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An analysis of prosodic F-effects in interrogatives: Prosody, syntax and semantics

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Abstract

This paper provides a prosodic, syntactic and semantic analysis of prosodic F-effects in interrogatives. It is argued that alternative questions involve a question-related F-feature on the alternatives, and that the sentence stress on the wh-word in echo questions is due to a wh-word inherent F-feature. These cases, like Japanese wh-in situ questions, show a full prosodic F-effect (attraction of sentence stress). German and English wh-questions show a reduced prosodic F-effect on the wh-phrase in situ and no prosodic F-effect on moved wh-phrases (in single-wh-questions). Surprisingly, the wh-phrase in situ shows evidence of percolation of F to the wh-phrase. These effects are related to a postulated relation of I-agreement that connects the Q-marker to one or more wh-phrases. Evidence for the agreement relation is that it can be blocked by an intervening wh-phrase construed with another Q-marker, with striking prosodic consequences. An account at the syntax–semantic interface is suggested, in which F can be interpreted relative to the Q-marker and replaces the feature wh. Semantically, F in interrogatives connects expressions to the interrogative interpretation. Absence of F on moving wh-phrases (but not on others) provides evidence that these rely on a different mechanism of construal with the Q-marker.
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Keywords: Interrogatives; Focus; Alternative questions; Echo questions; Wh-questions; Agreement

1. Introduction and overview

This paper addresses the issue of what the F-feature is doing in wh-words and in questions more generally. Why are Japanese and Turkish wh-words prosodically marked as though they are inherently focused? Is it a coincidence that echo questions in English and German show a similar stress pattern? Why do alternative questions have stress on the alternatives? Why do English and German wh-questions sometimes show inherent prosodic focus effects on the wh-word, but often not?

In the current paper, an integrated prosodic, syntactic and semantic account is developed. The prosodic effects are established in some detail against simple assumptions about default prosody, and in consideration of alternative hypotheses about the observed stress patterns.

The leading idea of the account, taken from Cable (2010) (with related ideas in Haida, 2007) is that the F-feature is not only involved in calculating information structure alternatives, but is also an inherent part of the syntax–semantic interface of interrogatives, and that this F-feature in interrogatives *is* the feature that we are otherwise calling *wh*; we recognize it as F because its prosodic consequences emerge both in information structure use and in interrogative, i.e. Q-related, use.

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In the syntax, we will see that detailed observation of the prosodic facts provide a range of evidence for the syntax underlying wh-movement: The prosody provides evidence for a particular kind of agreement relation between the interrogative scope-marker Q and one or more associated wh-phrases. The agreement relation is here called l-agreement, since it connects two F-related lexical items (the Q-marker and the question words with the wh-morpheme, i.e. F-morpheme). The prosody provides evidence that F percolates to the wh-phrase in all wh-phrases that participate in the relation of l-agreement. Furthermore, the relation of l-agreement exempts all participating wh-phrases from one of two prosodic focus requirements. L-agreement is found only where one wh-phrase moves, i.e. not in Japanese questions and not in English or German echo-questions. In English or German wh-questions, the link that l-agreement establishes can also be broken by an intervening wh-phrase. A further wh-phrase can be co-construed with the question, but since it lacks l-agreement, its prosody is now like the prosody of Japanese wh-words or that of echo-questions: Its F-feature no longer percolates to the wh-phrase, and it is not exempt from one of the prosodic focus requirements.

Other details of the syntactic account are informed by the semantic interpretation, which is formulated as an extension of Rooth (1992), Kratzer (1991) and Beck (2006). The semantic account follows the intuition that all F-features for which we have prosodic evidence (including the percolated ones) play a role in the interpretation. Where we have evidence of the lack of an F-feature, this is taken to be evidence for the lack of a semantic need of F, i.e. for a different mechanism that takes over the function of F. We will be led to the perspective that overt movement (not l-agreement more generally) connects the Q-marker to a wh-element (here: referential co-indexing) but that this semantic connection is available only for the moving wh-phrase. Other wh-elements need to employ F to establish a semantic connection to the Q-marker. If the presence of F establishes relations to Q in a 'second dimension' of interpretation (focus semantic value), then l-agreement determines a 'third dimension' of interpretation. It is a specialized version of the second dimension, also using the focus semantic value, but introducing a calculation specialized to the Q-marker and not interfering with the second dimension.

