

Intonational meaning: the case of alternative questions*

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Abstract

This paper investigates which prosodic features distinguish alternative questions from identically worded yes/no questions, and presents a compositional semantics which explicitly takes the contribution of the relevant prosodic features into account.

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1 Introduction

The central tenet of most contemporary work in semantics, the *principle of compositionality*, holds that “the meaning of a complex expression is determined by its structure and the meanings of its constituents” (Szabó, 2007, p.1). Usually, the atomic constituents of a sentence are taken to be the words that it consists of. Sometimes words are broken up into morphemes that each make their own semantic contribution.

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However, the meaning of a sentence is often determined not only by the words/morphemes that it contains and its syntactic structure, but also by its *intonation*. In trying to capture the semantic impact of different intonation patterns, one could again take a compositional approach. That is, one could assume that each intonation pattern is characterized by a number of more elementary ‘intonational features’, each of which makes an independent semantic contribution. In effect, these intonational features could then be treated just like morphemes, and one may indeed expect that the semantic effects that are established by an intonational feature in one language might be established by actual morphemes in other languages, and perhaps by variation in syntactic structure in yet other languages.

This approach, however, faces an immediate challenge: what are the elementary building blocks of the intonation patterns that we observe? Words have clear boundaries, morphemes are sometimes somewhat more difficult to distinguish, but intonational features are of a completely different order: intonation patterns can in principle be broken up into pieces in infinitely many ways. The relevant pieces can only be identified by carefully investigating minimal pairs of utterance types that differ only in one intonational aspect. If there is a robust semantic difference between such utterance types, then the intonational aspect in question may be assumed to make a significant semantic contribution. And that contribution may indeed be characterized based on the observed overall difference in interpretation between the two utterance types.¹

This is the general programme that the present paper attempts to advance. We will look at a particular construction—disjunctive interrogatives—whose interpretation is notoriously affected by intonation. To get an impression of this phenomenon, consider the following example:

- (1) Did Sally bring wine or juice?

This disjunctive interrogative can be pronounced in different ways, and its interpretation is partly determined by the choice of intonation pattern. The literature has paid most attention so far to two specific intonation patterns: one which exhibits high pitch accents on ‘wine’ and ‘juice’ and a falling pitch movement at the very end of the sentence, and one which exhibits a low pitch accent on ‘juice’ and a rising pitch movement at the end of the sentence. The relevant pitch contours are depicted in figures ?? and ??, respectively, and will be discussed in more detail below. It has been observed by several authors that these intonation patterns yield distinct semantic interpretations. For instance, if pronounced with the first intonation pattern (with separate high pitch accents on each of the disjuncts and a final fall), (1) does not licence ‘yes’ or ‘no’ as an answer. Moreover, it conveys that the speaker expects that Sally brought wine or juice, but not both. On the other hand, if pronounced with the second intonation pattern (with no pitch accent on the first disjunct and no final fall), (1) does licence ‘yes’ and ‘no’ as possible answers, and it does not convey an expectation on the speaker’s part that Sally brought wine or juice.

Because of the difference in answerhood conditions, sentences like (1) are usually called *yes/no questions* when pronounced with the second intonation pattern, and *alternative questions* when pronounced with the first intonation pattern.

Different assumptions have been made in the literature as to which intonational features crucially distinguish alternative questions from yes/no questions. Some authors assume that the separate pitch accents on each of the disjuncts are essential, others assume that the final fall is crucial, or that a combination of these two features is necessary to enforce an alternative question interpretation.

The first part of this paper presents an experiment that tests these assumptions. The outcome of the experiment, in a nutshell, is that the final fall is absolutely crucial, and that the separate pitch accents on each of the disjuncts are not strictly necessary to achieve an alternative question interpretation, although their absence does deteriorate the rate at which such interpretations are established.

These findings contradict the assumptions that underlie the formal semantic accounts of alternative questions that have been developed in the literature so far (cf. Aloni and van Rooy, 2002; Han and Romero, 2004a,b; Beck and Kim, 2006).² Thus, these accounts need to be revised. The second part of this paper presents a formal semantic account of disjunctive interrogatives that takes the relevant intonational features into account, and associates them with a precisely defined semantic contribution. The proposal makes crucial use of formal tools that have been developed recently within the framework of *inquisitive semantics* (Groenendijk and Roelofsen, 2009; Ciardelli and Roelofsen, 2009; Anderbois, 2009; Balogh, 2009; Cia-

¹Add references. Ladd 1996? Pierrehumbert and Hirschberg?

²Also (von Stechow, 1991)? Mention also (Bartels, 1999)?

rdelli, 2009; Mascarenhas, 2009, among others) and further develops these tools in ways that may be useful for the analysis of other empirical phenomena as well. Some of these phenomena will be briefly discussed in the final section of the paper.

2 Identifying the relevant prosodic features

2.1 Two hypotheses

The *canonical* prosodies associated with alternative questions and their yes-no question counterparts in English are relatively well-described. The most extensive discussion of the intonation of alternative questions has been undertaken by Bartels (1997: Ch 4), who cites early descriptions including Schubiger (1958), Rando (1980), and Quirk, et al. (1985). These sources converge on two primary features of alternative question prosody: (i) all disjuncts are pitch accented and usually pronounced in separate prosodic phrases with accompanying boundary tones, and (ii) the end of the sentence or disjunctive phrase ends with falling intonation. An example of a canonical pitch contour for an alternative question illustrating these features is shown in Figure 1.³

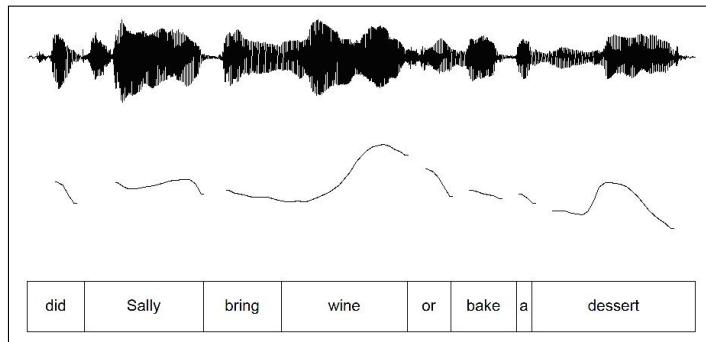


Figure 1: Canonical alternative question prosody

In contrast, corresponding yes-no questions with disjunction typically prosodify the disjuncts into one intonational unit and canonically end with a pitch rise, as illustrated in Figure 2. As a consequence of the unified intonational phrasing of the disjuncts, this contour is formally identical to the canonical prosody of a yes-no question without disjunction. Yes-no questions in general have been observed with a range of non-canonical final pitch contours when the context allows (e.g., Bartels 1997: Ch 5; Hedberg, Sosa, and Fadden 2004), and yes-no questions with a disjunctive phrase are no exception.

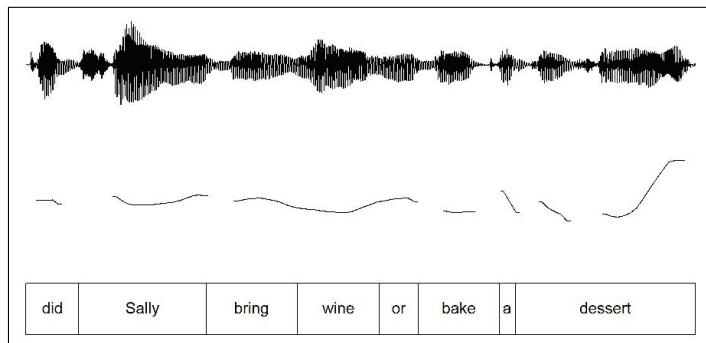


Figure 2: Canonical disjunctive yes-no question prosody

³This and other pitch tracks in this paper were created by Praat speech analysis software (Boersma and Weenink 2006) on the basis of author recordings. Pitch excursions measured at consonantal bursts and errant pitch tracking due to non-modal voice have been removed for clarity, but these omissions change neither the local nor global pitch contours represented.

Intuitively, alternative questions and their yes-no question counterparts illustrate a rather clear example of ambiguity resolved by intonation. For this reason, alternative questions in particular have been the focus of analyses that associate prosodic features with meaning. However, because several prosodic features distinguish canonical alternative questions from their yes-no question counterparts, the literature describing these differences yields analyses somewhat diverse in their emphases. The analyses can be grouped into two categories, **ACCENT ONLY** and **ACCENT + FINAL FALL**, based on what their proponents take to be the crucial prosodic features.

Accent only. Han and Romero (2004b; Romero and Han 2003) provide an analysis of the role of prosody in alternative question interpretation with the assumption that the difference between alternative and identically worded yes-no questions lies primarily in the way the disjuncts themselves are pronounced. In their words, “the [yes-no]-reading presents neutral intonation on the disjunctive phrase... whereas the [alternative]-reading is in general achieved by placing focus stress on each disjunct” (2004b: 547). They adopt focus semantics in order to explain why an alternative question reading is blocked in certain sentence constructions (e.g., with ‘preposed negation’, Han and Romero 2004a). Beck and Kim (2006) follow Han and Romero in adopting a focus-centric prosodic description of alternative questions, and adopt focus semantics in deriving the meaning of alternative questions and to explain other peculiarities in their distribution. We take “focus stress” in these descriptions to mean that each disjunct is pitch accented, which is consistent with the canonical description provided above. We refer to these hypotheses as **ACCENT ONLY** because the presence of focus-derived pitch accents is taken to be the only relevant prosodic feature that sets alternative questions apart from disjunctive yes-no questions. None of these accounts mentions other intonational features that may be relevant, including final pitch contours.⁴

Accent + Final fall. Another approach to intonational meaning in alternative questions is taken by Bartels (1997: Ch 4). Her descriptions emphasize that in addition to having pitch accents on each disjunct, alternative questions must be pronounced with a final pitch fall, as in the canonical prosody in Figure 1. The final fall is important for Bartels’ proposal because it is the locus of the low boundary tone that is argued to be an essential meaning-contributing prosodic element in a wide range of declarative and interrogative sentence types.⁵ She hypothesizes that disjunct pitch accents and a final fall are the minimal requirements of an alternative question, and when they are not all present, the sentence is likely to be interpreted as a yes-no question, or an ellipted concatenation of yes-no questions.⁶ In other words, Bartels’ description requires that both elements of the canonical prosody of alternative questions be present in order to obtain an alternative question reading.

