

# The interpretation of prosody in disjunctive questions\*

Kathryn Pruitt

Floris Roelofsen

**Abstract.** Alternative questions differ prosodically from identically-worded disjunctive yes/no questions in their accentual characteristics and their final pitch contour. Alternative questions are canonically pronounced with a final fall and with pitch accents on all disjuncts, while disjunctive yes/no questions are canonically pronounced with a final rise and generally without pitch accents on every disjunct. This paper presents an experiment investigating the importance of these prosodic features in disambiguation. The experiment shows that the final contour is the most informative prosodic feature. Accentual characteristics also play a significant role, but, contrary to what is often assumed in the literature, cannot force an alternative question interpretation or a yes/no question interpretation on their own. Several theories of disjunctive questions are discussed in the light of these experimental results.<sup>1</sup>

**Keywords:** prosody, disjunction, alternative questions, intonational meaning

## 1 Introduction

Disjunctive questions have received attention recently as a case in which prosody is crucial to determining meaning. A standard disjunctive question such as that in (1) has two primary interpretations, depending on the intonation with which it is pronounced.

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<sup>1</sup>The experiment discussed in this paper was first presented in Pruitt (2008a,b). The present paper describes the experiment in more detail, provides more in-depth statistical analysis, and discusses the theoretical implications of the experiment more extensively.

(1) Is Marcia allergic to dairy or soy?

Adopting for the moment a simplified prosodic description, when (1) is pronounced with emphasis on both disjuncts (*dairy* and *soy*) and falling pitch at the end, it is understood to be asking which of dairy or soy it is that Marcia is allergic to; in this case it is usually referred to as an alternative question. If instead (1) is pronounced without particular emphasis on the disjuncts and rising intonation at the end, it is generally interpreted as asking whether Marcia is allergic to either of dairy and soy, with the understanding that the distinction between the two is unimportant (or at least not salient); in this case the sentence in (1) is a yes/no question that happens to contain a disjunction.

Disjunctive questions present an interesting puzzle for any general principles of the prosody-meaning mapping. On the one hand the prosodic differences between alternative questions and disjunctive yes/no questions (which are presented in more detail below) are quite robust. Beck and Kim (2006), for example, give the sentence in (2); context and convention guarantee that this sentence will be an alternative question, but it must still be pronounced with alternative question intonation.

(2) Is Ning's baby a boy or a girl? (Beck and Kim 2006:165)

Unlike many prosodic features which associate in some way with syntax or semantics, examples like this give the impression that alternative questions and yes/no questions are distinguished prosodically even when no ambiguity is likely to arise. The relative stability of the prosodic features of disjunctive questions suggest that they would be a promising place to look for improving our understanding of how prosody signals meaning.

On the other hand, while it is relatively straightforward to informally describe the prosodic and interpretational differences between alternative questions and disjunctive yes/no questions, it is not immediately clear which prosodic differences are crucial in disambiguation, and how the interpretational differences are to be derived in a compositional way.

In order to address these issues, this paper presents a perception experiment that examines the extent to which different prosodic features determine whether a given disjunctive question is interpreted as an alternative question or as a yes/no question. The experiment shows that the final pitch contour is the most informative prosodic feature: disjunctive questions with a final fall are generally interpreted as alternative questions, while disjunctive questions with a final rise are generally interpreted as yes/no questions. The accentual characteristics of the given question also play a role: if a disjunctive question is pronounced with accents on all disjuncts, it is more likely to be interpreted as an alternative question. However, in the absence of a final fall, multiple accents generally do not result in an alternative question interpretation, and in the presence of a final fall, an alternative question interpretation generally arises even in the absence of multiple accents, contrary to what is often assumed in the literature (see, for instance, Aloni and van Rooij 2002, Romero and Han 2003, Han and Romero 2004a,b, Beck and Kim 2006).

The paper is organized as follows. In §2 we review the detailed description of the canonical prosodies of alternative questions and disjunctive yes/no questions provided by Bartels (1999:Ch. 4), and characterize some of the general hypotheses that can be found in the literature as to which of the prosodic differences between the two question types are most important in disambiguation. In §3 we present a perception experiment that tests these hypotheses, confirming the crucial importance of the final contour and the supporting role of the accentual characteristics. In §4 we discuss several theoretical accounts of disjunctive questions in light of the experimental results, and §5 concludes.

## 2 Canonical disjunctive question prosodies

Bartels (1999:Ch. 4) provides an extensive discussion of the canonical prosody of alternative questions, identifying the following primary features: all disjuncts are accented and usually pronounced in separate prosodic phrases; when pronounced in separate prosodic phrases, non-final disjuncts end with a pitch rise; and the disjunctive phrase ends with falling intonation. Bartels cites earlier descriptions of alternative question intonation that converge on similar descriptions (Schubiger 1958, Rando 1980, Quirk et al. 1985).

The example in (3) illustrates this characteristic prosody of an alternative question.<sup>2</sup> In this example sentence, adapted from Bartels (1999:Ch. 4), the disjuncts *mineral water* and *lemonade* have non-final primary stress so that separation of the accents and boundary tones is more easily illustrated. As the (a) and (b) examples in (3) indicate, the obligatory accent on the non-final disjunct may be low or high. The perceived rise on the non-final disjunct (H\* H- or L\* H-) is a result of a prosodic phrase break with a high phrase accent, while the final fall is a consequence of a high accent on the syllable with the nuclear stress followed by a low phrase accent-boundary tone sequence aligned to the end of the disjunctive phrase (H\* L-L%). When pronounced in this way, the sentence in (3) does not license *yes* or *no* responses and moreover, it conveys, roughly, the speaker's expectation that exactly one of the disjuncts is true.