The paper is structured as follows. Section 2 introduces background on the prosodic structure that will help us isolate prosodic effects of F. Section 3 argues that Q-related F is found in three cases in which a full prosodic effect of F (attraction of sentence stress) can be observed: alternative questions (with Q-related F on the alternatives), Japanese questions (a review from the literature) and German echo questions (with Q-related F in the wh-word). Section 4 solidifies observations of Haida (2007) about the prosody of single- and multiple-wh-questions in German and English. Section 5 presents the prosodic evidence for l-agreement. Section 6 develops details of the syntactic account. Section 7 provides the details of the semantic interpretation. Section 8 sums up the paper.

2. Default prosodic structure and the prosodic effect of F

2.1. General remarks on relevant aspects of prosodic structure of English and German

The prosodic representation adopted in this article distinguishes two levels of prominence above word stress, as illustrated in (1). The lower level is what Gussenhoven (1983a, 1992) and Selkirk (1984, 1995) described as *accent*. In the conception of Pierrehumbert (1980) and others, this notion combines two components: abstract prominence, and a tonal pitch accent such as H* that is assigned to it. In (1), prominence at the lower level (also called 'phrasal stress') is represented by a grid-mark in the prosodic structure. It is assigned relative to the syntax (see below) and it entails the assignment of an obligatory pitch accent. I will often refer to the combination of phrasal stress and pitch accent as 'accent'. The higher level in (1) is that of the intonation phrase. In the cases we are concerned with here, the intonation phrase is the sentence.[1] The strongest stress of the intonation phrase, which will be referred to as 'sentence stress', is represented by a second grid-mark, as in (1). In (1), the grid-representation is redundantly doubled by a notation in terms of underlining, with accent indicated by (single or double) underlining, and sentence stress indicated by double underlining. In the remainder of this paper, the prosodic structure will be shown only by underlining.

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(1)   [                              x ]       intonation phrase, 'sentence stress'
          x              x      x            'phrasal stress', 'accent'
        John    introduced    Bill to   Sue
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Once the positions of accents are determined (see below), the position of sentence stress is given by a rule that strengthens the rightmost accent, following Gussenhoven (1983a,b), Uhmann (1991), and Selkirk (1995). The name

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[1] In a classical suggestion (Downing, 1970; Nespor and Vogel, 1986) edges of root clauses coincide with obligatory intonation phrase boundaries. Standard phonetic cues for intonation phrases are pauses, final lengthening, and F0 cues. In the account of English intonation in Beckman and Pierrehumbert (1986) the intonation phrase is assigned two edge tones in sequence.

NSR-I is used here, since the rule is a remnant of the classical Nuclear Stress Rule (NSR) of Chomsky and Halle (1968), which applies at the level of the intonation phrase.

(2)   NSR-I: Strengthen the rightmost phrasal stress in the intonation phrase.

The rule in (2), and the notion 'sentence stress', is also useful for connecting to a segment of the literature that is concerned only with the position of the 'strongest stress in the sentence', e.g. Höhle (1982) and Cinque (1993).

