low agreement contexts showed a contour preference scale such that L\* H% > L+H\* LH% > L+;H\* L% > H+L\* L%, indicating that rising questions position the speaker as skeptical of or in disagreement with the addressee's proposition. In mid agreement contexts, both L+H\* LH% and L\* H% were preferred over L+;H\* L%, and all three were also preferred over H+L\* L%. Finally, high agreement contexts showed a contour preference scale such that L+H\* LH% > L+;H\* L% > L\* H% > H+L\* L%, indicating that the two circumflex contours (L+H\* LH% and L+;H\* L%) signal speaker agreement with an addressee's proposition.

#### 4 Discussion and conclusions

The broader purpose of the present study was to characterize in greater detail the contribution of intonational tunes to utterance interpretation. Because Catalan is a language that can use at least four types of intonational tunes serving different purposes in discourse, it is a language that is well suited for investigation of this issue. It was decided therefore to focus on pinning down the fine-grained distinctions in the interpretation of Catalan polar questions which are contingent on differences in intonation. The main novelty of the hypothesis tested in this study—framed in Krifka's (2015, 2017) semantic theory of speech acts—was that biased question intonation might encode epistemic operators which dynamically encode two complementary dimensions of meaning, namely a speaker's epistemic commitment to the proposition expressed (e.g., the ASSERT operator) and a speaker's agreement or acceptance of the addressee's proposition (e.g., the REJECT operator).

In order to test this hypothesis, we ran an acceptability judgment task in which 119 participants were asked to rate the perceived degree of appropriateness between

various intonational contours and their preceding discourse context. These contexts were created to trigger three levels of commitment and three levels of agreement. The rating results revealed that question intonation in Catalan is sensitive to these two dimensions of epistemic meaning. Specifically, the results showed that (1) the high-fall pitch contour  $H+L^* L\%$  is preferred for the expression of high epistemic commitment, (2) the low-rise pitch contour  $L^* H\%$  is preferred for the conveyance of both low epistemic commitment and low epistemic agreement, and (3) the two circumflex contours, e.g., the rise-fall  $L+\uparrow H^* L\%$  and the rise-fall-rise  $L+H^* LH\%$  are preferred for the expression of high speaker agreement.

First, our results clearly reveal that question intonation contours in Catalan encode binary (and not degree) distinctions in speaker commitment and speaker agreement. This is so because none of the four intonation contours was preferred for the encoding of the mid levels of strength of commitment or agreement (see Figs. 2 and 3). Thus our results do not back up the initial hypothesis that intonation contours would directly encode the *relative strength* of the commitment and agreement operators. However, as we will discuss below, it is also the case that these results seem to be consistent with the idea that conversational implicatures are obtained in a gradual way and interact with contextual strength indicators (see Figs. 2 and 3 for the gradual accommodation of pitch contours).

From the rating results, two interrelated issues are worth mentioning, namely (a) the lack of invariant interpretations of the pitch contours; and (b) the relative acceptance of certain intonational tunes across contexts within the same dimension. For example, while the  $H+L^* L\%$  contour is preferred for conveying high epistemic commitment, it is also judged to be relatively appropriate for mid and low epistemic commitment. Similarly, the  $L^* H\%$  contour is preferred for the expression of low epistemic commitment but is also appropriate for mid and high commitment. These results thus indicate that rather than one-to-one mappings between particular intonation contours and epistemic stances, one finds contours that are regarded as more acceptable for a particular stance. In recent pragmatic and semantic frameworks, depending on the degree of dependence on context, intonational meanings have been claimed to contribute conventional implicatures as well as conversational implicatures (see Prieto 2015 for a review). Although in this paper we claim that conventional implicatures are associated with each one of the contours, it is also clear that conversational implicatures are obtained in an incremental way in the sense that they are progressively less adequate along the strength dimensions (see Figs. 2 and 3). Along with Armstrong and Prieto (2015), we claim that contextual evidence can show different strength values and interact with contour meaning (and thus semantic operators expressed through intonation), leading to different types of implicature strengthening. Some of these questions still remain open and further research could investigate the types of conventional and conversational implicatures raised by these tunes to firmly characterize intonational meaning and its dependence on context.