- (3) Canonical alternative question<sup>3</sup>  
 Would you like mineral water or lemonade?  
 a. (                    H\*        H- ) (   H\*   L-L% )  
 b. (                    L\*        H- ) (   H\*   L-L% )

<sup>2</sup>We follow Bartels (1999) and others (Pierrehumbert 1980, Beckman and Pierrehumbert 1986, Pierrehumbert and Beckman 1988; see also Ladd 1996) in assuming that an intonational contour is represented as a string of high and low tonal targets which are either pitch accents (pitch excursions aligned to stressed syllables within phrases and designated X\*), phrase accents (tonal targets that align to the edges of intermediate prosodic constituents, designated X-), or boundary tones (tonal targets that align to the edges of larger prosodic constituents, designated X%). We indicate prosodic phrasing with parentheses, although we have not tried to be precise in the marking of hierarchical or nested prosodic constituents. Where relevant, we indicate optional prosodic elements with gray text.

<sup>3</sup>The possibility for downstep across the high accents in an alternative question, which Bartels (1999) reports as an optional pronunciation, is not represented here.

Although a disjunctive yes/no question may have the same wording as an alternative question, its pronunciation is quite different. According to Bartels (1999), disjuncts in a disjunctive yes/no question may be optionally accented but are typically not pronounced in separate prosodic phrases, and they are assumed to pattern with other yes/no questions in allowing a range of final contours, including both rises and falls as the context allows (see, e.g., Hedberg et al. 2004 for evidence of falling intonation in yes/no questions).

The example in (4) shows two variants of a canonical rising disjunctive yes/no question contour with the same example sentence. An accent on the non-final disjunct is optionally realized, but when present it may be high or low and will usually match the nuclear accent, which is on the final disjunct in this example. Unlike alternative questions, disjunctive yes/no questions generally have no prosodic phrase break or phrase accent between the disjuncts, and although considerable variability in the final contour of yes/no questions exists, it is canonically rising (most commonly H\* H-H% or L\* H-H%). When pronounced with either of the intonational contours in (4), this question does license *yes* and *no* responses and does *not* generally convey an expectation on the speaker's part about whether either of the disjuncts is true.

- (4) Canonical disjunctive yes/no question prosody  
 Would you like mineral water or lemonade?  
 a. (                    H\*                    H\* H-H% )  
 b. (                    L\*                    L\* H-H% )

The canonical contours show that alternative questions and their disjunctive yes/no question counterparts may differ along several prosodic dimensions—likelihood of disjunct pitch accents, presence or absence of a prosodic phrase boundary with H- and the final contour. One of the central issues that arises, then, is which of these prosodic features play a decisive role in determining whether a given disjunctive question is interpreted as an alternative question or as a yes/no question.

An assumption that is often made in the literature is that the accentual characteristics play a crucial role. Han and Romero (2004b:547), for example, say of disjunctive questions that “focus intonation disambiguates the two readings: the [yes/no]-reading presents neutral intonation on the disjunctive phrase. . . whereas the [alternative question]-reading is in general achieved by placing focus stress on each disjunct.” Similar descriptions can be found in Aloni and van Rooij (2002), Romero and Han (2003), Han and Romero (2004a) and Beck and Kim (2006).

Bartels emphasizes that the final contour in an alternative question is invariably falling, unlike in yes/no questions, whose final contour appears to be more flexible, and she presents an analysis of alternative question pragmatics which assumes that the final contour of an alternative question is a reflex of a morpheme that conveys an essential part of an alternative question's meaning.<sup>4</sup> Bartels assumes that the accentual differences are also important but says explicitly (p.85) that “the fact that [some contours]. . . place an accent on each of their

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<sup>4</sup>More precisely, the morpheme she proposes is signaled by a low phrase accent, L-, which is part of the tone sequence perceived as a fall at the end of an alternative question.

disjuncts clearly does not suffice to make them eligible as [alternative questions].”

In the next section we report an experiment that was designed to test how the final pitch contour and the presence or absence of prominent pitch accents on each disjunct affect the interpretation of disjunctive questions.

### 3 Experiment: disambiguating disjunctive questions

#### 3.1 Overview and predictions

In order to test the hypotheses that alternative questions and yes/no questions are disambiguated by their accentual characteristics or by their final contour (or both), we conducted an experiment to test listeners’ interpretations of disjunctive questions with varying prosodies. We use the umbrella term “accentual characteristics” to include both the pattern of pitch accents and the likelihood of having a prosodic phrase break (and concomitant phrase accent) between disjuncts. Although it would in principle be possible to decouple the prominent pitch accents and prosodic phrase accent to evaluate their relative contribution, we group them in order to highlight the comparison between the accents and the final contour.

In the experiment listeners were presented with disjunctive questions with prosodic contours that varied along two dimensions, and they were asked to indicate the meaning of sentences they heard (essentially, whether it sounded more like an alternative question or a yes/no question; details are presented below). Each disjunctive question in the experiment had the accentual characteristics of an alternative question or a yes/no question (a two-level factor we will abbreviate ACCENT) and the final contour of an alternative question or a yes/no question (a two-level factor we will call FINAL). We will refer to the levels of ACCENT as *multiple* and *single*, abbreviated M and S. *Multiple* describes contours with the accentual characteristics of an alternative question—multiple prominent accents (here, one for each disjunct) and a prosodic phrase break between disjuncts—while *single* describes contours with the accentual characteristics of a yes/no question—only one prominent accent (i.e., the nuclear stress of the sentence) and no medial prosodic phrase break.<sup>5</sup> The two levels of FINAL are *fall* and *rise*, which we indicate with ↓ and ↑, respectively.

