The Interpretation of Prosody in Disjunctive Questions

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The interpretation of prosody in disjunctive questions

Kathryn Pruitt Floris Roelofsen

Abstract. Alternative questions are distinguished prosodically from identically-worded disjunctive yes/no questions. Recent work has interpreted this to mean that the underlying difference between the question types is the presence of 'focus' on the disjuncts of alternative questions, which is also argued to account for various aspects of their meaning and distribution. We challenge this assumption by presenting the results of a perception experiment which show that the final contour is the most informative prosodic feature of disjunctive questions. We conclude that recent accounts of alternative questions that rely on focus are in need of revision.

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.

(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 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 easy enough to informally describe the meaning difference between alternative questions and disjunctive yes/no questions, a formal account of this difference is hindered by difficulties with the semantics of disjunction and questionhood and by the need to account for peculiarities in the distribution of alternative questions, such as their inability to co-occur with preposed negation (Han and Romero 2004a) and sensitivity to intervention effects (Beck and Kim 2006). In practice this means that it is a challenge to know what formal associations are even possible between the different prosodies seen in disjunctive questions and their different meanings, because it is not immediately obvious how their meanings are formally derived.

A number of recent proposals have made attempts to bring clarity to this state of affairs by using prosodic information to bootstrap into syntactic and semantic proposals (Aloni and van Rooij 2002, Beck and Kim 2006, Han and Romero 2004a,b, Romero and Han 2003). These proposals have in common the assumption that the prosodic emphasis on the disjuncts of an alternative question signals focus-marking. Disjunct focus is then taken to account for the meaning and/or distribution of alternative questions in contrast to disjunctive yes/no questions, which are assumed (sometimes implicitly) to lack disjunct focus-marking.[1] While we would like to endorse this general approach—bootstrapping from prosody to syntax and semantics—the argument that we make here is that these proposals are missing an important generalization. Detailed examination of the canonical prosodies of alternative questions and disjunctive yes/no questions, which we will present in §2, reveals that they differ in more ways than the descriptor "focus" generally covers; namely, the disjunctive phrase of an alternative question must end with falling intonation. In §3 we present a perception experiment that confirms the importance of this fall by showing that a disjunctive question tends not to be perceived as an alternative question if it ends with rising rather than falling intonation. In §4 we discuss proposals for deriving disjunctive question meaning in light of the experimental results, and §5 concludes.

2 Canonical disjunctive question prosodies

An extensive discussion of the intonation of alternative questions is undertaken by Bartels (1999:Ch. 4), who identifies 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

[1] The actual meaning that is argued to be contributed by focus differs among these sources, which perhaps indicates the rather unfortunate polysemy that the term *focus* has acquired.

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.[2] 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 pitch 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-H% or L* H-H%) is a result of a prosodic phrase break with a high phrase accent and optional boundary tone (H-H%), 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[3]

	Would you like mineral water			or lemonade?	
a. (	H*	H-H%) (	H*	L-L%)	
b. (	L*	H-H%) (	H*	L-L%)	

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

[2]We follow Bartels (1999) and others (Pierrehumbert 1980, Beckman and Pierrehumbert 1986, Pierrehumbert and Beckman 1988, 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 do not attempt precision in the marking of hierarchical or nested prosodic constituents. Optional prosodic elements are indicated with gray text.

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

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-H%, and the final contour. This detailed description stands in contrast to the many recent accounts of disjunctive questions which identify only one prosodic feature as potentially relevant. Han and Romero (2004b:547), for example, say of disjunctive questions, citing Romero (1998), 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 are found in the other papers cited in the introduction.[4]

The prosodic descriptions assumed in this work are not so much contradicted by this detailed look at the prosodies of alternative questions and disjunctive yes/no questions, as they are shown to be incomplete. Pitch accents do indeed seem to reliably occur on the disjuncts of alternative questions, unlike in yes/no questions whose non-final-disjunct accent is optional, but the differing disjunct emphasis occurs along with a phrase break with concomitant edge tones and a different final contour. These canonical contour descriptions should give us reason to doubt that accents are the only important prosodic feature in alternative questions, and thus, that focus is the only relevant syntactic/semantic feature.