In an English assertion without continuation, the standard tonal pattern consists of H* pitch accents assigned on the accented syllables and a final sequence of L–L% edge tones (Pierrehumbert and Hirschberg, 1990). Fig. 1 shows two plots for this melody laid across a sentence in different ways. The plot on the left is compatible with an 'all-new' stress-pattern, here *Marianna made the marmalade*. Each accented word contains a H* tone on its stressed syllable, which defines a high point in the sentence melody. The plot on the right is compatible with a stress pattern in which narrow focus on the subject has forced stress retraction: *(Who made the marmalade?) Marianna_F made the marmalade.* Here, only the subject is accented and contains an H* tone that corresponds to a high point of the melody.
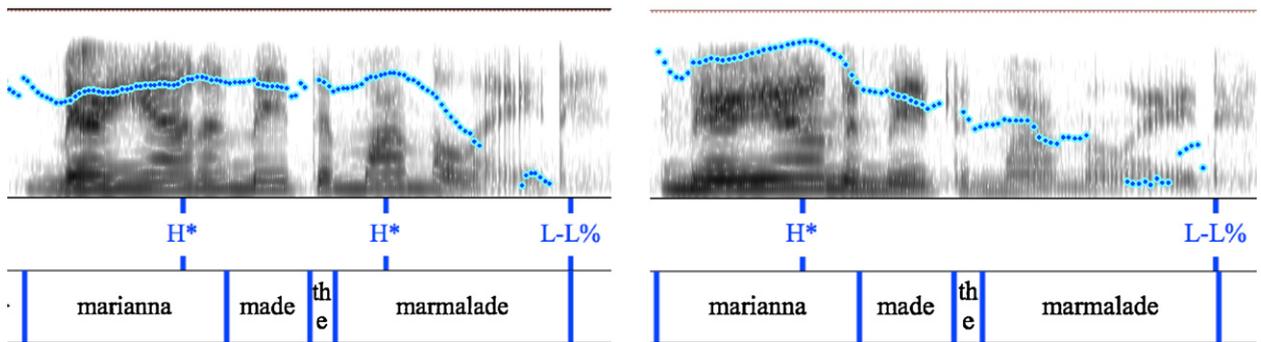
Fig. 1. F0 contours for [Marianna made the marmalade] (left) and [Marianna made the marmalade] (right). The F0-scale ranges from 60 Hz to 300 Hz. The recordings and the labels are from Beckman and Ayers (1993).

The position of the last accent (the sentence stress, in the analysis) is cued particularly clearly: It is the position of the last high point (H*) at which the fall towards the L–L% tones sets in. The plot on the left also shows that a H* pitch accent preceding the final one is not cued as clearly in this assertive F0 contour, since such a preceding accent defines a high point in a continuing plateau.

In standard German, H* is also a standard option in assertions (Grice et al., 2005; Peters, 2006). Another option, possible in Central and Northern varieties and the standard choice in Southern varieties, assigns rising pitch accents in non-final position, followed by a final falling pitch accent. The rises show different alignment with the stressed syllables in Northern and Southern varieties (Atterer and Ladd, 2004). An example from a Southern speaker from Baden-Württemberg is shown in Fig. 2.

In the Southern varieties, the non-final rises are analyzed as L* + H pitch accents: As can be seen in Fig. 2, the non-final accented syllables contain a low point that is followed by a rise that here extends into the following syllable. The final pitch accent is analyzed as H + L*. This intonation pattern provides clear F0 cues for the last accent and sentence stress: It is a falling, rather than a rising accent. This intonation pattern also provides clear F0 cues for the accents preceding the final one, in the form of the dramatically visible rising accents.

The relative tonal height of these rises with speakers of Southern standard varieties is investigated in detail in Truckenbrodt (2002, 2004, 2007a). These studies are based on hundreds of recordings with six speakers from
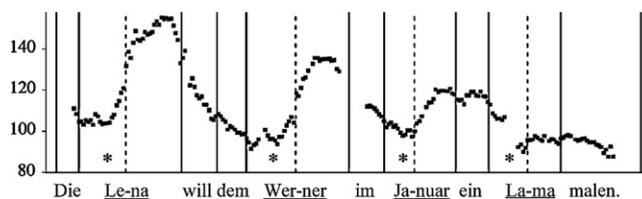
Fig. 2. F0 contour for *Die Lena will dem Werner im Januar ein Lama malen*, 'Lena wants to paint a llama for Werner in January.' Speaker TL from Baden-Württemberg. The sentence was read during a recording session from a computer print-out as an answer to the question *Was gibt's Neues?* 'What's new?'. Word boundaries are delimited by solid lines. Accented syllables are further delimited by dashed lines, and are marked by a star. Adapted from Truckenbrodt (2007a).

Baden-Württemberg and two speakers from Austria. Throughout, the non-final L* + H rising accents were found, and they were found in the positions predicted by the account that is employed below, with very few (and unsystematic) exceptions. Related studies that show that non-final accents in German have clear F0 cues include Grabe (1998), Féry and Truckenbrodt (2005), Féry and Kügler (2008), and Féry and Kentner (2010).