Another related issue is what our results say about the functional polysemy of intonational meaning. In our data, while falling and circumflex contours are consistently associated with the expression of commitment and agreement respectively,  $L^* H\%$  rising contours obtain high acceptability ratings for both dimensions. This result confirms the recent claim made by Crespo-Sendra et al. (2014) regarding

Catalan interrogative tunes that L\* H% is used for unmarked yes-no questions as well as for incredulity questions. This can be interpreted as a case of intonational polysemy,<sup>5</sup> a phenomenon that has been frequently documented for intonational meaning across languages (see Prieto 2015). Similarly, in English the rising intonation contour L\* H% is used for both unbiased yes-no questions such as *Are you a member of the Communist party?* and disbelief declarative questions such as *You're a member of the Communist party?* (Gunlogson 2001). By contrast, other languages like Dutch or Puerto Rican Spanish use a specific incredulity question contour that is different from the unmarked yes-no question contour (see, e.g., Armstrong and Prieto 2015 for Puerto Rican Spanish and Crespo-Sendra et al. 2014 for Dutch). Though researchers of intonational meaning generally look for invariant meanings or regularities in intonational interpretation (such as rising intonation L\* H% being interpreted as an unmarked yes-no question), there are too many counter-examples to conclude that particular intonational contours map to straightforward interpretations. Interestingly, types of functional polysemy similar to that described here have been frequently reported for discourse markers in non-signed languages and for non-manual markers in signed languages (Schiffrin 1987; Dachkowsky and Sandler 2009).

Interestingly, while the results reveal distinct epistemic preferences for the target intonation contours, the two circumflex contours both appear to be related to the high agreement interpretation. We hypothesize that other factors that are not related to agreement and commitment might be involved in the meaning distinction between the two, probably including echoic intensification. While the rise-fall pitch contour is typically used in echo questions with high degree of agreement, the rise-fall-rise contour can be used to intensify the echoic meaning of the utterance. However, we acknowledge that further investigation would be needed to tease out the difference between the two.

Let us now present a speech act dynamic analysis of the most relevant intonational contours under investigation, namely high commitment (or confirmatory) questions and low agreement (or incredulity) questions. The two intonational contours characterizing these two question types will be taken to encode ASSERT and REJECT operators in Catalan questions. In addition to the illocutionary operator QU, following Krifka (2017) we will use the REQUEST operator for biased questions. This operator will be combined with the ASSERT and REJECT operators, which will be instantiated by prosody. In order to explain the other two types of questions within Krifka's framework, namely low commitment questions and high agreement questions, other operators such as ACCEPT might potentially play a role. We assume that those illocutionary operators are able to turn syntactic categories into speech acts. In the

<sup>5</sup>As one of the reviewers points out, there is no incompatibility between the joint conveyance of low epistemic commitment and the conveyance of low epistemic agreement. However, we would like to point out that, while it is true that these dimensions can be expressed together, it is important that we regard them as independent from one another. Crucially, low epistemic agreement can be paired either with low epistemic commitment (i.e., the speaker expresses low commitment to the truth of a proposition that at the same time challenges a proposed change of commitment) or with high epistemic commitment (i.e., the speaker expresses high commitment to the truth of a proposition that at the same time challenges a proposed change of commitment).



analysis, we will make a clear distinction between the syntactic analysis and the semantic/pragmatic analysis, and will pay special attention to the interpretation of the types of commitments (and conventional meanings) that intonation contributes.

Confirmation questions (or high commitment questions) are analyzed in (4). The overall intention of these sentences is for the speaker to ask for confirmation of a proposition (e.g., *vindràs demà* ‘will you come tomorrow’), that is, they are biased towards a positive answer. As noted above, they will be implemented as the combination of two speech acts. Specifically, they are conceived as a request of an assertion through the use of a double operation REQUEST + ASSERT. Following Krifka (2017: 25), we assume that ForceP can be recursive, assuming that the REQUEST operator merely embeds the effect of an ASSERT operator. First, by means of the interrogative clause syntax (the syntactic operator REQUEST) the speaker will express the interrogative speech act. A second commitment will be effectuated through prosody, namely the nuclear configuration H+L\* L%, which will be carried out by the operator ASSERT (see (4)), and which plays the central part in the construction of this question bias.

- (4a) *Vindràs demà?*  
 [FORCEP REQUEST [FORCEP ASSERT: H+L\* L% [TP *vindràs demà* ]  
 ‘Will you come tomorrow?’ (confirmation question)

The semantic interpretation of these questions is analyzed in (4b), where C is conceived as a commitment space composed of two commitment states at the time the speaker S1 addresses the question to the addressee. In this specific case, S1 requests that S2 indicate whether his/her assumption is true that S1 will come.