Bartels emphasizes that the final contour in an alternative question is invariably reported to be falling, unlike a yes/no question, whose final contour appears to be more flexible, and she presents an analysis of alternative question pragmatics that assumes the final contour of an alternative question is a reflex of a morpheme that conveys an essential part of an alternative question's meaning.[5] Bartels assumes that the accentual differences are also important but says explicitly (p147), "The fact that [some contours]. . . place an accent on each of their disjuncts clearly does not suffice to make them eligible as [alternative questions]".

If Bartels is correct that accents are not a sufficient cue to distinguish an alternative question from a disjunctive yes/no question, it would suggest that the recent focus-centric alternative question proposals would need to be revised. If other prosodic features turn out to be at least as important as the accents, then at best these proposals would have

[4]Aloni and van Rooij (2002:29): "In alternative questions, the alternatives are stressed" (their examples then show the disjuncts of alternative questions as focus-marked, whereas for a yes/no question the entire sentence is focus-marked). Beck and Kim (2006:166): "Availability of the AltQ reading depends on intonation: it seems that both disjuncts must be focused in order for it to be present". Romero and Han (2003): "the disjunct associated with *whether/Q* bears Focus stress. A pitch accent on each NP within the disjunction is needed in order for [alternative question]-readings to obtain". Han and Romero (2004a) give the same description found in Han and Romero (2004b), quoted in the text above.

[5]More specifically, 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.

assumed an incomplete description of relevant prosodic differences; at worst, they may have attributed to a focus feature aspects of alternative question meaning and distribution that could be better explained in some other way.

We report in the next section an experiment that was designed to test how the presence or absence of prominent pitch accents on each disjunct affects listeners' interpretations of disjunctive questions with the final contour varied orthogonally.

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. In the rest of this section we will 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 boundary tones) between disjuncts. Although it would in principle be possible to decouple the prominent accents and prosodic phrase boundary 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.[6] 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 an alternative question (M↓), or a single accent, no break, and a rise like a 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↓)).

		ACCENT	
		Multiple	*Single*
FINAL	*Fall*	M↓	S↓
	Rise	M↑	S↑

M↓ = canonical Alternative question

S↑ = canonical Yes/no question

Table 1: Factors crossed in design of stimuli

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 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 reflects an underlying syntactic or semantic difference between alternative questions and disjunctive yes/no questions, as argued for or

[6]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*.

assumed by most of the recent work on alternative questions, then we would expect to see multiple-accent contours associated with alternative question interpretations, but not single-accent contours. We can distinguish a strong version of this prediction and a weak version. The strong prediction holds that a disjunctive question will be interpreted as an alternative question if and only if the disjuncts have the accentual characteristics of an alternative question (i.e., prominent accents on both disjuncts and a prosodic phrase break). This is what we would expect if disjunct focus-marking were the only difference between the two kinds of disjunctive questions. If the strong prediction is correct, the M↑ contour should be interpreted as an alternative question more often than not, since it has the accentual characteristics of an 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 schematized in (5).

(5) Strong predictions of focus-based accounts[7]

M↑ > 50% Alternative question interpretations

S↓ < 50% Alternative question interpretations

We can alternatively identify a weaker version of the focus hypothesis. The weak version of the prediction holds only that the accentual characteristics will sway interpretation, with M contours being more likely to be interpreted as alternative questions 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

[7]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.

often on average than contours with a single prominent accent. This prediction is schematized in (6).

(6) Weak prediction of focus-based accounts

% of Alternative question interpretations: M > S

The weak version of this hypothesis is consistent with Bartels (1999), though 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 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 in (8a) with one of the experimental items, while for the

yes/no question pronunciation, the prosody in (8b) was used. 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. 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. 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.

(8) Canonical prosodies recorded for experiment[8]

		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

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

[8]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.