The **ACCENT ONLY** and **ACCENT + FINAL FALL** accounts propose different views of the essential prosodic differences between alternative questions and their yes-no question counterparts, and the difference of views corresponds to different roles for intonation in the compositional semantics of alternative questions.

Neither account is falsified by examining the canonical prosodies of alternative or yes-no questions, but they make different predictions about which features should be important in disambiguating alternative questions from identically worded yes-no questions. Thus, each of the analyses can be assessed by the degree to which it accords with listeners’ treatment of non-canonical contours with some but not all of the canonical features. These predictions are explored in the next section, which reports an experiment designed to test which intonational feature(s) in these contours are most influential in determining how the sentence will be interpreted—particularly whether pitch accents (and prosodic phrasing) or the final pitch movement can be an informative clue without the aid of the other. The results in turn can be interpreted as evidence in favor of specific meaning contributions from specific prosodic elements.

⁴The difference in prosodic phrasing is not generally mentioned in these descriptions either, though the presence of a focus pitch accent on each disjunct could be argued to induce a prosodic phrase boundary, so a difference in prosodic phrasing may be argued to be implicit in such descriptions.

⁵Should this be more specific at this point?

⁶need to find this part of her chapter, to double check, and I’m guessing this might need to be in quotes as well

2.2 Experiment

2.2.1 Overview

A perception experiment was conducted to determine listeners' interpretations of disjunctive questions when they exhibit both canonical and non-canonical combinations of prosodic features. Participants were presented with disjunctive questions with four different prosodic contours and were asked to choose the most appropriate paraphrase. Contours 1 and 2 were the canonical pronunciations of alternative and yes-no questions with the features described in Section 2.1 and shown in Figures 1 and 2. The other two contours were modified versions of the canonical prosodies. The first modified contour (Contour 3) mirrored that of an alternative question except with a final rise rather than the expected fall, while the other modified contour (Contour 4) was similar to that of a yes-no question except with a final fall rather than a final rise. Thus, Contour 3 featured disjunct pitch accents and a rise, while Contour 4 had only the accent on the final disjunct and a fall. These contours, though not canonical versions of either an alternative or a yes-no question, had features of both. We adopt the following notational conventions for describing the prosodies:

Contour 1:	$M\downarrow$	(pronounce as 'M-down')	multiple pitch accents, final fall
Contour 2:	$S\uparrow$	(pronounce as 'S-up')	single pitch accent, final rise
Contour 3:	$M\uparrow$	(pronounce as 'M-up')	multiple pitch accents, final rise
Contour 4:	$S\downarrow$	(pronounce as 'S-down')	single pitch accent, final fall

Although we expect to find that the canonical contours ($M\downarrow$ and $S\uparrow$) reliably disambiguate, thus far empirical evidence supporting this assumption has been lacking. One of the purposes of this experiment was to test the robustness of this prediction. As for the non-canonical contours, Contour 3 ($M\uparrow$) is predicted by the ACCENT ONLY account to be interpreted as an alternative question because both disjuncts contain pitch accents, while the ACCENT + FINAL FALL account predicts that $M\uparrow$ should receive yes-no paraphrases because the sentence ends in a rise rather than a fall. Contour 4 ($S\downarrow$) on the other hand is predicted by both accounts to receive a yes-no question interpretation because the disjuncts are not both pitch accented.⁷ A summary of the predictions made by these accounts is shown in Table 1.

Prosodic features	ACCENT ONLY	ACCENT + FINAL
$M\downarrow$	Alternative	Alternative
$S\uparrow$	Yes-no	Yes-no
$M\uparrow$	Alternative	Yes-no
$S\downarrow$	Yes-no	Yes-no

Table 1: Predicted interpretations of canonical and non-canonical prosodies

For consistency, the experiment that follows includes just sentences in which there are only two disjuncts, the disjunctive phrase is final in the sentence, and the nuclear pitch accent within each disjunct occurs in the final word of the disjunct. This last point is important insofar as the final pitch accent-boundary tone sequence is what creates the percept of a rise or a fall ($L^*H-H%$ or $H^*L-L%$, respectively), and in all of the examples in the experiment, this perceived rise or fall occurs on the final word of the disjunct or sentence.

2.2.2 Method

Materials and Stimulus construction. For the $M\downarrow$ and $S\uparrow$ contours, twenty-four disjunctive questions were recorded spoken by one of the authors (Pruitt) with the two canonical pronunciations. The sentences with a canonical yes-no contour were pronounced as relatively monotonous prior to their final rise so that a pitch accent could not be inferred from the prosodic contour. Eighteen of the sentences contained VP-level disjunction, while six contained a disjunction of DPs; all disjunctions were sentence-final. A list of the sentences appears in....

⁷Note that it would not generally be possible to create a contour in which both disjuncts were accent-less, unless the focus of the question were on some other word, e.g., *Did [Sally]_F bring wine or juice?*, in which case a yes-no question interpretation would be practically guaranteed.

The non-canonical $M\uparrow$ and $S\downarrow$ contours were created by digitally splicing the original $M\downarrow$ and $S\uparrow$ recordings to interchange the final pitch movements (rise or fall). Splicing was conducted using Praat speech analysis software (Boersma and Weenink 2006). To create $M\uparrow$, the final word from an alternative question recording was cut out and replaced with the final word from its yes-no question counterpart. Conversely, for $S\downarrow$, the final word was removed from a yes-no question and replaced with the final word from its alternative question counterpart. This methodology was employed for two reasons. First, the final word in these sentences houses the final pitch accent, phrase accent, and boundary tone of the question which create the percept of a rise ($L^*H-H\%$), or a fall ($H^*L-L\%$). Second, digitally splicing ensures contours are minimally different. The $M\uparrow$ contour is *exactly* like the $M\downarrow$ contour, but with a rise on the final disjunct, and the $S\downarrow$ contour is *exactly* like the $S\uparrow$ contour, but with fall at the end. The splicing was performed for all twenty-four sentences, so that they each had an $M\downarrow$, $S\uparrow$, $M\uparrow$, and $S\downarrow$ version, for a total of 96 stimuli. A representative group of the four contours for one sentence is shown in Figure 3. These diagrams make clear that the only difference in the vertically aligned contours is the pitch movement on the final word (*dessert* in these cases).

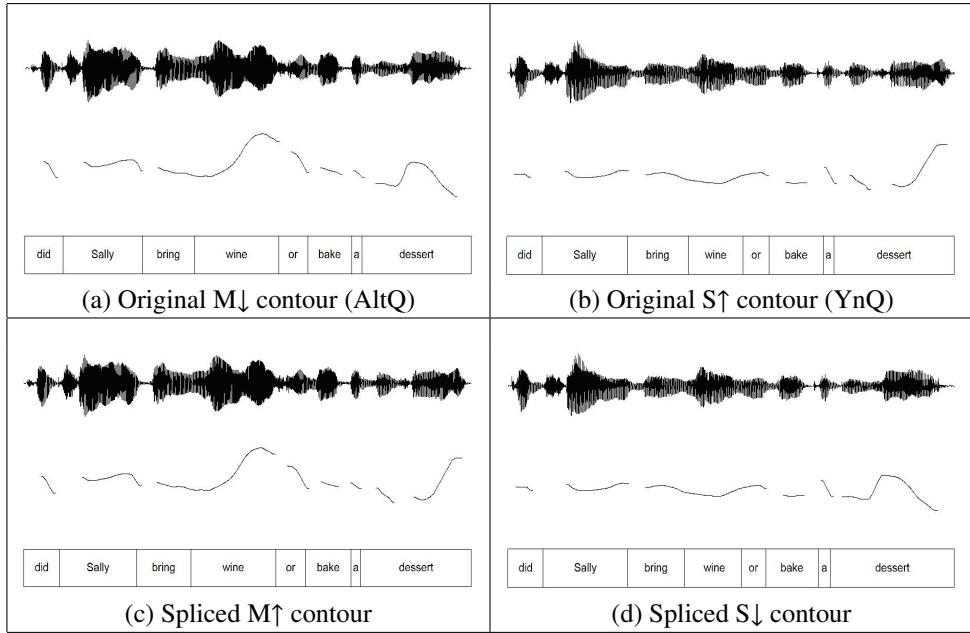


Figure 3: Examples of the four contours used in the experiment.

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

Procedure. Subjects were placed into one of four groups. The twenty-four sentences were randomly assigned to be heard with one of the four contours for Group 1, then the contours were rotated for the other groups. For example, the sentences that Group 1 heard with the $M\downarrow$ contour, Group 2 heard with $S\uparrow$, Group 3 heard with $M\uparrow$, and Group 4 heard with $S\downarrow$, and so on. This was done in order to ensure that a subject would not hear a given sentence with more than one contour in the course of the experiment. Thus, each group heard all 24 sentences once and each of the four contours six times.⁸ Each group also heard a set of 36 of the 67 filler 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.