- (4b) (... , C) + REQUEST<sub>S1,S2</sub> (ASSERT ( $\psi$ ))

Another type of question bias is illustrated by incredulity questions (or low agreement questions), in which the speaker expresses a doubt that the proposition is true, at the same time challenging the addressee to assert it. In our analysis of incredulity questions, intonation (and in particular the nuclear configuration L\* H%) carries out the operator REJECT, by which a speaker expresses opposition to the commitment suggested by the interlocutor and forces a change of commitment. Thus the REJECT operation is made visible by prosody. Again, incredulity questions will be regarded as the implementation of two operators, REQUEST + REJECT. Two steps will be involved in their interpretation, as expressed in (5). By deploying interrogative clause syntax (the syntactic operator REQUEST), the speaker expresses the interrogative speech act. The L\* H% nuclear configuration is responsible for the second commitment and encodes the conventional incredulity implicature.

- (5a) *Vindràs demà?*  
 [FORCEP REQUEST [FORCEP REJECT: L\* H% [FORCEP ASSERT [TP *vindràs demà* ]  
 ‘Will you come tomorrow?’ (incredulity question)

The semantic form of (5a) is represented in (5b), where the previous move was an assertion of  $\psi$ . The response is asserting a commitment to the truth of the proposition

corresponding to the TP of the discourse polar question, that is,  $\psi$ , and at the same time requesting and rejecting it.

(5b) (... , C) REJECT + REQUEST<sub>S1,S2</sub> (ASSERT ( $\psi$ ))

Examples (4) and (5) involve specific question biases (e.g., confirmation and incredulity) which are constructed almost exclusively on the basis of the intonation contour. In the analyses presented in (4) and (5), both the ASSERT and the REJECT operators are implemented through the corresponding intonation contours and contribute a conventional implicature. In addition, they may contribute context-sensitive conversational implicatures.

Note that our semantic analysis of these intonation patterns has relied on complete configurational tunes and has not taken a compositional approach, that is, we have not tried to semantically decompose the target nuclear configurational tunes into separate pitch accents and boundary tones. As yet there is no consensus regarding the semantic compositionality of tunes proposed within the AM framework (see Prieto 2015 for a review), and in the specific case of Catalan there is no clear way to straightforwardly map unified semantic meanings to separate tonal units. To take an example from Catalan, L\* is the most frequent nuclear pitch accent, being used for encoding broad focus statements and imperative tunes as well as information-seeking and incredulity questions. This wide variation clearly makes it rather difficult to propose an acceptable unified semantic meaning for the L\* pitch accent.

It is important to point out that the experiment presented in this article treated the two epistemic dimensions under discussion (speaker commitment and speaker agreement) as two independent dimensions. Crucially, they were dealt with separately and their potential interactions were not analyzed because we did not include contexts which combined a specific bias for one type of speaker commitment with a bias for one type of speaker agreement. On the other hand, it is clear that they might not be completely independent. For example, while high agreement questions can be combined with both low and high commitment operators, it seems that low agreement questions are typically combined with high commitment (as clear disagreement requires a strong statement). This constitutes one of the limitations of the study and a potential fruitful direction for further research. Another promising avenue would be to further explore the relationship between the operators ASSERT and REJECT, as would attempting to integrate other volitional dimensions of meaning that are important in dynamic semantic models (see Beysade and Marandin 2006b).

Our results complement claims by Beysade and Marandin (2006a,b) and recent experimental findings by Portes et al. (2014) on the contribution of statement/question intonation to sentence interpretation in French. Though these studies found evidence that intonational tunes in French are related to two types of dialogical meanings, namely attribution of intention to the addressee and call on the addressee (as a volitional effect in imperative questions), none of them have dealt with the encoding of the agreement dimension separately. Moreover, it is clear from the different sets of studies that the dialogical dimensions of meaning that intonation encodes in questions are closely related to the semantics of epistemic intonation in declaratives (see also Prieto and Roseano 2016). For example, Portes et al. (2014) found that

different contour types were related to information about speaker commitment and attitude attribution to the addressee, given that French listeners consistently associated L\* L% with the interpretation ‘I get it,’ both H\* H% and H\* L% with ‘I have no idea,’ and H+!H\* H% with ‘No, really, it’s true.’ Importantly, these contours encode both information about the commitment of the speaker to the truth of the proposition and also information about the beliefs attributed to the addressee (incidentally, in the case of H+!H\* H%, this tune signals anticipated disagreement between speaker and listener). In conclusion, taken together these results provided strong evidence that intonational tunes function as dynamic pragmatic operators which encode epistemic meanings in several independent dialogical dimensions.