The current study relies mostly on German; however, a prosodic account is employed that extends across English and German. The prosodic observations concerning the topic of this paper seem to also be parallel in German and English. The suggestions are thus presented as a cross-linguistic account for both languages. The relation between English and German non-final accents is taken to be as follows: The current account provides a good approximation to the assignment of *obligatory* accents in English (those also assigned as obligatory by the suggestions of Gussenhoven (1983a, 1992) and Selkirk (1984, 1995)). A good deal of flexibility appears to exist in English concerning the assignment of non-final accents in addition to those predicted by the account. There is a tendency to add an initial accent (Shattuck-Hufnagel et al., 1994), but also considerable freedom for adding accents in other positions that precede the final accent (Pierrehumbert, 1980, 1993; Gussenhoven, 1983b).

Many of the reports on accents and sentence stress in this paper converge with existing descriptions in the literature that are cited, and none differ from pertinent literature that I am aware of (unless otherwise noted, in one case). Almost all of the remaining reports are robust, since they can either be assessed in the position of sentence stress, or concern the distinction between an accent-rejecting pronoun and a fully accented phrase. In one case, where no robust intuitions are available, this is explicitly noted. The author is a native speaker of Southern standard German, with default intonation as shown in Fig. 2.

2.2. The position of (obligatory) accents

How are the accents at the lower levels of (1), Figs. 1 and 2 assigned? The *Sentence Accent Assignment Rule* (SAAR) of Gussenhoven (1983a, 1992) was written for English, Dutch, and German. A slightly simplified version is shown in (3). It works in all-new sentences in which stress is not affected by narrow focus or by givenness of some element.

(3)   SAAR (Gussenhoven, 1983b, 1992)
      Each argument and each adjunct (modifier) receives an accent. A verb (predicate) also receives an accent unless it is adjacent to an accented argument.

In the English examples in (4) and in their German translations in (5), the bracketed arguments and adjuncts each receive an accent by the SAAR. In addition, the verb in (4b) and (5b) receives an accent, since it does not stand next to an accented argument (but next to an adjunct). In (4a) and (5a), it stands next to an accented object, and therefore receives no accent by the SAAR. Pronouns like the subject in (4b)/(5b) must be exempt from the SAAR by a stipulation.

(4)   a.   [John] introduced [Bill] to [Sue]
      b.   He slept [during the show]

(5)   a.   [John] hat [den Bill] [der Sue] vorgestellt.
           John   has DET Bill   DET Sue   introduced
      b.   Er hat [während der Vorstellung] geschlafen.
           he has during   the show   slept

A more principled statement to replace the SAAR was suggested in Truckenbrodt (1995, 2006); see also Samek-Lodovici (2005), Féry and Samek-Lodovici (2006) and Truckenbrodt and Darcy (2010):

(6)   STRESS-XP: Each lexical XP must contain phrasal stress (here taken to be coextensive with accent).

The examples in (4) and (5) are repeated below as (7) and (8), this time with the lexical XPs bracketed. In an adjunction structure, it is the inner segment of VP that is to count for STRESS-XP, so adjuncts are drawn as outside of the VP. (6) works on the assumption that phrasal stress assignment applies only where forced by STRESS-XP. In each of the one-word lexical XPs [John], [Bill], [Sue], [slept] and [show] the assignment of phrasal stress by STRESS-XP is forced. Higher lexical XPs such as [during the show] and [introduced Bill to Sue] then already contain phrasal stress on these smaller XPs, and no additional stress-assignment in them is forced. (A single stress can do duty for multiple lexical XPs.)

(7)   a.   [John] [VP introduced [Bill] to [Sue]]
      b.   He [VP slept] [PP during the [NP show]]

(8)   a.   [<u>John</u>] hat [$_{VP}$ den [<u>Bill</u>]   der [<u>Sue</u>] vorgestellt]
            John has   DET   Bill   DET   Sue introduced
      b.   Er hat [$_{PP}$ während der [<u>Vorstellung</u>]] [$_{VP}$ <u>geschlafen</u>]
            he has   during   the   show   slept