The factors were crossed so that four prosodic contours resulted, as schematized in Table 1—two had a canonical combination of features (multiple accents, a prosodic phrase break, and a fall like a canonical alternative question (M↓), or a single accent, no break, and a rise like a canonical yes/no question (S↑)), while the other two contours had non-canonical combinations of prosodic features (multiple accents, a break, and a rise (M↑), or a single accent, no break, and a fall (S↓)).

We expect that the canonical prosodies, M↓ and S↑, will reliably disambiguate, with M↓ interpreted as an alternative question and S↑ as a yes/no question. But of particular

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<sup>5</sup>Constraints on the intonational phonology of English prevent there from being an utterance contour with no accents, which is why the levels of this factor are *multiple* and *single*, not *accented* and *unaccented*.

		ACCENT	
		<i>Multiple</i>	<i>Single</i>
FINAL	<i>Fall</i>	M↓	S↓
	<i>Rise</i>	M↑	S↑

M↓ = canonical alternative question  
S↑ = canonical yes/no question

Table 1: Factors crossed in design of stimuli

interest is how listeners will interpret a disjunctive question with a non-canonical contour, since these have conflicting prosodic information.

If a difference in accentual characteristics is the crucial distinction between alternative questions and disjunctive yes/no questions, then we would expect to see multiple-accent contours associated with alternative question interpretations, and single-accent contours associated with yes/no question interpretations. We can distinguish a strong version of this hypothesis and a weak version. The strong hypothesis holds that a disjunctive question will be interpreted as an alternative question if and only if the disjuncts have the accentual characteristics of a canonical alternative question. If this strong hypothesis is correct, the M↑ contour should be interpreted as an alternative question more often than not, since it has the accentual characteristics of a canonical alternative question. The S↓ contour, on the other hand, should not receive a majority of alternative question interpretations, since it lacks the usual accents and phrase break characteristic of such questions. These predictions are summarized in (5).

- (5) Predictions of the strong Accent Hypothesis<sup>6</sup>  
M↑ > 50% alternative question interpretations  
S↓ < 50% alternative question interpretations

We can also identify a weaker version of the Accent Hypothesis. This weaker hypothesis holds that the accentual characteristics will sway interpretation, with the M contours being more likely to receive alternative question interpretations than the S contours, but does not claim that multiple accents are necessary or sufficient for forcing an alternative question interpretation. To assess the weak prediction we will look for evidence that contours with multiple prominent accents are interpreted as alternative questions more often on average than contours with a single prominent accent. This prediction is summarized in (6).

- (6) Prediction of the weak Accent Hypothesis  
% of alternative question interpretations: M > S

<sup>6</sup>These percentages are based on the assumption that subjects have a choice between two interpretations—an alternative question or a yes/no question. The experiment contained a third option (“other”), but as we will see in a moment this option was so rarely chosen that it does not significantly affect the generalizations being made here.

The weak version of the Accent Hypothesis is consistent with Bartels (1999), but the strong version is not, since her analysis predicts that a contour with a final rise will not be interpreted as an alternative question even if it has multiple accents (as in M↑). Moreover she presumes that although a final fall is necessary, it is not sufficient, and that a contour that has a final fall but does not have accented disjuncts (i.e., S↓) is most likely to be interpreted as a yes/no question. These predictions are summarized in (7).

- (7) Predictions of Bartels’ analysis  
 M↑ < 50% alternative question interpretations  
 S↓ < 50% alternative question interpretations

The next sections describe the experimental method and results in detail.

## 3.2 Method

### 3.2.1 Stimuli

Twenty-four disjunctive questions were selected for use in the experiment. They are listed in Appendix A. For consistency, all sentences had only two disjuncts and the disjunctive phrase was sentence-final. The items were recorded spoken by the first author, a female native speaker of American English, with both an alternative question (M↓) and a yes/no question (S↑) pronunciation. For the alternative questions, the disjuncts were pronounced with the prosody represented with one of the experimental items in (8a), while for the yes/no question pronunciation, the prosody in (8b) was used. For the yes/no questions an attempt was made to avoid significantly accenting the first disjunct, but some of the items with longer disjuncts were pronounced with a non-prominent low pitch accent on the first disjunct in order to sound natural. The sentences were recorded in a sound-attenuated chamber in the Phonetics Lab of the University of Massachusetts Amherst at a sampling rate of 44.1 kHz using a Marantz PMD671 Compact Flash Recorder with an Audio-technica AT3032 microphone. Recordings of several of the sentences were subsequently slowed by a small factor (~10%) to increase intelligibility, using the PSOLA function in Praat (Boersma and Weenink 2007) which preserves the original pitch and spectral properties of the recording.<sup>7</sup>

- (8) Canonical prosodies recorded for experiment<sup>8</sup>
- |       |   |        |                                 |
|-------|---|--------|---------------------------------|
|       | Did Sally bring wine or bake a dessert? |        |                                 |
| a. M↓ | (                                       | H* H-) | ( H* L-L%) Alternative question |
| b. S↑ | (                                       | L*     | L* H-H%) Yes/no question        |

<sup>7</sup>In later versions of Praat, this function is called “Lengthen (overlap-add)”. The algorithm is the Time-Domain Pitch-Synchronous Overlap-Add algorithm discussed by Moulines and Charpentier (1990).

<sup>8</sup>After the experiment was performed it was discovered that the M↓ contours were more likely to show a pitch accent on the subject of the sentence than the S↑ recordings. The results of the experiment do not suggest that this difference interfered with the experimental manipulation, but future work should control for the prosodic properties of the pre-disjunct portion of the sentence as well.