Participants were presented with the auditory stimuli and asked to choose the best paraphrase from

⁸The appendix (or website) lists all of the experimental items by group.

among provided choices on a multiple-choice-type answer sheet. For all items in the experiment, there were three choices: two paraphrases and “other”, with the instruction to provide a different paraphrase if participants chose “other”. Participants were told 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 to an alternative and a yes-no question paraphrase, an example of which is shown in (2). The order of the alternative and yes-no paraphrase choices was counterbalanced, with the choice of “other” always last (c).

- (2) Example of paraphrase options
- Which of these things did Sally do: bring wine or bake a dessert?
 - Did Sally do any of these things: bring wine or bake a dessert?
 - Other _____

Subjects. Thirty-seven undergraduate students at the University of Massachusetts Amherst participated in the experiment for course credit in an introductory linguistics class. Nine subjects participated in each of Groups 1 and 2, eleven participated in Group 3, and eight in Group 4.

2.2.3 Results

The results are shown in Table 2. Across all subjects and sentences, a total of 222 tokens of each contour were heard. For the canonical alternative question contour, M↓, subjects provided 204 alternative question paraphrases, accounting for 91.9% of the responses to this contour. For the canonical yes-no question contour, S↑, subjects provided 197 yes-no question paraphrases, for 88.7% of responses. These results suggest that canonical intonations reliably disambiguate disjunctive questions, which is consistent with all previous descriptions of the prosodies of these question types. As for the modified contours, M↑ received mostly yes-no question paraphrases (185 out of 222; 83.3%), while the S↓ contour received mostly alternative question paraphrases (181 out of 222; 81.5%). Responses of “other” were very infrequent, and there did not appear to be any systematicity in subjects choice of this option: “other” was chosen twice each for the M↓, M↑, and S↓ contours and once for S↑. The results are illustrated graphically in Figure 4.

Contour heard	Paraphrase response		
	Alt question	Yes-no question	“Other”
M↓	91.9%	7.2%	0.9%
S↑	10.8	88.7	0.5
M↑	15.8	83.3	0.9
S↓	81.5	17.6	0.9

Table 2: Experimental results

Participants’ responses to the spliced contours indicate that they were most influenced by the identity of the final portion of the contour, whether a fall or a rise. Hence, subjects responded comparably to M↑ and S↑, while S↓ and M↓ received a pattern of responses similar to one another. Not surprisingly, a logistic regression shows the final contour to be a significant predictor of paraphrase response ($\text{Exp}(B)=67.39$, $p<0.001$).⁹ However, the presence vs. absence of a pitch accent on the non-final disjunct also had a significant influence on subjects’ responses ($\text{Exp}(B)=2.75$, $p=0.001$). While the final portion of each contour was the more decisive element, as assessed by the larger $\text{Exp}(B)$, the initial portion nonetheless influenced the likelihood of a particular paraphrase. There was no interaction between the dependent variables contours ($\text{Exp}(B)=0.57$, $p=0.178$).

⁹Response variable coded: 1 = Alternative question paraphrase, 0 = Yes-no question paraphrase or “other”. Dependent variables were multiple vs. single pitch accent (i.e., M vs. S) and final rise vs. final fall (i.e., ↑ vs. ↓).

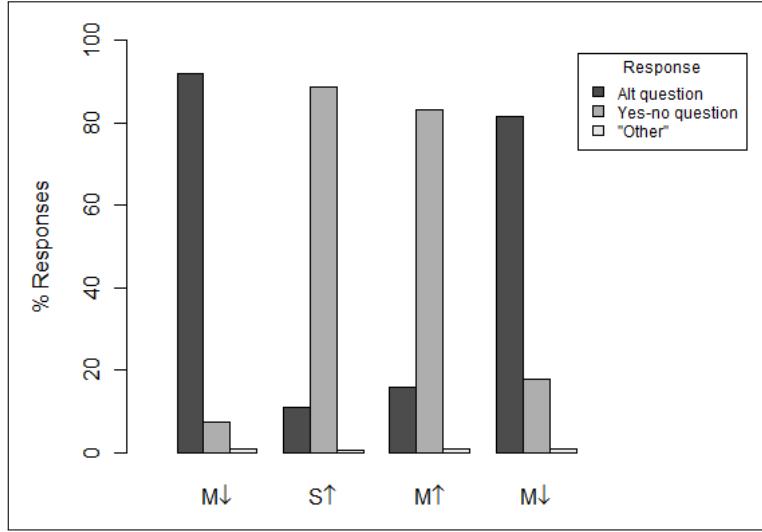


Figure 4: Distribution of responses for each contour

2.3 Discussion

The overall conclusion from the experiment is that the final fall is the prosodic feature that most significantly distinguishes alternative questions from identically worded yes-no questions. Even when there are no separate pitch accents on each of the disjuncts, the final fall generally favors an alternative question interpretation. And on the other hand, if there are separate pitch accents on each of the disjuncts, but no final fall, then the alternative question interpretation does usually *not* arise.

However, even though separate pitch accents on each of the disjuncts do not by themselves enforce an alternative question interpretation, they do significantly boost the extent to which a final fall enforces such an interpretation. That is, given the presence of a final fall, the additional presence of separate pitch accents significantly increases the number of alternative question interpretations.

The results of the experiment do not support the assumption that the presence of separate pitch accents on each of the disjuncts is what distinguishes alternative questions from identically worded yes-no questions. This assumption underlies most theoretical accounts of alternative questions that have been proposed in the literature so far (cf. Aloni and van Rooy, 2002; Han and Romero, 2004a,b; Beck and Kim, 2006).¹⁰ Hence, these proposals need to be revised.

The results of the experiment do not fully support the ACCENT+FINAL hypothesis either. This hypothesis does accurately predict that the M↑ contour does not receive an alternative question interpretation, but it fails to predict the majority of alternative question paraphrases for the S↓ contour. However, the fact that the presence of a first-disjunct pitch accent had a statistically significant effect on subjects' responses suggests that this hypothesis does find some support in the results of the experiment. The most sophisticated theoretical analysis based on the ACCENT+FINAL hypothesis is that of Bartels (1999). Thus, to account for the experimental results, we could take Bartels' analysis as a point of departure, and propose certain additions and/or modifications to capture the observed effects. However, one disadvantage of Bartels' account is that it is not easy to integrate into a more general framework of compositional semantics.¹¹ Therefore we start anew, and develop, in the remainder of this paper, a novel formal compositional semantics of alternative questions that takes the relevant prosodic features into account, and complies with the experimental results.

¹⁰Add von Stechow? Others?

¹¹Elaborate and possibly add more references.

3 Compositional semantics

3.1 Preliminaries

In order to develop a compositional semantics we first need to fix some basic terminology, make some assumptions concerning the syntactic structure of the relevant constructions, and specify the basic range of semantic effects that our system needs to capture.

Syntactic structure. We will from now on use the term *disjunctive interrogatives* as a technical term referring to two types of syntactic structures: those that consist of a single interrogative clause containing a disjunction, and those that consist of two or more interrogative clauses, conjoined by disjunction. To the former we will also refer more specifically as *narrow-scope* disjunctive interrogatives, and to the latter as *wide-scope* disjunctive interrogatives. We will also refer to *sentences* as (narrow/wide-scope) disjunctive interrogatives whenever their underlying syntactic structure is assumed to qualify as such. Some examples are given in (3) and (4) below.

- (3) Narrow-scope disjunctive interrogatives:
 - a. Does Ann or Bill play the piano?
 - b. Does Ann love Bill or Chris?
- (4) Wide-scope disjunctive interrogatives:
 - a. Does Ann play the piano, or does Bill play the piano?
 - b. Does Ann play the piano, or Bill?

There are at least two reasons to assume that sentences like (4a) consist of *two* interrogative clauses conjoined by disjunction (contra, for instance Han and Romero, 2004b, who assume that disjunctive interrogatives always consist of a single interrogative clause). One reason is that this assumption facilitates a straightforward explanation of the auxiliary inversion in both disjuncts: if there are two interrogative clauses, there are two interrogative complementizers, and each of them triggers auxiliary inversion in its respective clause. If there is only one interrogative complementizer, then the auxiliary inversion in (4a) seems to require some non-standard explanation.

Another reason to assume that disjunctive interrogatives may consist of two separate interrogative clauses conjoined by disjunction comes from languages like Japanese, where disjunctive questions may be formed by conjoining two clauses that both exhibit an overt interrogative morpheme.

As for sentences like (4b), we will assume that they have exactly the same underlying syntactic structure as sentences like (4a); only some material is left unpronounced. Of course, our semantics should be able to deal with narrow- and wide-scope disjunctive interrogatives in a uniform way.

Intonation patterns. Our aim is to identify the semantic contribution of the two prosodic features that distinguish alternative questions from identically worded yes-no questions. It is impossible to do this by considering just the two canonical intonation patterns. For, the interpretive differences between these two intonation patterns can only reveal what the *cumulative* semantic contribution of the two relevant prosodic features is. This will not allow us to identify the semantic contribution of each *individual* prosodic feature.