Finally, though we did not find any evidence for direct conventional marking of degree operators in our data, we would like to point out that the use of epistemic modal particles across languages may well prove a rich vein for further typological research in this area. Crosslinguistic analysis of the contribution of prosody (together with other types of linguistic markers) to utterance interpretation might be able to address the issue of gradience in more proper terms and in greater detail. In this connection, we would argue that the epistemic discourse function of intonation has strong parallels with discourse markers, as both of them can be regarded as semantic-pragmatic resources that encode epistemic distinctions in the commitment spaces created by interlocutors (see also Malamud and Stephenson 2014, who compare the meaning of tags and rising intonation, in French and English respectively, in terms of commitments; see Prieto and Roseano 2016 for a review of the functional distinctions between epistemic particles and epistemic intonation). Interestingly, in languages like Manado Malay, fine-grained epistemic distinctions in these two dimensions (commitment and agreement) are encoded not by intonation (as in Catalan or French) but by sentence-final discourse particles (see Stoel 1995, 2005). Varying degrees of speaker commitment in both statements and questions can be seen in the Malay examples in (6a), while in (6b) the sentence-final discourse particles mark different degrees of speaker agreement (or disagreement) with the context or with the addressee’s views. Crucially, no specific epistemic intonational marking has been reported in Manado Malay. Only differences between emphatic and non-emphatic discourse particles, as well as an intonational distinction between statements and questions, have been documented in the language (see Stoel 2005: Ch. 6).

- (6) a. Speaker commitment
- |                   |  |
|-------------------|--|
| so mo ujang sto   | ‘it is probably going to rain’                                   |
| so mo ujang no    | ‘it is definitely going to rain’                                 |
| so mo ujang kata  | ‘someone said it is going to rain’                               |
| so mo ujang kote’ | ‘I sense that it is going to rain (I felt the first rain-drops)’ |
| so mo ujang kang? | ‘it is going to rain, isn’t it?’                                 |
- b. Speaker agreement
- |                    |                                     |
|--------------------|-------------------------------------|
| so mo ujang le     | ‘and now it is even going to rain!’ |
| so mo ujang kwa’   | ‘but it is going to rain!’          |
| so mo ujang komang | ‘once again it is going to rain’    |

so mo ujang so?	‘is it really going to rain?’
so mo ujang to	‘it is going to rain, as you may know’

Examples are taken from Stoel (1995: 15)

In a study of the question particles in three typologically diverse languages, Dutch, Lao, and Tzeltal Mayan, Enfield et al. (2012: 219) have shown that question-final particles “are more than just question markers, in the sense that they make subtle distinctions in relative strengths of knowledge or commitment to a proposition, of both speaker and addressee, manipulating the local epistemic gradient.” In their work, the term *epistemic gradient* refers to the difference between interlocutors in terms of epistemic commitment to the truth of a proposition. For example, the epistemic gradient of an assertion such as *It is still snowing outside* can be represented as follows: while the speaker has a high commitment to the truth of the proposition (i.e., the speaker knows for sure that it is still snowing outside), the addressee has in principle low commitment to this proposition. By contrast, the epistemic gradient of the question *Is it still snowing outside?* represents the reverse situation, namely the speakers’ low commitment to the truth of the proposition (i.e., the speaker has no idea whether it is still snowing outside), which contrasts with the presumed higher commitment on the part of the addressee. In its review of data from the three languages, the article shows that speakers of all these languages use question-final particles to tilt the epistemic gradient into a questioning stance through a lowering or strengthening of their epistemic commitment. While we have noted here the important function of sentence-final particles in the marking of speaker (and addressee) commitment, the dynamic dimension of speaker agreement or disagreement with the interlocutor’s proposition would need to be incorporated into the model. Moreover, by assessing the epistemic meanings of discourse particles, it would be possible to determine the extent to which epistemic operators contain scales of semantic strength (see for example Sauerland 2004 for a treatment of scalar implicatures).