The non-canonical contours were then created by digitally splicing the alternative question and yes/no question versions of each of the items to interchange their final contours using Praat (Boersma and Weenink 2007). In order to create M↑, a contour with multiple accents, a prosodic break, and a final rise, the group of words pronounced with the final fall (H\* L-L%) was cut out of each alternative question recording and replaced with the equivalent word group of its yes/no question counterpart, which showed the opposite final contour (L\* H-H%). This yielded the pronunciation in (9a). To create S↓, a contour with just one prominent accent, no prosodic phrase break, and a final fall, the word group that was cut out of the yes/no question to make the contour in (9a) was replaced with its alternative question equivalent. This resulted in the contour in (9b). For each sentence, the splicing was performed at or before the word which had the nuclear accent so that the entire final contour (pitch accent, phrase accent, and boundary tone) was captured.<sup>9</sup>

(9) Spliced contours

		Did Sally bring wine	or bake a dessert?			
a.	M↑	(	H* H-)	(	L* H-H%)	Multiple accents, rise
b.	S↓	(	L*		H* L-L%)	Single accent, fall

The interchange of final contours was performed for all twenty-four sentences, so that they each had an M↓, M↑, S↑, and S↓ version, for a total of 96 stimuli. A representative illustration of the four contours for one item is shown in Figure 1.

In addition to the target sentences, 67 filler sentences were recorded. These included declarative, imperative, and interrogative sentence types; some of them were ambiguous and many had intonational features that were relevant for ambiguity resolution.

### 3.2.2 Procedure

The twenty-four disjunctive questions were randomly divided into four lists of six items each, and participants were placed into one of four groups. The four contours were rotated among the list/group combinations to create a Latin square; each group heard all 24 sentences once and each of the four contours six times. Appendix A indicates which prosodies were presented to each group for each list. Each group of participants also heard a set of 36 of the 67 filler items, for a total of 60 items. The order of the test sentences was pseudo-randomized both relative to each other and relative to the fillers, but was the same for each group.

The experiment was performed for all participants in a group in the same session with the exception of Group 3, whose participants were tested at one of two separate times. Participants were seated at a table in a small room with the door closed and were presented with the auditory stimuli played from a laptop computer to external speakers. They were asked to choose the best paraphrase from among provided choices on a multiple-choice-type an-

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<sup>9</sup>Splicing was done at the beginning of the word with the nuclear accent unless it began with a sonorant consonant, as this made it difficult to create a clean break with respect to the pitch contour. In such cases, the next closest word before the nuclear accent that began with an obstruent was chosen as the site of splicing.

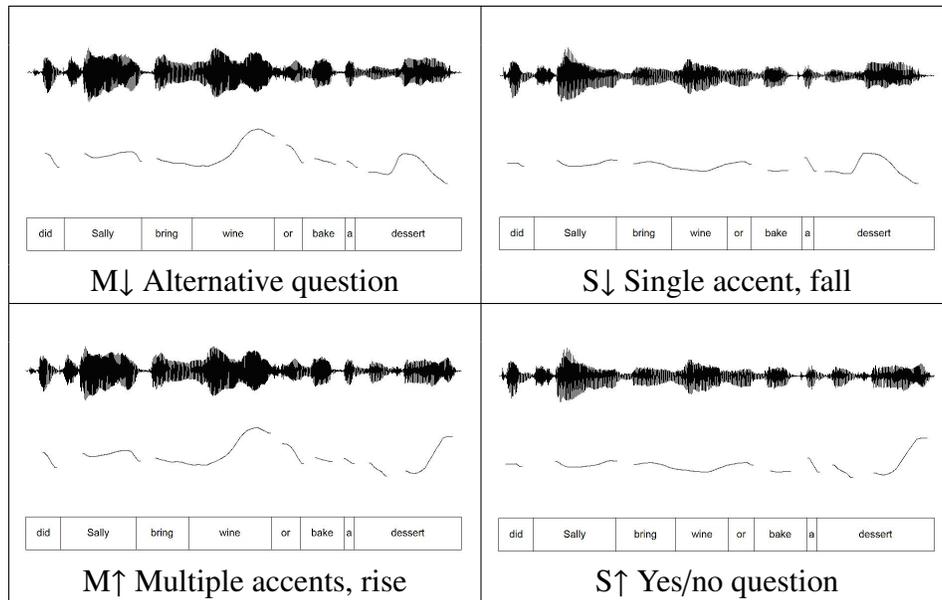


Figure 1: Examples of the four contours used in the experiment. Pitch tracks created in Praat (Boersma and Weenink 2007); errant pitch tracking at consonantal bursts has been removed.

swer sheet. For all items in the experiment, there were three choices: two paraphrases and “other”. Participants were instructed to listen to the sentence, decide on an interpretation, and then look at the provided paraphrases, choosing the one that matched their interpretation or choosing “other” and providing a different paraphrase if the given choices were inadequate. For the target items, the provided paraphrases corresponded approximately to an alternative and a yes/no question paraphrase, an example of which is shown in (10). The order of the alternative and yes/no question paraphrase choices was counterbalanced, with the choice of “other” always last (c).

- (10) Example of paraphrase options for target items
- a. Which of these things did Sally do: bring wine or bake a dessert?
  - b. Did Sally do any of these things: bring wine or bake a dessert?
  - c. Other \_\_\_\_\_

Presentation of the stimuli was controlled by the experimenter and proceeded at a pace determined by how long it took subjects to respond to each item. Each group took under one hour to listen and respond to the presentation of the 60 (24 target + 36 filler) items.