In order to do so, we must consider intonation patterns that exhibit just *one* of the relevant features, and not the other. These are exactly the ‘sliced’ intonation patterns in the experiment discussed above. In setting up the experiment, these patterns were artificially constructed in order to create minimal pairs. But they do occur in natural speech, and one of them—the one that has pitch accents on each of the individual disjuncts, but lacks the final fall—actually exhibits certain telling semantic contrasts with the two canonical intonation patterns. These contrasts will allow us to identify the semantic contribution of the separate pitch accents, and once this is established, we will be able to determine the contribution of the final fall as well.¹²

¹²Most previous semantic accounts of disjunctive interrogatives distinguish only two intonation patterns (cf. Han and Romero, 2004a,b; Beck and Kim, 2006). Bartels (1999) does observe a larger variety of possible intonation patterns, but does not employ this variety to isolate the semantic contribution of the separate pitch accents on each of the disjuncts.

For convenience, we will use the following shorthand names to refer to the relevant intonation patterns:¹³

$M\uparrow$	(pronounce as ‘M-up’)	multiple pitch accents, final rise
$M\downarrow$	(pronounce as ‘M-down’)	multiple pitch accent, final fall
$S\uparrow$	(pronounce as ‘S-up’)	single pitch accent, final rise
$S\downarrow$	(pronounce as ‘S-down’)	single pitch accent, final fall

Moreover, to visualize the intonation patterns of particular example sentences we will use underlining to represent the distribution of pitch accents (each underlined constituent is supposed to be pronounced with exactly one pitch accent), and we will use \uparrow and \downarrow to represent rising and falling pitch movements:

- (5) Visualization of intonation patterns for narrow-scope disjunctive interrogatives:
 - a. $M\uparrow$ pattern: Does Ann \uparrow or Bill \uparrow play the piano?
 - b. $M\downarrow$ pattern: Does Ann \uparrow or Bill \downarrow play the piano?
 - c. $S\uparrow$ pattern: Does Ann-or-Bill \uparrow play the piano?
 - d. $S\downarrow$ pattern: Does Ann-or-Bill \downarrow play the piano?
- (6) Visualization of intonation patterns for wide-scope disjunctive interrogatives:
 - a. $M\uparrow$ pattern: Does Ann \uparrow play the piano, or Bill \uparrow ?
 - b. $M\downarrow$ pattern: Does Ann \uparrow play the piano, or Bill \downarrow ?

Notice that wide-scope disjunctive interrogatives always require separate pitch accents on each of the disjuncts. That is, they only licence two of the four relevant intonation patterns: $M\uparrow$ and $M\downarrow$.

Syntactic interface features. Our general architectural assumption is that intonational meaning is mediated via syntax. That is, the intonation and the interpretation of a sentence are both ultimately determined by the syntactic representation of that sentence. Differences in intonation reflect differences in syntactic representation, and those differences in syntactic representation yield differences in interpretation.

More specifically, we assume that a pitch accent in the acoustic signal correlates with a *focus* feature in the syntactic representation,¹⁴ and that the rising-and-falling pitch contour in (5c) and (6b) correlates with a *closure* feature in the syntactic representation. It seems that this closure feature affects the pronunciation of the entire sentence (not just of, say, the contrastive elements in both disjuncts). Therefore, we assume that it is adjoined to the sentence as a whole. The possible syntactic representations of our running example sentences are listed in the table below, along with the intonation pattern that they inflict. Focus features, closure features, and interrogative complementizers are denoted by F, C, and Q, respectively.

Pattern	Acoustic signal	Syntactic representation
Narrow		
$M\uparrow$	Does <u>Ann</u> \uparrow or <u>Bill</u> \uparrow play?	[Q-does [Ann] _F or [Bill] _F play]
$M\downarrow$	Does <u>Ann</u> \uparrow or <u>Bill</u> \downarrow play?	[Q-does [Ann] _F or [Bill] _F play] _C
$S\uparrow$	Does <u>Ann-or-Bill</u> \uparrow play?	[Q-does [Ann or Bill] _F play]
$S\downarrow$	Does <u>Ann-or-Bill</u> \downarrow play?	[Q-does [Ann or Bill] _F play] _C
Wide		
$M\uparrow$	Does <u>Ann</u> \uparrow play, or <u>Bill</u> \uparrow ?	[[Q-does [Ann] _F play] or [Q-does [Bill] _F play]]
$M\downarrow$	Does <u>Ann</u> \uparrow play, or <u>Bill</u> \downarrow ?	[[Q-does [Ann] _F play] or [Q-does [Bill] _F play]] _C

¹³This naming convention should perhaps be introduced up front.

¹⁴There are other options that could be explored here: it is generally assumed that the distribution of pitch accents is (at least partly) determined by phonological phrase structure, and that phonological phrase structure is (at least partly) determined by syntactic constituent structure (and possibly by certain abstract features in the syntactic representation). Thus, we may assume that different distributions of pitch accents correlate with different constituent structures (e.g., flat versus nested disjunction), or with the presence of certain abstract syntactic features that partly determine phonological phrase structure. The corresponding differences in interpretation should then be derived from these differences in constituent structure, or from the semantic contribution of these abstract syntactic features.

Basic data. Our theory should capture, at the very least, the effects of intonation on answerhood conditions. The basic empirical observations are summed up in (7), (8), and (9) below.

- | | | |
|------------------------------------|--|--|
| (7) S↑ | (8) M↑ | (9) M↓ |
| Does <u>Ann-or-Bill</u> ↑ play? | Does <u>Ann</u> ↑ or <u>Bill</u> ↑ play? | Does <u>Ann</u> ↑ or <u>Bill</u> ↓ play? |
| a. No. \Rightarrow neither | a. No. \Rightarrow neither | a. #No. |
| b. Yes. \Rightarrow at least one | b. #Yes. \Rightarrow yes what?! | b. #Yes. |
| c. (Yes,) Ann does. | c. Ann does. | c. Ann does. |
| d. (Yes,) Bill does. | d. Bill does. | d. Bill does. |

Wide-scope disjunctive interrogatives are not explicitly listed here; they behave exactly like their narrow-scope counterparts as far as answerhood conditions are concerned. The S↓ intonation pattern has been left out of consideration, since judgments regarding answerhood conditions are not so crisp for this pattern. We will return to this issue in section ?? . Notice that the ‘non-canonical’ M↑ intonation pattern behaves in some ways like S↑, but in other ways more like M↓: it licenses a *no* answer, but it does not license a *yes* answer. To the best of our knowledge, this observation has not been taken into account before.

A further observation that should be accounted for is that disjunctive interrogatives with M↓ intonation convey that the speaker expects exactly one of the disjuncts to be true. In this respect, disjunctive interrogatives with M↓ intonation are similar to disjunctive *declaratives* with M↓ intonation. However, there is also an important difference, as illustrated in (10) and (11):

- | | |
|---|--|
| (10) <u>Ann</u> ↑ or <u>Bill</u> ↓ plays the piano. | (11) Does <u>Ann</u> ↑ or <u>Bill</u> ↓ play the piano? |
| a. No, neither of them does. | a. #No, neither of them does. |
| | b. Actually, neither of them does. |

The difference is subtle but clear: (10) really *excludes* the possibility that neither Ann nor Bill plays, while (11) merely conveys an *expectation* on the speaker’s part that at least one of them does. In the first case, disagreement can be signalled with *no*; the second case calls for a weaker disagreement particle, such as *actually* or *in fact*.

3.2 Inquisitive semantics

This section presents an analysis of disjunctive interrogatives in inquisitive semantics (Groenendijk, 2009; Mascarenhas, 2009; Groenendijk and Roelofsen, 2009; Ciardelli and Roelofsen, 2009; Ciardelli, 2009; Anderbois, 2009, among others). This analysis will not directly account for the above observations, but it will serve as a useful basis.

In inquisitive semantics, a sentence is taken to propose one or possibly several ways to update the common ground of a conversation. Formally, the proposition expressed by a sentence is a set of *possibilities*, each of which is in turn a set of *possible worlds*, and represents a potential update of the common ground. In previous work (see the references above), inquisitive semantics has been defined for the language of propositional logic and the language of first-order predicate logic, largely abstracting away from issues of sub-sentential syntactic and semantic composition. In the present paper, we are specifically interested in this process of semantic composition at the sub-sentential level, and especially in the role that certain prosodic features play in that process. So, to start with, we need to define a compositional inquisitive semantics for a suitable fragment of English. Fortunately, much of the technical machinery that we need is familiar from *alternative semantics* (Hamblin, 1973; Kratzer and Shimoyama, 2002; Alonso-Ovalle, 2006, among others).

Basic ingredients. As usual, we will say of each expression in our language that it is of a certain *type*. The basic types are *e*, *s*, and *t*, and whenever σ and τ are types, $(\sigma\tau)$ is also a type. Our semantics will map each expression to a certain model-theoretic object. The type of an expression determines the kind of object that it is mapped to. Each model-theoretic object belongs to a certain *domain*. There is a domain

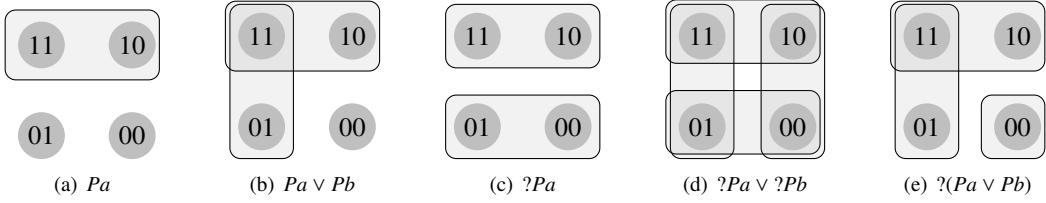


Figure 5: Some propositions visualized.