This account derives the effects circumscribed by the SAAR as follows. Arguments and adjuncts contain accent because they contain lexical XPs, typically NPs. A verb next to an accented object, as in [$_{VP}$ see <u>Mary</u>] or in [$_{VP}$ introduce <u>Bill</u> to <u>Sue</u>] is not forced to be accented, because its VP contains accent on the object or objects. In these cases, the verb itself is only a head, and does not invoke S$_{TRESS}$-XP. This is different for the verb next to an adjunct, as in (7b) and (8b), where the verb is a VP in the relevant sense, and therefore requires accent by S$_{TRESS}$-XP. Within a DP such as [$_{DP}$ the [$_{NP}$ <u>show</u>]] the lexical NP attracts stress by S$_{TRESS}$-XP while the functional DP is irrelevant. Pronouns such as [$_{DP}$ she] are therefore correctly predicted not to attract stress by S$_{TRESS}$-XP. However, this does not exhaustively capture their prosodic behavior (Truckenbrodt, 2007b). They must be taken to be stress-rejecting by an additional stipulation. Thus, in [$_{VP}$ etwas <u>lesen</u>], in English [to [$_{VP}$ <u>read</u> something]], S$_{TRESS}$-XP requires stress in the VP but leaves open where it falls. S$_{TRESS}$-XP here does not lead to a preference for stress on either the verb (which is a syntactic head) or the pronoun (which does not invoke S$_{TRESS}$-XP). The observed verb stress must therefore be due to a stress-rejecting property of the pronoun.[2]

The result of applying the NSR-I to (7) and (8) is shown in (9) and (10). Sentence stress is shown by double underlining. The results are empirically adequate in both languages. Notice that sentence stress is not final in the German example (10a), since an unaccented verb follows the last accented object. Notice also that the adjunct receives sentence stress in the English (9b), while the verb receives sentence stress in the German equivalent (10b). This suggests that (2) correctly captures that it is the rightmost accent that carries sentence stress (rather than consistently the verb or consistently the adjunct across the two languages).

(9)   a.   [<u>John</u>] [$_{VP}$ introduced [<u>Bill</u>] to [[<u><u>Sue</u></u>]]]
      b.   He [$_{VP}$ <u>slept</u>] [$_{PP}$ during the [$_{NP}$ <u><u>show</u></u>]]

(10)   a.   [<u>John</u>] hat den [<u>Bill</u>] der [<u>Sue</u>] vorgestellt.
            John   has DET Bill   DET Sue introduced
      b.   Er hat [$_{PP}$ während der [<u>Vorstellung</u>]] [$_{VP}$ <u><u>geschlafen</u></u>]
            he has   during   the   show   slept

Results comparable to those of the SAAR or S$_{TRESS}$-XP are achieved by a mechanism of focus feature percolation in Selkirk (1984, 1995). A suggestion in terms of syntactic phases (Chomsky, 2008) can be found in Kratzer and Selkirk (2007). The latter account, like the current account in terms of S$_{TRESS}$-XP and NSR-I, assigns default stress independent of focus.

2.3. Effects of focus and givenness on the prosodic structure

Relative to the pattern of default stress, we can now observe the effects of narrow focus. In (11), there is narrow focus on *Bill*, which is marked by F. The F-features employed here come with a referential index, written [F,1] or F1, which will be relevant in the semantic interpretation and in the extension to wh-phrases. For completeness, they are represented throughout the paper. F1 in (11) is interpreted relative to the scope-marker ∼ (Rooth, 1992). The effect of focus on the stress in (11) is that focus attracts the strongest stress in the sentence. This is captured by the suggestion of Jackendoff (1972) in (12). This prosodic effect of focus overrides the default prosody defined by S$_{TRESS}$-XP and NSR-I and forces the sentence stress to retract to the focused constituent *Bill* in (11).

(11)   Did John introduce Peter to Sue?
        No, ∼[<u>John</u> introduced <u><u>Bill</u></u>$_{F1}$ to Sue]

(12)   Jackendoff (1972): F must contain the strongest stress in the sentence.