### 3.2.3 Subjects

Thirty-seven undergraduate students at the University of Massachusetts Amherst participated in the experiment for course credit in an introductory linguistics class. All were

native speakers of American English and reported no speech or hearing difficulties. Nine subjects participated in each of Groups 1 and 2, eleven participated in Group 3, and eight in Group 4.

### 3.3 Results

Across the experiment, responses were elicited for 222 tokens of each contour. Table 2 shows the number of each response type for each contour. The M↓ contour, which had the canonical features of an alternative question, was interpreted as an alternative question 92% of the time (204 out of 222), and the S↑ contour, which had the canonical features of a yes/no question, was interpreted as a yes/no question 89% of the time (197 out of 222). These results confirm that the canonical combinations of the prosodic features disambiguate disjunctive questions reliably, as expected. As for the non-canonical contours, M↑, which had the accentual pattern of an alternative question with the final rise of a yes/no question, received mostly yes/no question paraphrases (83%, 185 out of 222), and the S↓ contour, which had the accentual pattern of a yes/no question but the final fall of an alternative question, received mostly alternative question paraphrases (82%, 181 out of 222). Responses of “other” were very infrequent, and there did not appear to be any systematicity in participants’ choice of this option: “other” was chosen twice each for the M↓, M↑, and S↓ contours and once for S↑. One subject accounted for five of the seven instances of “other” responses, with an additional two subjects selecting “other” once each.<sup>10</sup> Figure 2 illustrates the responses for each contour as the proportion of alternative question paraphrase choices.

<i>Heard</i>	<i>Paraphrase choice</i>			<b>Total</b>
	Alternative question	Yes/no question	“Other”	
M↓ Alternative question	204	16	2	222
M↑ Multiple accents, rise	35	185	2	222
S↑ Yes/no question	24	197	1	222
S↓ Single accent, fall	181	39	2	222
<b>Total</b>	444	437	7	888

Table 2: Number of responses for each stimulus type

We modeled the experimental data with a mixed-effects logistic regression in the statistical software program R (R Development Core Team 2009) using the `lmer` function

<sup>10</sup>In the blank next to the choice of “c. Other”, the subject who selected this choice five times simply rewrote the question each time. For example, when the target item was *Does Paula sing or dance*, the subject wrote “Does Paula sing or dance”. For the other two instances of “other”, one subject left the fill-in option blank and the other subject slightly reworded the target item.

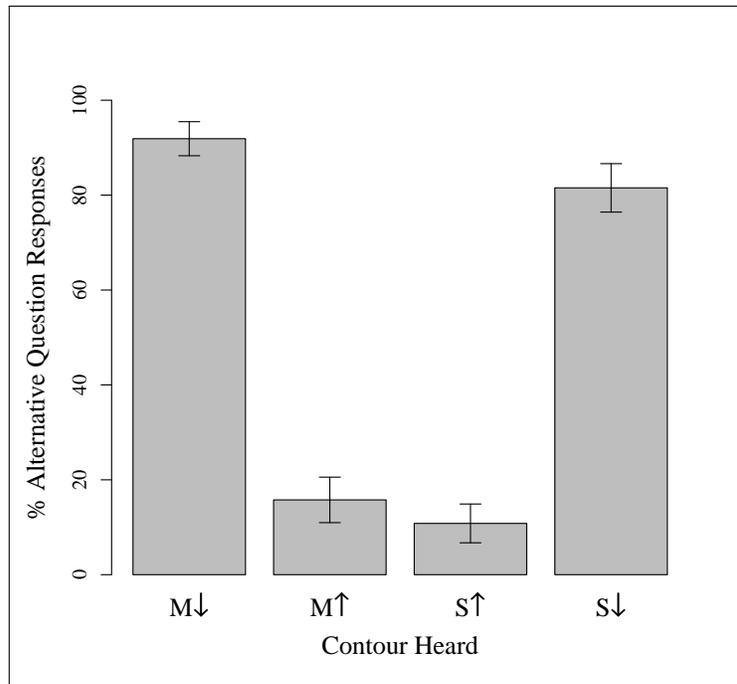


Figure 2: Proportion of Alternative question responses for each contour ( $\pm 95\%$  Confidence interval)

from the `lme4` package (Bates and Maechler 2009).<sup>11</sup> The logistic regression evaluated the likelihood of an alternative question paraphrase response (coded as 1) vs. a yes/no question paraphrase or “other” (coded as 0). The final contour (*fall* vs. *rise*) and the accentual pattern (*multiple* vs. *single*) were treated as fixed effects. Contrast coding was used for the predictors (FINAL: *fall* =  $\frac{1}{2}$ , *rise* =  $-\frac{1}{2}$ ; ACCENT: *multiple* =  $\frac{1}{2}$ , *single* =  $-\frac{1}{2}$ ). Random intercepts and random slopes for FINAL by Subject and by Item were also included in the model. This was the maximal random effects structure justified by the data, as determined by a series of likelihood ratio tests (Baayen et al. 2008).