D_e of individuals, a domain D_s of possible worlds, and a domain D_t consisting of the truth values 0 and 1. Furthermore, for every complex type $(\sigma\tau)$ there is a domain $D_{(\sigma\tau)}$ consisting of all functions from D_σ to D_τ . As in alternative semantics, each expression of type τ is mapped to a set of objects in D_τ . The semantic value of an expression α will be denoted by $\llbracket \alpha \rrbracket$. Notice that $\llbracket \alpha \rrbracket$ is always a set. Therefore, we will refer to it as the *denotation set* of α .

Semantic values are composed by means of pointwise function application:

(12) *Pointwise Function Application*

If $\llbracket \alpha \rrbracket \subseteq D_{(\sigma\tau)}$ and $\llbracket \beta \rrbracket \subseteq D_\sigma$, then

$$\llbracket \alpha\beta \rrbracket := \llbracket \beta\alpha \rrbracket := \{ d \in D_\tau \mid \exists a \in \llbracket \alpha \rrbracket. \exists b \in \llbracket \beta \rrbracket, d = a(b) \}$$

Basic lexicon. Most lexical items are mapped to singleton sets, consisting of their standard denotations.

$$(13) \quad \begin{array}{ll} \text{a. } \llbracket \text{Ann} \rrbracket := \{\text{Ann}\} & \text{c. } \llbracket \text{play} \rrbracket := \{\lambda x. \lambda w. \text{play}_w(x)\} \\ \text{b. } \llbracket \text{Bill} \rrbracket := \{\text{Bill}\} & \text{d. } \llbracket \text{love} \rrbracket := \{\lambda y. \lambda x. \lambda w. \text{love}_w(x, y)\} \end{array}$$

Disjunction. Disjunction introduces alternatives. The denotation set of a phrase ‘ α or β ’, where α and β are two expressions of some type τ , is the union of the denotation set of α and the denotation set of β :

$$(14) \quad \text{For any type } \tau, \text{ if } \llbracket \alpha \rrbracket, \llbracket \beta \rrbracket \subseteq D_\tau, \text{ then } \llbracket \alpha \text{ or } \beta \rrbracket := \llbracket \alpha \rrbracket \cup \llbracket \beta \rrbracket$$

For example:

$$(15) \quad \begin{array}{ll} \text{a. } \llbracket \text{Ann or Bill} \rrbracket = \left\{ \begin{array}{l} \text{Ann,} \\ \text{Bill} \end{array} \right\} & \text{b. } \llbracket \text{Ann or Bill plays} \rrbracket = \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \text{play}_w(\text{Bill}) \end{array} \right\} \end{array}$$

Notice that the denotation set of a complete sentence, such as ‘Ann or Bill plays’ is a set of objects in $D_{(st)}$. Such objects are functions from possible worlds to truth values, or equivalently, sets of possible worlds. In inquisitive semantics, sets of possible worlds are referred to as *possibilities*, and a set of possibilities is called a *proposition*. So complete sentences express propositions.

Visualization. As long as we limit our attention to a language that contains, besides disjunction, just two names, ‘Ann’ and ‘Bill’, and a single intransitive verb ‘play’, the propositions expressed by the sentences in our language can be visualized in a helpful way. For instance, the sentence ‘Ann plays’ expresses the proposition $\{\lambda w. \text{play}_w(\text{Ann})\}$, which contains a single possibility consisting of all possible worlds in which Ann plays. This proposition is depicted in figure 5(a), where 11 is the index in which both Ann and Bill play, 10 the index in which only Ann plays, etcetera. Figure 5(b) depicts the proposition expressed by ‘Ann or Bill plays’. As we saw in (15b), this proposition consists of two possibilities: the possibility that Ann plays, and the possibility that Bill plays.

Excluded possibilities. Recall that the possibilities for a sentence α embody the ways in which α proposes to update the common ground. If some possible world w is not included in any possibility for α , then we say that w is *excluded* by α . For in this case, w will be eliminated from the common ground by any of the updates proposed by α . If α excludes any worlds, then we refer to the set of all such worlds as

the *possibility excluded* by α . If α does not exclude any worlds, then we say that it does not exclude any possibility. We use $\llbracket \alpha \rrbracket$ to denote the set of possibilities excluded by α (which is always either a singleton set, or empty).

Interrogative clauses. The interrogative complementizer, Q , always operates on an expression α of type (st) , and the resulting clause $\llbracket Q \alpha \rrbracket$ is always again of type (st) . So even though there is a shift in syntactic category, there is no shift in semantic type. The proposition expressed by $\llbracket Q \alpha \rrbracket$ consists of the possibilities for α itself, plus the possibility that α excludes.

$$(16) \quad \llbracket Q \alpha \rrbracket := \llbracket \alpha \rrbracket \cup \llbracket \alpha \rrbracket$$

For example, the proposition expressed by the simple polar interrogative ‘Does Ann play?’ consists of two possibilities: the possibility that Ann plays, and the possibility that she does not play. These possibilities embody two possible updates of the common ground, and the responder is invited to provide information such that either one of these updates can be established.

$$(17) \quad \llbracket Q\text{-does Ann play} \rrbracket$$

$$= \llbracket \text{Ann plays} \rrbracket \cup \llbracket \neg \text{Ann plays} \rrbracket = \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \neg \text{play}_w(\text{Ann}) \end{array} \right\} \Rightarrow \text{see figure 5(c)}$$

Disjunctive interrogatives. Given these assumptions, the propositions expressed by wide- and narrow-scope disjunctive interrogatives are the following:

$$(18) \quad \text{Wide-scope disjunctive interrogative:}$$

$$\begin{aligned} & \llbracket Q\text{-does Ann play or } Q\text{-does Bill play} \rrbracket \\ &= \llbracket Q\text{-does Ann play} \rrbracket \cup \llbracket Q\text{-does Bill play} \rrbracket \\ &= \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \neg \text{play}_w(\text{Ann}) \end{array} \right\} \cup \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Bill}), \\ \lambda w. \neg \text{play}_w(\text{Bill}) \end{array} \right\} \Rightarrow \text{see figure 5(d)} \end{aligned}$$

$$(19) \quad \text{Narrow-scope disjunctive interrogative:}$$

$$\begin{aligned} & \llbracket Q\text{-does Ann or Bill play} \rrbracket \\ &= \llbracket \text{Ann or Bill plays} \rrbracket \cup \llbracket \neg \text{Ann or Bill plays} \rrbracket \\ &= \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \text{play}_w(\text{Bill}) \end{array} \right\} \cup \{ \lambda w. \neg \text{play}_w(\text{Ann}) \wedge \neg \text{play}_w(\text{Bill}) \} \Rightarrow \text{see figure 5(e)} \end{aligned}$$

Thus, the wide-scope disjunctive interrogative ‘Does Ann play or does Bill play?’ expresses a proposition consisting of four possibilities: the possibility that Ann plays, the possibility that Ann does not play, the possibility that Bill plays, and the possibility that Bill does not play. The narrow-scope disjunctive interrogative ‘Does Ann or Bill play?’ expresses a proposition consisting of three possibilities: the possibility that Ann plays, the possibility that Bill plays, and the possibility that neither of them plays. These propositions are depicted in figure 5(d) and 5(e), respectively.

So much for the compositional treatment of our basic fragment inquisitive semantics. Notice that this treatment does not yet say anything about the licensing and interpretation of yes/no answers, or about the ‘exactly one implication’ of disjunctive interrogatives with M↓ intonation. The following sections propose an extension of the system that will allow us to capture these phenomena.

3.3 Focus and highlighting

The general idea that we would like to pursue in this section is that a sentence, besides proposing one or more possible updates, may also *highlight* certain possibilities, and that *focus* plays an important role in determining the possibilities that a sentence highlights.

We think that highlighting is of particular relevance for the licensing and interpretation of yes/no answers. More specifically, we hypothesize that a *yes* answer to a question α presupposes that α highlights exactly one possibility, and if this presupposition is met, *yes* confirms that highlighted possibility. A *no* answer on the other hand, if felicitous, simply rejects all the possibilities highlighted by α (for now we will assume that a *no* answer is always felicitous; a felicity condition will be specified in section 3.4).

Initial motivation: opposing polar questions. Initial motivation for this idea comes from an old puzzle concerning polar questions, exemplified by the contrast between (20a) and (20b):

- (20) a. Is the door open? b. Is the door closed?

According to inquisitive semantics, as it has been developed so far, (20a) and (20b) are equivalent: they both express a proposition consisting of two possibilities, the possibility that the door is open, and the possibility that the door is closed. However, there is a clear empirical difference between the two: in reply to (20a), *yes* means that the door is open, while in reply to (20b), it means that the door is closed.¹⁵

This difference is captured straightforwardly if we assume that (20a) highlights the possibility that the door is open, that (20b) highlights the possibility that the door is closed, and that the interpretation of *yes* and *no* is as hypothesized above. Our aim is to give a similar explanation of the licensing and interpretation of yes/no answers in response to disjunctive questions. In order to do so, we must first specify how the possibilities highlighted by a given sentence are compositionally determined, and in particular how focus affects this process.

Proposing and highlighting. We will henceforth assume that the semantic value of a sentence α consists of two components, $\llbracket \alpha \rrbracket_P$ and $\llbracket \alpha \rrbracket_H$. Both $\llbracket \alpha \rrbracket_P$ and $\llbracket \alpha \rrbracket_H$ are sets of possibilities; $\llbracket \alpha \rrbracket_P$ embodies the proposal that α expresses, and $\llbracket \alpha \rrbracket_H$ consists of the possibilities that α highlights.