In a nutshell, the results of this experiment have shown that question intonation contours in Catalan can be interpreted as epistemic operators which encode distinctions in speaker commitment not only in relation to the speaker’s own propositions but also in relation to the addressee’s propositions. Thus intonational tunes, like discourse particles in other languages, can function as epistemic operators that strongly interact with commitment spaces set out by discourse participants in normal conversation. Both intonational tunes and discourse particles encode a key aspect of human interaction, namely the need to dynamically signal the epistemic stance of the interlocutors in a conversation, and future work in the semantics-phonology interface needs to examine the semantic contribution of intonation as well as lexicosyntactic marking to discourse meaning.

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## Appendix

Catalan versions (and English translations) for one of the two contexts used for each pragmatic meaning in the acceptability judgment task. Target utterances are shown in italics; L, M, and H stand for Low, Mid, and High degrees of Commitment (C) and Agreement (A), respectively.

### Commitment

- (CL) Fa poc que t'has mudat a un nou barri i aquesta setmana estan de festa major. El teu veí et diu que avui a la nit fan el correfoc, però no saps quin recorregut fa.

TARGET SENTENCE: —*Passaran per sota de casa?*

**English translation:** Not long ago you moved to a new neighborhood. This week it is celebrating its annual fiesta. Tonight your neighbor tells you there is going to be a traditional street parade with dragons and fireworks, but you don't know what route it will take.

—*Will they go by our house?*

- (CM) Som al novembre, i ja fa unes setmanes que a totes les fruiteries hi ha mandarines. Surts a comprar i passes per davant d'una fruiteria, suposant que en deuen tenir.

TARGET SENTENCE: —*Teniu mandarines?*

**English translation:** It's November, and tangerines have been available for a few weeks now. When you go out shopping, you stop by your local greengrocer's, assuming they'll have some.

—*Do you have tangerines?*

- (CH) Són quasi les dues del migdia i tu i la Sònia sou al despatx treballant, com de costum. Estàs concentrada amb les teves coses quan de sobte sents que els budells li comencen a roncar.

TARGET SENTENCE: —*Tens gana?*

**English translation:** It's almost two in the afternoon and you and Sonia are together working at the office, as always. You're concentrating on your work, when all of a sudden you hear her stomach growl.

—*Are you hungry?*

### Agreement

- (AH) Has intentat trucar a un amic un parell de cops però comunica. Al cap d'una estona et truca ell, però el sents una mica tallat i no saps si l'has sentit gaire bé.

—Perdona, estava parlant amb ma germana.

TARGET SENTENCE: —*Parlaves amb ta germana?*

**English translation:** You've tried calling a friend a couple of times but without success. A second later he calls you, but you can't hear him very well and you don't know if you heard what he said clearly.

—Sorry. I was talking with my sister.

—*You were talking with your sister?*

- (AM) Són festes majors i avui a la nit fan els correfocs. Havies parlat amb en Joan i en Pau i t'havien dit que no vindrien perquè eren fora. Ara et trobes en Pere, un altre dels teus amics, i et diu que finalment hi podrà venir tothom.

—Serem tots els de la colla.

TARGET SENTENCE: —*Serem tots els de la colla?*

**English translation:** It's fiesta time in the city and tonight they are going to do the traditional street parade with dragons and fireworks. You are planning to go see it with some friends. You already spoke to your friends Joan and Pau, but they told you that they were out of town and wouldn't be there tonight. Now you see Pere, another member of the group, and he tells you that in the end everyone will be able to come.

—We'll all be there.

—*We'll all be there?*

- (AL) La teva companya de pis és fotògrafa, i avui, que feia un dia esplèndid i assolellat, havia marxat cap a Salou per fer un reportatge de casament. Quan torna et diu que se'ls ha posat a ploure. Tu no t'ho acabes de creure perquè feia dia de tot menys de ploure.

—Doncs se'ns ha posat a ploure.

TARGET SENTENCE: —*Se us ha posat a ploure?*

**English translation:** Your roommate is a photographer. It's a gorgeous, sunny day out today, and she has gone to Salou to cover a wedding. When she gets back, she tells you that it started raining while she was there. You can't believe it because it has been such a gorgeous day.

—So we got caught in the rain.

—*You got caught in the rain?*

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