The parameter estimates are shown in Table 3. The coefficient for the intercept was non-significant ( $p = .9097$ ), reflecting the absence of a baseline preference for either an alternative question or non-alternative question response in the experiment. Alternative question responses were provided for exactly half of the experimental items (444 out of 888; see Table 2), with a yes/no question paraphrase or “other” chosen for the other half. There was a significant and positive main effect of the final contour ( $p < .0001$ ), indicating that a final fall contributed significantly to the likelihood of an alternative question paraphrase. The main effect of the ACCENT manipulation was also significant and positive ( $p = .0001$ ), indicating that multiple accents and a prosodic phrase boundary also contributed significantly to the likelihood of an alternative question paraphrase. The estimate of the coefficient for

<sup>11</sup>See Jaeger (2008) for discussion of mixed logit models for categorical linguistic data using `lmer`. See Baayen et al. (2008) for similar discussion of linear mixed models.

the interaction of FINAL and ACCENT did not reach statistical significance ( $p = .1351$ ).<sup>12</sup>

A comparison of the estimates of the coefficients for the two factors reflects the relationship that is visible in Figure 2. Namely, though a final fall and multiple accents were both associated with a significant increase in alternative question responses, the effect of the final contour ( $B=5.18$ ,  $SE=0.54$ ) was larger than that of the accentual characteristics ( $B=0.89$ ,  $SE=0.23$ ). Contours ending with a final fall ( $M\downarrow$  and  $S\downarrow$ ) received an alternative question paraphrase in 87% of cases, while contours ending in a rise ( $S\uparrow$  and  $M\uparrow$ ) were interpreted as alternative questions only 13% of the time. Contours with multiple accents ( $M\downarrow$  and  $M\uparrow$ ) were interpreted as alternative questions 54% of the time, compared to contours with a single prominent accent ( $S\uparrow$  and  $S\downarrow$ ), which received 46% alternative question responses.

<i>Predictor</i>	Coefficient	Std. Error	Wald Z	<i>p</i>
Intercept	0.02	(0.18)	0.11	.9097
FINAL	5.18	(0.54)	9.55	< .0001
ACCENT	0.89	(0.23)	3.84	.0001
FINAL $\times$ ACCENT	0.69	(0.46)	1.49	.1351
<i>Goodness of fit</i> (Baayen 2008)				
Somers' $D_{xy}$	.9175			
Concordance C	.9588			

Table 3: Estimates of fixed effects from mixed-effects logistic regression on likelihood of alternative question paraphrase and statistics evaluating model fit. Model included random intercepts and random slopes for FINAL by Subject and by Item.

### 3.4 Discussion

In section 3.1 we identified a strong and a weak version of the Accent Hypothesis. The strong version holds that prominent accents are a necessary and sufficient condition for a disjunctive question to be interpreted as an alternative question. Thus, it predicts that the  $M\uparrow$  contour should receive mostly alternative question interpretations, while the  $S\downarrow$  contour should receive predominantly yes/no question paraphrases. This prediction was not supported. The  $M\uparrow$  contour was interpreted as an alternative question only 16% of the time, and the  $S\downarrow$  contour was interpreted as a yes/no question only 18% of the time.

<sup>12</sup>Qualitatively similar results hold in models with different combinations of random effects, except for the fully-specified model (with random intercepts and slopes for FINAL, ACCENT, and their interaction by Subject and by Item), which differs from all others in that the interaction of FINAL and ACCENT is statistically significant. A definitive interpretation of the interaction is not pursued in detail here because this model was not significantly better than the one reported above according to the likelihood ratio tests used to determine the maximal justified random effects structure. Nonetheless, it is worth noting that the interaction in the fully-specified model appears to be due to the fact that for most (but not all) subjects and items, the effect of the accent manipulation was greater for falling contours while for rising contours it was smaller or non-existent.

The weak version of the Accent Hypothesis holds that contours with multiple accents and a prosodic phrase break are more likely to be interpreted as alternative questions compared to contours with a single prominent accent and no prosodic break. This prediction was supported by the experimental results, which saw the M contours paraphrased as alternative questions significantly more often than the S contours (54% and 46%, respectively). Thus, the experimental results are consistent with a theory that predicts accentual characteristics to play a supporting role in the interpretation of disjunctive questions.

The results also provide support for Bartels' (1999) contention that the final fall (or some component of it) signals a meaningful contrast in disjunctive questions, since contours with a final fall were interpreted as alternative questions substantially more often than contours with a final rise (87% vs. 13%). In particular, M↑ received only 16% alternative question paraphrases. However, Bartels' assumption that a falling contour without accents on both disjuncts (that is, S↓) is generally *not* interpreted as an alternative question did not receive support from the experiment, as this contour was nonetheless interpreted as an alternative question in 82% of cases.

## 4 General discussion

The overall conclusion from the experiment is that both of the target prosodic features—accentual characteristics and final contour—are influential in distinguishing alternative questions from disjunctive yes/no questions. However, the final contour is the most important of these features in disambiguation. Even in the absence of a prominent accent on the first disjunct and a prosodic phrase break, a final fall generally favors an alternative question interpretation. And on the other hand, if there are pitch accents on each of the disjuncts and a prosodic phrase break but no final fall, then the alternative question interpretation usually does *not* arise.

In the remainder of this section we discuss a range of syntactic and semantic assumptions that would be compatible with the experimental results, and we consider existing theoretical proposals in the light of these results. In section 4.1 we focus on the final contour and in section 4.2 on the accentual characteristics.

### 4.1 The final contour

Disjunctive questions with a final fall were paraphrased as alternative questions 87% of the time, while those ending with a rise received only 13% alternative question paraphrases. In principle these experimental results are equally likely under the following three hypotheses: (i) a final fall is integral to alternative questions, (ii) a final rise is integral to yes/no questions, and (iii) alternative questions require a fall *and* yes/no questions require a rise. However, it is relatively well-documented that yes/no questions need not always end in a rise and may often be pronounced with falling or level intonation (Bartels 1999:Ch 5, Hedberg et al. 2004). Because there is no reason to suppose that disjunctive yes/no questions

behave any differently from other kinds of yes/no questions, we will assume that disjunctive questions in general need not end in a rise in order to be interpreted as yes/no questions.<sup>13</sup> On the other hand, alternative questions are always reported to end with a final fall (see references cited in §2). The relative stability of the final fall in alternative questions compared to the less predictable final contour of yes/no questions provides some evidence in favor of hypothesis (i)—that the final fall of an alternative question is essential.