The demand in (12) is met in the structure in (11): The F-marked constituent *Bill* carries the strongest stress of the sentence. Notice that the requirement of focus in (12) is in conflict with S$_{TRESS}$-XP and with NSR-I: S$_{TRESS}$-XP otherwise

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[2] I take the class of pronouns that have this property to be the class of D-heads with no complement.

assigns phrasal stress to *Sue*, and NSR-I otherwise strengthens this to sentence stress, as in (9a). The requirement in (12) is stronger and overrides these defaults. There are two conceivable outcomes of this overriding effect: (a) ∼[John introduced $\underline{Bill}_F$ to $\underline{Sue}$] in which STRESS-XP is still satisfied for *Sue*, but NSR-I is violated, since the last phrasal stress is not the strongest; (b) ∼[John introduced $\underline{Bill}_F$ to Sue] in which STRESS-XP is not satisfied for *Sue*, but in this case NSR-I (understood as a constraint on the output) is still satisfied: With the omission of phrasal stress on *Sue*, the rightmost phrasal stress (on *Bill*) is the sentence stress. Option (b) is chosen, in which satisfaction of STRESS-XP for *Sue* is sacrificed, while NSR-I is satisfied. More generally, then, retraction of sentence stress by F comes with suppression of following accents in the domain in which stress is retracted. See Uhmann (1991), Truckenbrodt (1995:Ch5), Féry and Samek-Lodovici (2006), and Büring (2009) for more detailed discussion and formalization.

Important for the current paper is a refinement of Jackendoff's suggestion that was argued for in Truckenbrodt (1995:Ch4). Consider (13) and (14). In both examples, the assignment of focus does not lead to retraction of the sentence-stress from the end of the sentences (on *bar* in (13) and on *matter* in (14)). This is contrary to what is predicted by Jackendoff's statement about the prosodic effect of focus in (12): The focus would be expected to attract the strongest stress in the entire sentence. Relevant for understanding these cases is an understanding of the scope of the focus, marked by ∼. The scope of the focus is the level at which the alternatives to the focus are computed in the theory of Rooth (1992, 1996). Thus, the alternative to ∼*[American$_F$ farmer]* is *Canadian farmer*, replacing the focused *American* with a different element. Similarly, the alternative to the focused ∼*[Canadian$_F$ farmer]* is *American farmer*, replacing the focused *Canadian* with a different element. In (14) the alternatives to ∼*[introduced Bill$_F$ to Sue]* are introductions to Sue of people other than the focused Bill (alternatives of which the semantics of *only* asserts that they are false).

(13)   An ∼[$\underline{American}_{F1}$ farmer] and a ∼[$\underline{Canadian}_{F2}$ farmer] went to a $\underline{bar}$.

(14)   What did you observe?
        [$_{CP}$ that $\underline{John}$ only ∼[introduced $\underline{Bill}_{F1}$ to Sue] doesn't $\underline{matter}$.

Returning to the prosody, we may say that the effect of F is not as global as stated in (12). Matters will come out right if we maintain that focus attracts the strongest stress only within its scope-domain ∼. Consider first (13). The strongest stress in the scope-domains ∼[$\underline{American}_F$ farmer] and ∼[$\underline{Canadian}_F$ farmer] is in both instances retracted to the F-marked constituents there. However, stress outside of these ∼-domains is not affected by F. STRESS-XP assigns phrasal stress to the final [bar], which is strengthened by NSR-I. These effects are not in conflict with the requirements of focus if stress-assignment outside of the ∼-domains are not affected by F-assignment. Similarly in (14), stress within the scope-domain ∼[introduced $\underline{Bill}_F$ to Sue] is retracted to the focused *Bill*. Stress later in the sentence is not affected by this: STRESS-XP still assigns phrasal stress to the VP [matter], and this is still strengthened by NSR-I as the rightmost phrasal stress. Again, the latter effects are not undone by any demands of focus if the demands of focus are limited to the inside of the scope-domain ∼ of the focus. Therefore, Jackendoff's formulation in (12) needs to be revised as in (15).

(15)   FOCUS (Truckenbrodt, 1995:Ch4, revising Jackendoff, 1972)
        F attracts the strongest stress in the ∼-domain, its scope.

Notice that this revision still has the correct effect in (11). Here the scope-domain is the entire sentence. Therefore stress-attraction of F in the scope-domain by (15) is stress-attraction of F in the sentence. It will be important throughout this paper that the stress-attracting effect of F is a (prosodic) relation between F and its scope-domain.