The semantic value of subsentential expressions will also consist of these two components. For any expression α , sentential or subsentential, we will refer to $\llbracket \alpha \rrbracket_P$ as its P-set, and to $\llbracket \alpha \rrbracket_H$ as its H-set. Both P-sets and H-sets are composed by means of pointwise function application.

What we used to call the denotation set of an expression, then, is now called its P-set. As far as names, verbs, and disjunction are concerned, H-sets are defined just as P-sets. However, as soon as interrogative complementizers enter the derivation, P-sets and H-sets start to diverge. Recall that the proposal expressed by $[Q \alpha]$ consists of the possibilities for α itself, plus the possibility that α excludes:

$$(21) \quad [Q \alpha]_P := \llbracket \alpha \rrbracket_P \cup \{\alpha\}$$

We will assume that $[Q \alpha]$ simply highlights the possibilities that α itself highlights, not the possibility that α excludes:

$$(22) \quad [Q \alpha]_H := \llbracket \alpha \rrbracket_H$$

These assumptions are sufficient to capture the contrast between opposing polar questions:

(23) [Q-is the door open]	(24) [Q-is the door closed]
Proposes: open/closed	Proposes: open/closed
Highlights: open	Highlights: closed
<i>yes</i> \Rightarrow the door is open	<i>yes</i> \Rightarrow the door is closed
<i>no</i> \Rightarrow the door is closed	<i>no</i> \Rightarrow the door is open

Highlighting and focus. We will assume that focus affects the computation of H-sets. To see why, consider the two focus structures that give rise to S↑ intonation and M↑ intonation, respectively:

¹⁵This is sometimes taken to be a general argument against ‘proposition set’ approaches to questions—which include, besides inquisitive semantics, the classical theories of Hamblin (1973), Karttunen (1977), and Groenendijk and Stokhof (1984)—and in favor of alternatives such as the ‘structured meaning’ approach or the ‘orthoalgebraic’ approach (cf. Krifka, 2001; Blutner, 2009). Here, we choose not to pursue a full-fledged alternative to the proposition set approach, but rather to extend it in a suitable way.

- (25) a. Does [Ann or Bill]_F play the piano? $\Rightarrow S \uparrow$ intonation
 b. Does [Ann]_F or [Bill]_F play the piano? $\Rightarrow M \uparrow$ intonation

Recall that (25a) licenses both *yes* and *no* as an answer, while (25b) only licenses *no*. Our hypothesis about the interpretation of *yes* and *no* captures this contrast if we assume that (25a) highlights a single possibility (the possibility that Ann or Bill plays), while (25b) highlights two possibilities (the possibility that Ann plays, and the possibility that Bill plays). But this can only be if focus affects the computation of H-sets. For, apart from their focus structures, (25a) and (25b) are perfectly identical.

The intuitive idea that we will pursue is that ‘focus makes H-sets collapse’. Let us first make this more precise for the case where α is a complete sentence, of type *(st)*:

- (26) If α is of type *(st)*, then:

$$[[\alpha_F]]_H := \{ \bigcup_{\pi \in [[\alpha]]_H} \pi \}$$

If α is of type *(st)*, then every element of $[[\alpha]]_H$ is a possibility π , a set of worlds. The focus feature collapses all these possibilities into one big possibility, $\bigcup_{\pi \in [[\alpha]]_H} \pi$. This, then, is the unique possibility in $[[\alpha_F]]_H$.¹⁶

If α is a sub-sentential expression, of some type σ different from *(st)*, then the elements of $[[\alpha]]_H$ are not full-fledged possibilities, so we cannot simply take their union. However, following Partee and Rooth (1982), we can take their ‘generalized union’:

- (27) If α is of some type σ , different from *(st)*, then:

$$[[\alpha_F]]_H := \{ \lambda z. \bigcup_{y \in [[\alpha]]_H} z(y) \} \quad \text{where } z \text{ is a variable of type } (\sigma(st))$$

For our examples, the relevant case is the one where α is of type *e*. In this particular case, we have:¹⁷

- (28) $[[\alpha_F]]_H := \{ \lambda P. \bigcup_{y \in [[\alpha]]_H} P(y) \} \quad \text{where } P \text{ is a variable of type } (e(st))$

Let us first consider what this means for some disjunctive declaratives with different focus structures:

$$(29) [[\text{[Ann]}_F \text{ or } \text{[Bill]}_F \text{ plays }]]_H = \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \text{play}_w(\text{Bill}) \end{array} \right\}$$

$$(30) [[\text{[Ann or Bill]}_F \text{ plays }]]_H = \{ \lambda w. \text{play}_w(\text{Ann}) \cup \lambda w. \text{play}_w(\text{Bill}) \}$$

With narrow focus on each individual disjunct, ‘Ann or Bill plays’ highlights two possibilities. But, as desired, focus on the whole disjunctive subject NP collapses these two possibilities into one. Now let us turn to disjunctive interrogatives. First consider the narrow-scope variant. Recall that, by definition, an interrogative clause $[Q \alpha]$ highlights the same possibilities as α itself. So we have:

$$(31) [[Q\text{-does } [\text{Ann}]]_F \text{ or } [\text{Bill}]]_F \text{ play }]_H = \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \text{play}_w(\text{Bill}) \end{array} \right\}$$

$$(32) [[Q\text{-does } [\text{Ann or Bill}]]_F \text{ play }]_H = \{ \lambda w. \text{play}_w(\text{Ann}) \cup \lambda w. \text{play}_w(\text{Bill}) \}$$

Thus, it is predicted that the question ‘Does Ann or Bill play?’ only highlights two distinct possibilities if it has narrow focus on ‘Ann’ and on ‘Bill’. Wide-scope disjunctive interrogatives on the other hand, always highlight two distinct possibilities:

$$(33) [[Q\text{-does } [\text{Ann}]]_F \text{ play or } Q\text{-does } [\text{Bill}]]_F \text{ play }]_H = \left\{ \begin{array}{l} \lambda w. \text{play}_w(\text{Ann}), \\ \lambda w. \text{play}_w(\text{Bill}) \end{array} \right\}$$

The analysis so far yields a number of satisfactory predictions:

¹⁶Notice that this is reminiscent of what is called *non-inquisitive closure* in inquisitive semantics (cf. Groenendijk and Roelofsen, 2009), and what is called *existential closure* in alternative semantics (cf. Kratzer and Shimoyama, 2002).

¹⁷Computing the H-set of a sentence with a focused expression of type *e* in *object* position runs into type matching trouble in the present setup. The ‘problem’ is exactly the same as the one that arises for the interpretation of quantified noun phrases in object position in any system that starts with ‘low types’ (in particular, *(e(et))* for transitive verbs, cf. Heim and Kratzer, 1998). It also has the same solutions: type-lifting, function composition, quantifier raising, or simply starting out with higher types. For simplicity’s sake, we will not implement any of these possible solutions here, and simply focus on examples with focused noun phrases in subject position.

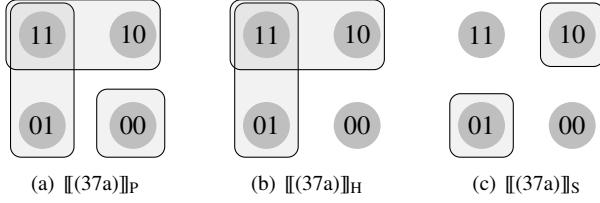


Figure 6: Exclusive strengthening illustrated.

- (34) Does $[\text{Ann or Bill}]_F$ play?
 - a. Highlights the possibility that Ann or Bill plays.
 - b. *yes* \Rightarrow at least one of them plays
 - c. *no* \Rightarrow neither Ann nor Bill plays
- (35) Does $[\text{Ann}]_F$ or $[\text{Bill}]_F$ play?
 - a. Highlights the possibility that Ann plays and the possibility that Bill plays.
 - b. *yes* \Rightarrow presupposition failure (the question highlights more than one possibility)
 - c. *no* \Rightarrow neither Ann nor Bill plays
- (36) Does $[\text{Ann}]_F$ play or does $[\text{Bill}]_F$ play?
 - a. Highlights the possibility that Ann plays and the possibility that Bill plays.
 - b. *yes* \Rightarrow presupposition failure (the question highlights more than one possibility)
 - c. *no* \Rightarrow neither Ann nor Bill plays

We seem to have obtained a basic understanding of the semantic effect of placing separate pitch accents on each of the disjuncts in a disjunctive interrogative. Now let us consider the effect of the final fall.

3.4 Closure and suggestions

Our basic intuition is that closure suggests that *exactly one of the highlighted possibilities can be realized*. (Recall that possibilities embody possible updates of the common ground; as such it makes sense to speak of them as ‘being realized’.) To see what this amounts to, consider our running examples (37a) and (37b):

- (37) a. Does Ann \uparrow or Bill \downarrow play the piano? b. Does Ann \uparrow play the piano, or Bill \downarrow ?

These questions both highlight two possibilities: the possibility that Ann plays, and the possibility that Bill plays. To suggest that exactly one of these possibilities can be realized is to suggest that exactly one of Ann and Bill plays the piano. In particular, it is to suggest that *at least one* of them plays, and that they do *not both* play. Such a suggestion seems to be an essential aspect of what (37a) and (37b) communicate.

There are several ways to formalize this intuition. We will assume here that the meaning of a sentence α does not just consist of $\llbracket \alpha \rrbracket_P$ and $\llbracket \alpha \rrbracket_H$, but has a third component, $\llbracket \alpha \rrbracket_S$, which is the set of possibilities/updates that α *suggests*. We will refer to $\llbracket \alpha \rrbracket_S$ as the S-set of α .