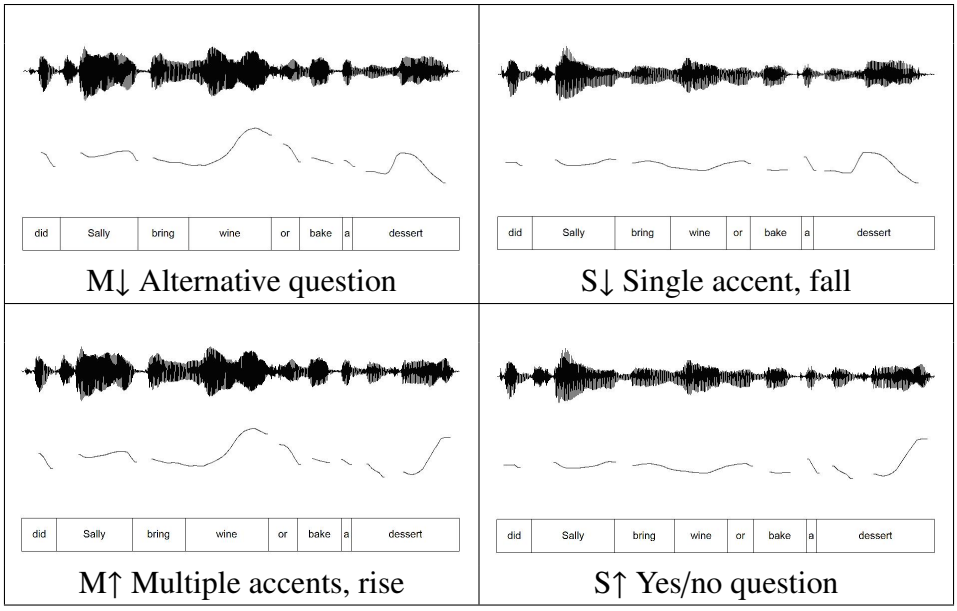

Figure 1: Examples of the four contours used in the experiment. Pitch tracks created in Praat (Boersma and Weenink 2007); errant pitch tracking at consonantal bursts has been removed.

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.[9]

(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.

[9]Splicing was done at the beginning of the word with the nuclear accent unless it began with a sonorant consonant, as these 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.

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 answer 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↑. Figure 2 illustrates the responses for each contour as the proportion of alternative question paraphrase choices.

	Paraphrase choice			
Heard	Alternative question	Yes/no question	"Other"	**Total**
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
Total	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 from the `lme4` package (Bates and Maechler 2009).[10] 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.[11]

[10] 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.

[11] Likelihood ratio tests were used to determine which random effects to include. Table 5 in Appendix B provides the results of these tests. The final model, including the random effects, was specified with the fol-

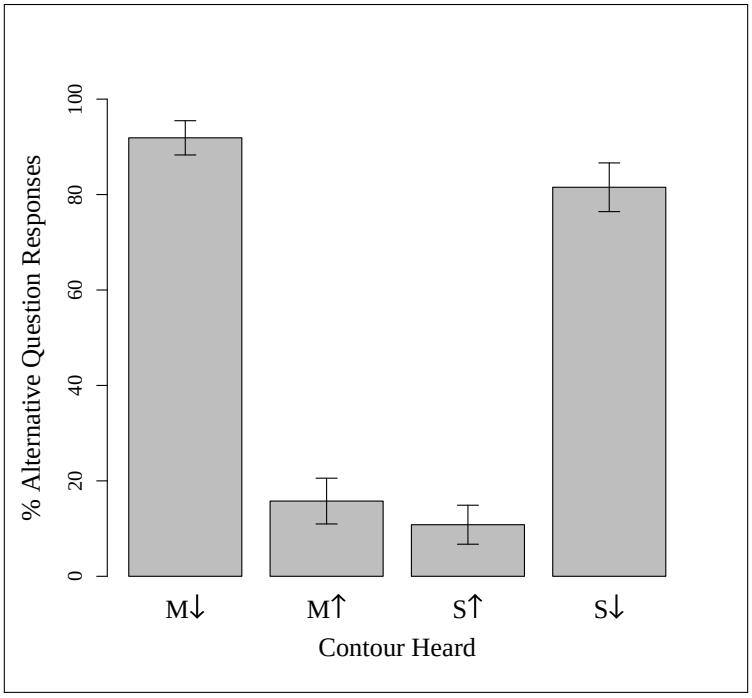

Figure 2: Proportion of Alternative question responses for each contour (±95% Confidence interval)

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 the interaction of Final and Accent did not reach statistical significance ($p = .1351$).