It is possible that it is not the fall per se that signals the relevant contrast, but rather one of the tones that makes up the sequence that is perceived as a fall. In Bartels' (1999) proposal, for example, the low phrase accent, L-, within the falling contour is taken to be crucial, rather than the fall as a whole. The falling contour used in the experiment was comprised of a high pitch accent followed by a low phrase accent and low boundary tone, H\* L-L%, which was compared with a rising contour that had precisely the opposite tones, L\* H-H%. Our experimental manipulation was thus not sensitive enough to distinguish hypotheses about the contribution of individual tones. Previous work on intonational meaning does not make it clear whether such an analysis is to be pursued in general (e.g., Gussenhoven 2004; though cf. Pierrehumbert and Hirschberg 1990), but in any case, addressing this uncertainty for disjunctive questions will require further empirical investigation. In the rest of this section we continue to refer to the relevant prosodic feature as the 'final fall', bearing in mind that a finer-grained prosody-meaning connection would also be consistent with the experimental results obtained.

Now let us consider the specific meaning contribution that may be associated with the final fall. First note that a canonical alternative question with the prosody shown in (11a) below gives an addressee a choice between a set of items (here, two), with the expectation that the addressee will pick exactly one of them. A contour with a reversed set of final tones, as in (b) below, also gives the addressee a list of options, but the expectation of 'exactly one' is not conveyed. This applies as well to the contour in (c), which reverses only the final phrase accent and boundary tones but leaves the high pitch accent in place. An addressee in response to (b) or (c) is free to answer with *neither* or *both*. When given in response to (a) such answers would go against the expectation signaled by the questioner. Thus, the formal representation of the meaning of alternative questions must restrict the space of answers in this particular way, and this restriction must be associated with falling intonation.

- |      |                            |                   |
|------|----------------------------|-------------------|
|      | Did Sally bring wine       | or bake a desert? |
| (11) | a. ( H* H-H% ) ( H* L-L% ) |                   |
|      | b. ( H* H-H% ) ( L* H-H% ) |                   |
|      | c. ( H* H-H% ) ( H* H-H% ) |                   |

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<sup>13</sup>Although this suggests that falling contours are not ungrammatical with yes/no questions, the majority of yes/no question paraphrase responses given in the experiment were nonetheless provided for contours with a rise. It is possible that this is due to the meaning of a final fall in the context of yes/no questions, which has been noted as "adversarial" (Hedberg et al. 2004) or "challenging" (Ladd 1996:24), and the fact that the absence of context in the experimental sentences would make subjects less inclined to interpret ambiguous intonation patterns in an adversarial or challenging way.

Some analyses of the syntax and semantics of alternative questions (von Stechow 1991, Aloni and van Rooij 2002, Romero and Han 2003, Han and Romero 2004a,b, Beck and Kim 2006) do not explicitly take the semantic contribution of the final fall into account and do not derive the ‘exactly one’ expectation. Rather, they derive a difference in semantic value between alternative questions and equally worded yes/no questions from a presumed difference in focus structure, which is normally reflected prosodically by a difference in accentual characteristics. It may be possible to extend these analyses so as to reflect the importance of the final fall and derive the ‘exactly one’ expectation. However, the experimental results presented here suggest that these analyses, in their current form, are too narrowly concerned with differences in focus structure and the associated differences in accentual characteristics.

Other theoretical proposals do acknowledge the importance of the final fall in a formal account of the syntax and compositional semantics of disjunctive questions (Rawlins 2008, Biezma 2009, Roelofsen and van Gool 2010, Haida 2010, Roelofsen and Pruitt 2011, Biezma and Rawlins 2012), though they differ in how they model the ‘exactly one’ expectation. Some conceive of it as a *presupposition* (Rawlins 2008, Biezma 2009, Haida 2010, Biezma and Rawlins 2012),<sup>14,15</sup> while others characterize it as an update that is *imposed* on the common ground, rather than proposed or presupposed (Roelofsen and van Gool 2010, Roelofsen and Pruitt 2011). Some focus on the expectation that exactly one of the disjuncts is *true* (Rawlins 2008, Roelofsen and van Gool 2010, Haida 2010, Roelofsen and Pruitt 2011), while others focus on the implication that the given alternatives exhaust the set of possibilities that are currently *at issue* in the conversation, i.e., the set of possibilities that the responder is expected to choose from (Biezma 2009, Biezma and Rawlins 2012).

A detailed comparison of relative merits of these proposals must be left for another occasion. We simply note here that any proposal which explicitly connects the final fall with the ‘exactly one’ interpretation is consistent with the observations in (11) and with the primary result of the experiment.

## 4.2 Accentual characteristics

Although the final contour was the most influential prosodic feature in disambiguation, the experiment also revealed a statistically significant increase in the number of alternative question paraphrases for the M contours, those with multiple prominent accents, compared to the S contours, those with only a single prominent accent (54% and 46%, respectively). In other words, multiple prominent accents increased the likelihood of an alternative question paraphrase. Moreover, the descriptions cited in §2 invariably characterize the *canonical* prosody of an alternative question as one that involves multiple accents and a prosodic

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<sup>14</sup>See also Aloni et al. (2009) and Aloni and Égré (2010) who discuss the ‘exactly one’ expectation of alternative questions in detail and characterize it as a presupposition, but are not concerned with the details of how this presupposition is derived compositionally.