We will assume that the S-set of expressions that do not bear a closure-feature is always empty, and define the semantic contribution of the closure-feature to be as follows:

$$(38) \quad \text{The effect of closure:} \quad \llbracket \alpha_C \rrbracket_P := \llbracket \alpha \rrbracket_P \quad \llbracket \alpha_C \rrbracket_H := \llbracket \alpha \rrbracket_H \quad \llbracket \alpha_C \rrbracket_S := \mathcal{EX}(\llbracket \alpha \rrbracket_H)$$

The definition of $\llbracket \alpha_C \rrbracket_S$ makes use of the *exclusive strengthening* operator \mathcal{EX} . For any set of possibilities Π , and for any possibility $\pi \in \Pi$, the exclusive strengthening of π relative to Π is defined as:

$$(39) \quad \mathcal{EX}(\pi, \Pi) := \pi - \bigcup\{\rho \mid \rho \in \Pi \text{ and } \pi \not\subseteq \rho\}$$

Finally, the exclusive strengthening of Π itself is defined as:

$$(40) \quad \mathcal{EX}(\Pi) := \{\mathcal{EX}(\pi, \Pi) \mid \pi \in \Pi\}$$

The effect of exclusive strengthening is illustrated for example (37a) in figure 6. Recall that (37a) proposes three possibilities, as depicted in figure 6(a), and highlights two possibilities, as depicted in figure 6(b). Applying \mathcal{EX} to these two highlighted possibilities removes the overlap between them, resulting in the two possibilities in figure 6(c). This reflects the fact that (37a) suggests that exactly one of Ann and Bill plays the piano. The same result is obtained for (37b), since (37a) and (37b) highlight exactly the same possibilities.¹⁸

Accepting and canceling suggestions. Suggestions can either be accepted or canceled by a responder. We will assume that acceptance is the default. That is, if a suggestion is not explicitly contradicted, then all conversational participants assume that it is commonly accepted, and the suggested information is added to the common ground. Thus, if you ask (37a) or (37b), and I reply: ‘Ann does’, then I tacitly accept your suggestion. As a result, the common ground will not only be updated with the information that Ann plays, but also with the information that Bill does not play.¹⁹

Licensing *no*. At the beginning of section 3.3 we hypothesized that *no*, in response to a question α , simply denies all the possibilities that α highlights. We left the felicity condition on the use of *no* unspecified at that point. Now that suggestions have entered the picture, we are ready to make this felicity condition explicit. Recall the contrast between disjunctive declaratives and interrogatives mentioned at the outset:

(41) Ann \uparrow or Bill \downarrow plays the piano.

a. No, neither of them does.

(42) Does Ann \uparrow or Bill \downarrow play the piano?

a. #No, neither of them does.

b. Actually, neither of them does.

The declarative licenses a *no* response; the interrogative does not. What is the relevant difference between the two? —The answer is that the declarative really *asserts* that at least one of Ann and Bill plays the piano (in the sense that it excludes—technically speaking—the possibility that neither Ann nor Bill plays), whereas the interrogative merely *suggests* that at least one of Ann and Bill plays. Thus, this example illustrates that *no* can be used to deny an assertion, but not to cancel a suggestion. As illustrated in (42b), cancellation of a suggestion requires a ‘weaker’ disagreement particle such as *actually* or *in fact* (if a disagreement marker is used at all).²⁰

Thus, *no*, in response to a question α , denies the possibilities that α highlights, but is felicitous only if denying these possibilities does not cancel the suggestion that α expresses. This accounts for the contrast between (41) and (42), and also for the licensing and interpretation of *no* in response to disjunctive interrogatives with S \uparrow or M \uparrow intonation.

Sincerity requirements. Grice’s (1975) quality maxim, formulated in our present terms, says that if a cooperative speaker s utters a sentence α , then s must *take himself to know* that at least one of the updates proposed by α can indeed be established (*informative sincerity*). In inquisitive pragmatics (Groenendijk and Roelofsen, 2009), it is further assumed that if α is inquisitive, then for each update that α proposes, s must be genuinely *uncertain* as to whether that update can indeed be established or not (*inquisitive sincerity*). In the present setting there is a third requirement, namely that if α suggests certain updates, then s must genuinely *expect* that exactly one of these updates can indeed be established (*expectative sincerity*).

One consequence of this is that denying an assertion is much more likely to give rise to conflicts than canceling a suggestion. For, in the first case, the speaker’s supposed knowledge is contradicted, while the second case may require merely a revision of expectations. This is illustrated by the following contrast:

¹⁸It should perhaps be emphasized that closure is *not* interpreted here as signaling *exhaustivity* (as in Zimmermann, 2000). That is, it does not imply that ‘nobody else plays the piano’ or something of that kind. And this is for a good reason: disjunctive interrogatives with closure intonation generally do not exhibit any exhaustivity effects. Therefore, closure intonation and exhaustivity effects should be seen as (at least partly) independent phenomena.

¹⁹For a detailed specification of how the common ground, and updates thereof, are modeled in inquisitive semantics, we refer to (Groenendijk, 2008) and (Balogh, 2009). These works also discuss the notion of a ‘suggestion’ that we make use of here in more detail, and provide formal definitions of acceptance and cancellation in the broader context of a dialogue management system.

²⁰See (Groenendijk, 2008) and (Groenendijk and Roelofsen, 2009) for closely related observations.

- (43) A: Ann \uparrow or Bill \downarrow is coming tonight.
 B: No, neither of them is.
 A: What?! (# Oh, thanks)

- (44) A: Is Ann \uparrow or Bill \downarrow coming tonight?
 B: Actually, neither of them is.
 A: Oh, thanks.

Thus, the proposed analysis accounts for all the puzzles that we started out with at the beginning of this section. Let us now turn back to the experiment, and see to what extent the observed effects match the proposed theoretical account.

3.5 Theory and practice

The results pertaining to the canonical intonation patterns are clearly in line with the proposed analysis.²¹

S \downarrow . The preponderance of alternative question paraphrases found in the experiment for the S \downarrow contour is surprising given the analysis developed here, in which crucial use is made of disjunct emphasis, or focus, in deriving the meaning of alternative questions. As discussed in Section 2.3, the likelihood of an alternative question interpretation is reduced in the absence of an initial disjunct pitch accent, as expected, but the absence of this accent only induces a roughly 10% reduction in alternative question paraphrases (from 91.9% to 81.5%). This finding is surprising upon first consideration, but we believe it can be accounted for by appealing to the realities of sentence processing and the particulars of the experimental context.

The task of the listener is to reconstruct a speaker's intended meaning, taking into account syntactic, lexical, and prosodic information. In an ideal situation all these elements point in the same direction. However, the production of prosody in particular may be subject to 'performance effects' because of the inherent variability of pitch and the lack of clearly discrete intonational elements in the signal. Thus distinctions between accented and non-accented words may be neutralized in production yet still be formally differentiated in the semantics (Lisa Selkirk, p.c.). Having knowledge of this fact, listeners may use other aspects of a sentence or context to infer the presence of a semantically-relevant feature such as focus. We propose that this kind of compensation can account for the large number of alternative question paraphrases for the S \downarrow contour in the experiment. Specifically, our analysis gives an important role to a more reliably communicated prosodic feature, the final fall which signals closure. A listener hearing a sentence with the S \downarrow contour will not have constructed an alternative question interpretation for such a sentence, but upon encountering the final fall, a search is initiated for a set of alternatives to which closure can be applied. The search turns up the disjunctive phrase as an obvious candidate, and a reanalysis is triggered, yielding an alternative question interpretation nonetheless.²² The reduction in alternative question paraphrases for the S \downarrow contour is consistent with this explanation, since it relies on a reanalysis process which cannot, by its very nature, be guaranteed to occur in every case.

A competing hypothesis a listener may entertain upon hearing the final fall of an S \downarrow contour is that of a falling intonation yes-no question. Yes-no questions are known to be possible with a relatively wide range of prosodies (e.g., Bartels 1997: Ch 5), including some that involve falling intonation. However, Hedberg, Sosa, and Fadden (2004) note that falling yes-no questions are much more common in 'adversarial' speech, suggesting that there are special contexts which license its use. From this point of view, a falling yes-no question is not the most likely interpretation for the S \downarrow contour in the experimental setting, given the absence of a context that would support such an interpretation.

Taken together, these two factors can account for the persistence of alternative question paraphrases for the S \downarrow contour. While this prosody is consistent with a falling yes-no question, its use is not licensed in the experimental setting. Instead, the final fall is likely to be interpreted as signaling the closure operator, given the relative plausibility of pitch accent neutralization.

M \uparrow . A final note should be made regarding the experimental results as regards the non-canonical M \uparrow contour. In our analysis the contours ending with a final rise, M \uparrow and S \uparrow , are analyzed as having different interpretations, yet subjects treated them as basically the same in the experiment, providing what we have

²¹Eloborate a bit.

²²This implicitly assumes that an alternative question is not the default interpretation. Is there any evidence for this?

described as yes-no question paraphrase choices in both cases. This, however, is an artefact of the experimental setup. The paraphrase choices that subjects were provided with were not sufficiently specific to capture the subtle contrast between these two question types. In particular, the offered “yes-no” question paraphrase, repeated here in (45), is in fact consistent both with a genuine yes-no question interpretation and with the ‘open list’ interpretation that our theoretical account ascribes to disjunctive interrogatives with an M↑ contour.

- (45) Did Sally do any of these things: bring wine or bake a dessert?