A comparison of the estimates of the coefficients for the two factors reflects the rela-

lowing formula in the call to `lmer`: `Response~Final*Accent+(1+Final | Subject)+(1+Final | Item)`.

tionship 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↓ and S↓) received an alternative question paraphrase in 87% of cases, while contours ending in a rise (S↑ and M↑) were interpreted as alternative questions only 13% of the time. Contours with multiple accents (M↓ and M↑) were interpreted as alternative questions 54% of the time, compared to contours with a single prominent accent (S↑ and S↓), which received 46% alternative question responses.

Goodness of fit statistics were calculated with the `somers2` function from the `Hmisc` package in R (Baayen 2008). Both Somers' D_{xy} (.9175) and the Concordance C-number (.9588) indicate that the model provides a very good fit to the data.

Predictor	Coefficient	Std. Error	Wald Z	p
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 × ACCENT	0.69	(0.46)	1.49	.1351
Goodness of fit				
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 two sets of predictions that are suggested by the many focus-based accounts of alternative questions in the recent literature. These accounts generally predict that prominent disjunct accents, insofar as they can be interpreted as focus, will

favor an alternative question interpretation. If we take these proposals at face value, they make the strong prediction that prominent accents are a necessary and sufficient condition for a disjunctive question to be interpreted as an alternative question. This strong hypothesis was not supported. It predicts that the M↑ contour should receive mostly alternative question interpretations, but in fact the M↑ contour was interpreted as an alternative question only 16% of the time. It also predicts that the S↓ contour will not receive predominantly alternative question paraphrases, also contrary to fact since this contour was interpreted as an alternative question in 82% of cases in the experiment.

We also identified these proposals as making a weaker prediction, namely, 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 did receive support from 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 will play a facilitatory or supporting role in the interpretation of disjunctive questions.

The results also provide support for Bartels' contention that the final fall (or some component of it) signals a meaningful contrast in disjunctive questions, since contours with a final rise were interpreted as alternative questions substantially less often than contours with a final fall (13% vs. 87%). M↑ in particular received only 16% alternative question responses. However, Bartels' assumption that a falling contour without accents on both disjuncts (that is, S↓) would *not* be 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 (independently) 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. It is this generalization that has been missing from recent work tying prosody to meaning in disjunctive questions.

At a minimum, then, the experimental results suggest that recent accounts of disjunctive questions that identify focus-derived accents as the only relevant prosodic feature need to be revised to take into account the role of the final contour. Since the final contour is so important in determining whether a disjunctive question is interpreted as an alternative question or not, it would seem to be crucial in any semantic account of alternative questions to identify what the final contour signals. In the rest of this section we first address the final contour and discuss the range of syntactic and semantic assumptions that would be compatible with the experimental results (and the difference in prosody generally).[12] We then return to the question of the accentual characteristics and briefly present evidence that a distributional fact about alternative questions that has been attributed to focus might require a different explanation.

[12]Although it is not crucial here, we assume that the relationship between prosody and semantics is mediated by a syntactic representation, so to fully understand disjunctive questions we would need to discover the underlying syntactic differences between alternative questions and disjunctive yes/no questions that give rise to their distinct prosodies on the one hand and distinct meanings on the other. By "syntactic differences" we do not wish to preferentially single out constituency. Rather, we also assume that presence vs. absence of semantically interpretable features or operators, including focus for example, constitute properly "syntactic differences" as well.