<sup>15</sup>See also Bartels (1999), who focuses on the implication that ‘at least’ one of the disjuncts holds rather than ‘exactly one’ and characterizes this implication as a presupposition.

phrase break between the disjuncts.

In our view, these facts are best explained by assuming that focus-marking is required on each of the disjuncts in order to derive an alternative question interpretation (Aloni and van Rooij 2002, Romero and Han 2003, Han and Romero 2004a,b, Beck and Kim 2006, Roelofsen and van Gool 2010, Haida 2010, Roelofsen and Pruitt 2011). Since focus-marking is normally reflected prosodically by prominent pitch accents, such theories directly account for the fact that the canonical prosody of alternative questions involves multiple accents, and for the fact that M contours received more alternative question paraphrases than S contours in the experiment.

At first sight it is surprising on these accounts that a large percentage of the S↓ contours received an alternative question paraphrase, even though multiple accents were not present. However, the S↓ contour may be seen as a case in which there are conflicting cues. On the one hand, the final fall strongly favors an alternative question interpretation, but multiple foci are needed as well in order for such an interpretation to arise. Although prominent pitch accents are not present, it may be assumed that the stronger cue (the final fall) wins out in this case. This is consistent with the assumption that focus, although normally reflected prosodically by prominent pitch accents, is not always signaled in this way, and that a listener may retrieve focus-marking even in the absence of clearly perceptible prominent pitch accents.

Under these assumptions about the processing of focus-related prosodic cues (and the absence thereof), the theories cited above account for the experimental results pertaining to the role of accentual characteristics in the interpretation of disjunctive questions. We note that these theories differ in how they implement focus as a necessary condition for alternative question interpretations. Some assume that focus semantics plays a crucial role in the compositional derivation of alternative question interpretations (Aloni and van Rooij 2002, Beck and Kim 2006, Roelofsen and van Gool 2010, Haida 2010). Others assume that the syntactic structure of alternative questions forces contrastive focus (Romero and Han 2003, Han and Romero 2004a,b, Roelofsen and Pruitt 2011).

There are also some recent proposals that concentrate exclusively on the final fall, leaving the influence of the accentual characteristics out of consideration (Rawlins 2008, Biezma 2009, Biezma and Rawlins 2012). The results of the experiment presented here suggest that these proposals may be incomplete, just as the earlier proposals that focused exclusively on accentual characteristics, disregarding the final fall.<sup>16</sup>

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<sup>16</sup>It must be noted that Rawlins (2008), Biezma (2009), and Biezma and Rawlins (2012) all refer to earlier expositions of the experiment discussed in this paper (Pruitt 2008a,b) for evidence that the final fall plays a crucial role in disambiguating disjunctive questions. These earlier expositions indeed emphasized the importance of the final fall. However, they also noted that the accentual characteristics play a significant role as well, albeit non-decisive.

## 5 Conclusion

This paper has presented a perception experiment investigating which prosodic features play a role in determining whether a given disjunctive question is interpreted as an alternative question or as a yes/no question. The experiment showed that the final pitch contour is the most informative prosodic feature. Accentual characteristics also play a significant role, although, contrary to what is often assumed in the literature, they cannot force an alternative question interpretation on their own. These results suggest that most existing theories of disjunctive questions, which only take one of the relevant prosodic features into account, are incomplete. We suggested that the experimental results are best accounted for by a theory predicting that both the presence of a final fall and the presence of focus-marking on all disjuncts are necessary to obtain an alternative question interpretation.

## A Experimental materials

<i>Sentence</i>		<i>Contours Heard by Group</i>			
		G1	G2	G3	G4
List 1	Did the professor ask Bill to come early or stay late?	M↓	S↑	M↑	S↓
	Does Paula sing or dance?	.	.	.	.
	Does Roger plan to mow the grass or take out the recycling?	.	.	.	.
	Is Pamela going to knit a scarf or buy a sweater?	.	.	.	.
	Does Maria plan to call in sick or take a vacation day?	.	.	.	.
	Was Samantha going to walk the dog or feed the cat?	.	.	.	.
List 2	Did Phil not use sunscreen or wear a hat?	S↓	M↓	S↑	M↑
	Is Bruce going to buy us a map or draw us a picture?	.	.	.	.
	Is the professor giving a quiz or a test?	.	.	.	.
	Did William attend the meeting or send an e-mail?	.	.	.	.
	Does Harry rent from from Blockbuster or use Netflix?	.	.	.	.
	Did Lisa order pizza or calzones?	.	.	.	.
List 3	Is Frank finishing his homework or studying for the test?	M↑	S↓	M↓	S↑
	Did Sally bring wine or bake a dessert?	.	.	.	.
	Would Emily like to visit the aquarium or go to the zoo?	.	.	.	.
	Did Eddie spend all night watching movies or playing video games?	.	.	.	.
	Was Pat going to wash the dishes or mop the floor?	.	.	.	.
	Would you like ranch or thousand island?	.	.	.	.
List 4	Do the kids need a snack or a bathroom break?	S↑	M↑	S↓	M↓
	Did you want mocha or French vanilla?	.	.	.	.
	Is Marcia allergic to dairy or soy?	.	.	.	.
	Did Alan write her a poem or buy her flowers?	.	.	.	.
	Is Mary going to file her taxes or pay the phone bill?	.	.	.	.
	Does Petra want to get drinks or go dancing?	.	.	.	.

Table 4: Experimental items and contours by group

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