A more fine-grained experiment would be needed to confirm the predicted difference in interpretation.

4 Conclusion and repercussions

A major challenge in the investigation of intonational meaning is to break up the observable intonation patterns into the ‘right’ pieces, and to identify those pieces that make a significant and independent semantic contribution. The experiment presented in the first part of this paper was designed to identify the prosodic features that distinguish alternative questions from identically worded yes-no questions. We found that the presence of a falling pitch movement at the end of the sentence is crucial to achieve an alternative question interpretation. We also found that the presence of separate pitch accents on each of the disjuncts is not strictly necessary, although it does significantly increase the rate at which an alternative question interpretations is established. These findings contradict the assumptions that contemporary semantic analyses of alternative questions generally make (cf. Aloni and van Rooy, 2002; Han and Romero, 2004a,b; Beck and Kim, 2006)²³ and thus call for a revision of these analyses.

The second part of the paper presented a compositional semantics that takes the two relevant prosodic features into account. The main challenge here was to isolate the semantic contribution of each individual feature. This would be impossible to do just on the basis of the two ‘canonical’ intonation patterns. For, the difference in interpretation between these two intonation patterns can at most reveal what the overall semantic effect is of the two prosodic features taken together. This is why we also considered an ‘intermediate’ intonation pattern, which exhibited one of the relevant features, but not the other. This allowed us to tease apart the independent semantic contribution of each of the individual features.

The proposed analysis was shown to account for the basic empirical observations concerning disjunctive interrogatives. We believe, however, that it may shed light on a much wider range of phenomena than the ones explicitly discussed here. We will end by briefly mentioning some such phenomena:

Disjunctive declaratives. The analysis directly carries over to disjunctive *declaratives*. In particular, it accounts for the ‘exclusive component’ of disjunctive declaratives. For instance, it correctly predicts that (46), with the indicated intonation pattern, does not only assert that at least one of Ann and Bill is coming, but also suggests that *at most* one of them is coming.

- (46) Ann↑ or Bill↓ is coming tonight.

This ‘exclusive component’ is traditionally derived pragmatically, following Grice (1975). However, it has been observed, for instance by Sauerland (2004) and Alonso-Ovalle (2006), that the basic Gricean account does not straightforwardly apply to slightly more involved cases. Problematic constructions include the following:

- (47) Ann↑ or Bill↑ or Chris↓ is coming tonight.

- (48) Ann↑ is coming, or Bill↑, or both↓.

The issue that example (47) raises is that it is not quite clear what the ‘alternatives’ are that a given sentence should be compared with in order to derive its implicatures. In the case of (46), which is of the form ‘A or B’, it may be plausible to take ‘A and B’ to be the only relevant alternative. But in the case of (47), which is of the form ‘A or B or C’, it is not so clear anymore to decide in a principled way what the relevant

²³Check von Stechow.

alternatives are. Several proposals have been made (cf. Sauerland, 2004; Fox, 2007; Katzir, 2007), but the general debate concerning this issue still seems quite unsettled.

Example (48) raises another problem for the Gricean account, at least if such an account is based on a classical truth-conditional semantics. The problem, first observed by Alonso-Ovalle (2006), is that (48) is truth-conditionally equivalent to (46). Thus, assuming a classical semantics, it is impossible to derive pragmatically that (46) has an ‘exclusive component’, while (48) does not. Alonso-Ovalle (2006) solves this problem by adopting a non-classical semantic analysis of disjunction, which has independent motivation, and is technically equivalent to the inquisitive semantics of disjunction adopted here.

It may be, however, that all this effort to save the Gricean account of the exclusive component of disjunction is ultimately unnecessary. For, the relevant facts immediately fall out of the analysis proposed here, which, unlike all the other analyses cited above, takes intonation into account. It is easy to see that, on the proposed analysis, (46) suggests that only Ann or only Bill is coming, (47) suggests that only Ann, only Bill, or only Chris is coming, and (48) suggests that only Ann, only Bill, or both Ann and Bill are coming. These are exactly the desired predictions.²⁴

Might. Ciardelli, Groenendijk, and Roelofsen (2009) provide an analysis of *might* in inquisitive semantics. Adopting this analysis, and assuming that a sentence *might* α highlights exactly the same possibilities as α itself, leads to a satisfactory account of sentences like:

- (49) a. Jim might talk to Ann-or-Bill.
 b. Jim might talk to Ann \uparrow or to Bill \uparrow .
 c. Jim might talk to Ann \uparrow or to Bill \downarrow .
 d. Jim might talk to Ann \uparrow , or he might talk to Bill \uparrow .
 e. Jim might talk to Ann \uparrow , or he might talk to Bill \downarrow .
 f. Jim might talk to Ann \uparrow , or to Bill \uparrow , or to both \downarrow .

Ignorance implicatures. Inquisitive pragmatics (in particular the inquisitive sincerity requirement mentioned above) accounts for ignorance implicatures triggered by disjunction, questions, and *might* in a uniform way. This account carries over straightforwardly to the extended semantic framework presented here.

Inquisitive disclosure. The proposed framework facilitates a perspicuous analysis of compound answers such as (50b):

- (50) a. Is Ann-or-Bill \uparrow coming tonight?
 b. Yes, Ann is coming.

The first part of the answer, *yes*, establishes the possibility that Ann or Bill is coming. This is the possibility that the question highlights. Then, the second part of the answer establishes the possibility that Ann is coming, which is one of the possibilities that the question proposes. In general, confirming a highlighted possibility often naturally leads the responder to consider the more specific possibilities that constitute the ‘underlying’ issue. We refer to this general phenomenon as *inquisitive disclosure*. It does not only pertain to questions containing disjunction, but also to questions containing indefinites:²⁵

- (51) a. Is anyone coming tonight?
 b. Yes, Ann is coming.

Closure variability. One aspect of the data that we abstracted away from entirely is that the rising-and-falling pitch contour that was taken to signal closure may be pronounced more or less dramatically, and this seems to correlate with the strength of the corresponding ‘exactly one’ suggestion. This could be captured by construing the closure feature not as a binary-valued feature—that is either ‘on’ or ‘off’—but rather as a continuous-valued feature—with values, say, between 0 and 1. Phonologically, this value would then

²⁴Perhaps also discuss downward entailing environments.

²⁵This should perhaps be worked out a little bit. Potentially very relevant for next week’s guest lectures by Martin and Anisa.

determine the sharpness of the rising-and-falling pitch contour, and semantically it would determine the strength of the corresponding ‘exactly one’ suggestion.

Cross-linguistic application. Of course, the syntactic structure and phonological characteristics of disjunctive questions differ widely across languages. However, the *interpretation* of disjunctive questions in different languages is usually reported to be similar or identical to the interpretation of their English counterparts. Therefore, we suspect that the general semantic mechanisms of proposing, highlighting, and suggesting possibilities may play a role cross-linguistically, even though the way in which these mechanisms are ‘implemented’ will differ from language to language. To give one example, it seems quite reasonable to hypothesize that while closure is signaled in English by intonation, it is conveyed in other languages by certain morphemes, or by variation in word order. Han and Romero (2004b), Alonso-Ovalle (2006, chapter 5), and Haspelmath (2007) provide data from Basque, Mandarin Chinese, Finnish, Hindi, Korean, and several other languages that seems to support such a hypothesis.

A Experimental materials

Table of experimental materials, with indications of which group heard which item with which intonation pattern.

B Note on Han and Romero’s account

Even if separate pitch accents did enforce an alternative question reading, this does not really seem to follow from Han and Romero’s account. That is, it does follow from their assumptions that separate pitch accents are *necessary* in order to establish an alternative question reading, but not that they are *sufficient* to do so. To see this consider one of their running examples:

- (52) Did John drink coffee or tea?

The alternative question reading of this sentence is derived assuming that it could have, among others, the following underlying syntactic structure (see, for instance Han and Romero, 2004b, p.537, example 31):

- (53) [Q_i-did [t_i [[John drink coffee] or [John-drink tea]]]]

That is, the disjunction is taken to associate with a silent *whether/Q* operator, which undergoes movement. The crucial assumption is that a disjunction that associates with a silent *whether/Q* operator must be *clausal*. This allows Han and Romero to account for the *impossibility* of alternative question readings in certain constructions, for instance, in disjunctive interrogatives with preposed negation:

- (54) Didn’t John drink coffee or tea? ⇒ no alternative question reading

This really seems to be the general aim of Han and Romero’s programme: to explain why alternative question readings *cannot* obtain in certain constructions. Another thing is to explain why an alternative question reading *must* obtain in the presence of separate pitch accents (recall that we are operating here under the counterfactual assumption that separate pitch accents enforce such a reading). And this does not seem to be derived. For, it does not follow from Han and Romero’s assumptions that (53) is the *only* syntactic structure for (52) that is consistent with separate pitch accents on ‘coffee’ and ‘tea’. Another such structure would be the following:

- (55) [Q_i-did [t_i [[John drink coffee or tea] or [John not drink coffee or tea]]]]

This is in fact one of the possible syntactic structures that Han and Romero propose for disjunctive interrogatives with a yes-no reading (see Han and Romero, 2004b, p.557, example 86). The disjunction that associates with the silent *whether/Q* operator is clausal here, so the structure is in line with Han and Romero’s central assumptions. But there is nothing in this structure that makes it impossible to have separate pitch accents on ‘coffee’ and ‘tea’. And this means that the presence of such pitch accents is compatible

with a yes-no interpretation. Thus, as it stands, Han and Romero's account does not derive the presumed fact that separate pitch accents on each of the disjuncts enforce an alternative question interpretation.

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