4.1 Final contour

In the experiment, 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. How should these near-categorical results be interpreted? In principle the experimental results are equally likely under the following hypotheses: (i) a final fall is integral to alternative questions, (ii) a final rise is integral to a yes/no question, 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.[13] 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.

As for the specific meaning contribution of the fall, we note that a canonical alternative question with a prosody like that shown in (a) in (11) below gives an addressee a choice between a set of items (here, two), with the expectation that the addressee will answer with 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

[13] 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), and the fact that the absence of context in the experimental sentences would make subjects somewhat less inclined to interpret ambiguous intonation patterns in an adversarial way.

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*—options which are not available to an addressee in response to (a) (unless the addressee wishes to object to the 'exactly one' expectation imposed by the speaker of (a)). Thus, it must be the case that the formal representation of the meaning of alternative questions restricts the space of answers in this specific way, and this restriction must be associated with falling intonation.

(11)

	Would you like mineral water		or lemonade?	
a. (	H*	H-H%) (	H*	L-L%)
b. (	H*	H-H%) (	L*	H-H%)
c. (	H*	H-H%) (	H*	H-H%)

We would like to note here the obvious connection between the prosody of alternative questions discussed here and the prosody of lists in general. Falling intonation at the end of a list (and, conversely, rising intonation on non-final elements) is generally associated with signaling the end of the list, and indeed, in an alternative question the fall on the final element seems to indicate the end of the set of options offered by the speaker. Zimmermann (2000) observes something similar in the behavior of disjunction in certain modal contexts, where a fall or a rise at the end of a disjunctive list determines whether it is interpreted as giving an exhaustive or non-exhaustive set of possibilities, respectively (e.g., "Mr. X may take a bus or a taxi", Zimmermann 2000:256). However, an alternative question (with the canonical falling intonation at the end) conveys not just that the enumerated options are the only ones available, but also that those options are mutually exclusive—at most one can be offered as a cooperative response. Thus, accounting for the role of the fall in conveying this meaning will require more than simply associating it with other listing contexts. A full account of the meaning contribution of this fall is outside the scope of this paper, but see

Roelofsen and van Gool (2010) and Roelofsen and Pruitt (In preparation) for proposals.[14]

A final note on the interpretation of the fall: 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%. 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 the important feature, rather than the fall itself. Our experimental manipulation was not sensitive enough to distinguish hypotheses about the contribution of individual tones, and 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 would require further empirical investigation, as the experiment presented here provides no evidence about the individual tones one way or another.

4.2 Accentual characteristics

We return now to the accentual characteristics of disjunctive questions. The difference in interpretation brought about by the accentual characteristics is consistent with the hypothesis that focus plays a supporting role in the interpretation of alternative questions, although the results show that these features are neither a necessary nor a sufficient condition for an alternative question interpretation. It is certainly the case that the information structure of alternative questions—in which the addressee is given a choice among a fixed set of options—lends itself to contrastive focus marking. But we think the experimental results make it doubtful that the semantics of contrastive focus delivers a crucial part of the

[14] See also Rawlins (2008), Biezma (2009), and Biezma and Rawlins (2010) who draw similar conclusions on the basis of an earlier presentation of these experimental results but present different formal proposals.

composition of alternative question meaning.

Moreover, we think it likely that turning attention to prosodic features other than those plausibly derived from focus may lead to novel insights about alternative question meaning and distribution. Han and Romero (2004a) give the example in (12) to illustrate that preposed negation is incompatible with an alternative question reading (though it is fine as a yes/no question). Han and Romero assume that focus (which they indicate with capital letters on the syllable with the accent) is not present in the yes/no question in (12a) but is present on the disjuncts of the alternative question in (12b), and that this focus, spelled out with pitch accents, is responsible for the ungrammaticality of alternative questions with preposed negation.

(12) a. Didn't John drink coffee or tea? (Han and Romero 2004a, example (6a))

b. *Didn't John drink COFfee or TEA? (ibid., example (6b))

If we consider this sentence with more detailed prosodic representations, it becomes clear that disjunct pitch accents are not enough to make the sentence ungrammatical. The contour in (13a) corresponds to a yes/no question intonation, and matches what we presume is the intended intonation of (12a). The contour in (13b) is the same sentence pronounced with canonical alternative question intonation, including disjunct emphasis and final falling pitch, which we can assume is the intended intonation of (12b). Our judgments of these sentences match those given by Han and Romero (2004a). However, the contour in (13c) (which is essentially the same as the M↑ contour used in the experiment), is not ungrammatical with this sentence despite having pitch accents on both disjuncts. It is interpreted to have a meaning closer to that of a yes/no question than to an alternative question.[15] A similar observation can be made for the sentence in (13d).

[15] See Roelofsen and van Gool (2010) for further discussion of these intonation patterns.

(13)		Didn't John drink	coffee	or tea?	Yes/no	Alt
	a.	(		L*H-H%)	✓	*
	b.	(	H*H-) (	H*L-L%)	*	✓
	c.	(	H*H-) (	L*H-H%)	✓?	*
	d.	(	H*H-) (	H*H-H%)	✓?	*

These examples suggest that it is the fall (or, the meaning signaled by the fall) that is incompatible with preposed negation in these examples, not disjunct pitch accents. If this is the case, the account provided by Han and Romero (2004a) is in need of revision. A revised account must either provide a formal representation for the contribution of the fall and show how it derives the data in (13), or it must explain the data in another way, for example by specifying why a rising contour would prevent disjunct pitch accents from being interpreted as focus.

5 Conclusion

In our view, a detailed examination of the prosodic features of disjunctive questions has not provided support for the assumption that underlies nearly all recent discussion of alternative questions in the literature, namely, the assumption that alternative questions are distinguished from their yes/no question counterparts only by the presence of focus on each disjunct (Aloni and van Rooij 2002, Romero and Han 2003, Han and Romero 2004a,b, Beck and Kim 2006). Instead, the final contour was shown to be critical in establishing the contrast between the two types of disjunctive questions explored here. Future work will be tasked with positing the correct set of assumptions to derive the different meanings and prosodies for alternative questions and disjunctive yes/no questions, and taking into account the centrality of the final contour in distinguishing the two question types can only aid in this effort.

A Experimental materials

		Contours Heard by Group			
	Sentence	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

B Random effects

Table 5: Likelihood ratio tests for random effects in mixed logit models with interaction

					Model comparison[a]		
Model formula	df	AIC[b]	BIC[c]	logLik[d]	χ^2	df	p
Response~Final*Accent+(1 | Subject)	5	692.93	716.87	-341.46			
Resp~Fin*Acc+(1 | Subj)+(1 | Item)	6	688.17	716.90	-338.08	6.7596	1	.0093
Resp~Fin*Acc+(1+Fin | Subj)+(1 | Item)	8	654.22	692.54	-319.11	37.9438	2	<.0001
Resp~Fin*Acc+(1+Fin | Subj)+(1+Fin | Item)	10	638.42	686.31	-309.21	19.8068	2	<.0001
Resp~Fin*Acc+(1+Fin+Acc | Subj)+(1+Fin | Item)	13	643.84	706.09	-308.92	0.5820	3	.9005
Resp~Fin*Acc+(1+Fin+Acc | Subj)+(1+Fin+Acc | Item)	16	648.04	724.67	-308.02	1.7915	3	.6168
Resp~Fin*Acc+(1+Fin*Acc | Subj)+(1+Fin*Acc | Item)	24	654.81	769.75	-303.41	9.2336	8	.3230

[a] Each successive model is compared with the previous model (a proper subset) using a likelihood ratio test to determine whether including a random effect provides a significant improvement in the fit of the model (Pinheiro and Bates 2000, Jaeger 2008). Because the log-likelihoods are approximated for generalized linear mixed models, the likelihood ratio test should likewise be considered only an approximation (Jaeger 2008:443-4).

[b] Akaike's Information Criterion

[c] Bayesian Information Criterion

[d] Quasi-log-likelihood (maximized by Laplace approximation)

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