Another prosodic effect relevant in this paper is that of contextual givenness. Consider the example in (16) from Ladd (1983). In A's utterance, stress is as expected, given the application of STRESS-XP to the object *Fred* and strengthening in this position due to NSR-I. In B's utterance, stress is retracted from the now contextually given object *Fred*. Ladd argues that in this and other cases, the stress retraction is not motivated by narrow focus (here: on *like*), because there are no plausible contextual alternatives to the focus that would need to be assigned. Contextually given constituents simply reject sentence stress, and often accent. Féry and Samek-Lodovici (2006) suggest that a feature G is assigned to such given constituent, and that the prosodic consequence of G is the rejection of accent and sentence stress, as in (17).

(16)   A: What about $\underline{Fred}$?
        B: I don't $\underline{like}$ Fred.

(17)   G-marked constituents reject accent and sentence stress.

The argumentation below will furthermore rest on the premise that the background of a focus, i.e. the part of the ∼-domain that is not F-marked, is subject to the same givenness requirement as a G-marked constituent. This 'old-information' status of the background has been seen early on by Jacobs (1988) and I believe that this is an aspect that is right about the attempts to unify the two information structure notions (e.g. Schwarzschild, 1999; Wagner, in press). I take the shared status of the background and of G-marked constituents to be Wagner's presupposed salience of the relevant semantic content.

In summary, Stress-XP provides a simple and useful way for understanding the position of accents ('phrasal stress'). NSR-I strengthens the rightmost accent to sentence stress. Focus involves alternatives, which are computed at the level of the scope of the focus ∼. Focus attracts the strongest stress within the scope-domain ∼. The effect is stress-retraction within ∼ to the position of F and suppression of following accents in the scope-domain. Given constituents reject accent and sentence stress.

3. Q-related F with a full prosodic F-effect

This section argues for the inherent presence of F in three question types: alternative questions, Japanese wh-questions and German echo questions. The Q-related F-features show a full prosodic F-effect in these cases. In the context of the overall plot of the current paper, these cases establish the relevance of Q-related F-features, and they establish that we are to expect a full prosodic F-effect from Q-related F. Where we find a reduced F-effect or an absence of F-effects in English and German wh-questions in later sections, this reduction or absence requires explanation.

3.1. Alternative questions

In this section, arguments are provided that alternative questions are inherently F-marked on the alternatives, and that this F is part of the syntax–semantics interface of the interrogative interpretation. The account is established in a comparison with suggestions of Han and Romero (2004a,b).

Alternative questions involve *whether* in an embedded position as in (18a) and inversion in unembedded position as in (18b), both testifying to the presence of the Q-marker. (18a) also has a yes/no-question reading. In unembedded position, assertive H*L–L% intonation as in (18b) tends to trigger the alternative question reading, while rising intonation as in (18c) tends to trigger the yes/no-question reading (Bartels, 1999; Truckenbrodt, in press-b). Possible answers of the alternative question (18b) are {John drank coffee, John drank tea} but not *yes*, or *no*. Possible answers to the yes/no-question (18c) are {John drank coffee or tea ("yes"), John didn't drink coffee or tea ("no")}. In the latter case, actual answers may add additional information (e.g. "yes, tea").

(18) a. I wonder [whether John drank coffee or tea]
      b. Did John drink coffee or tea [\]H*L–L%   (typically: alternative question)
      c. Did John drink coffee or tea [/]L*H–H%   (typically: yes/no-question)

There is an interpretative connection between the alternatives in alternative questions and the Q-marker, which comes out in the paraphrase of (18b) *What did John drink, coffee or tea?* Larson (1985) has argued for a syntactic connection between the alternatives in alternative questions and the Q-marker. He formalized this connection in terms of movement of *whether* (for embedded questions) or movement of a null operator (for unembedded alternative questions). Beck and Kim (2006) argue that there is no evidence for overt or covert movement of the disjunction phrase. They argue that intervention effects occur instead and testify to an interpretative connection between Q and the alternatives.

Han and Romero (2004a,b) argue that the alternatives in alternative questions are focused. In (19), for example (Han and Romero, 2004b:186), an alternative question reading is possible in (19a), but not in (19b).

(19) a. Did John drink COFfee or TEA?
      b. DID John drink coffee or tea?

The effect is particularly striking when the alternatives are in non-final position. Han and Romero (2004a) discuss the examples in (20) and (21).[3]

(20) Did <u>Mary</u> or <u>John</u> finish the paper?   (alternative question reading available)

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[3] Han and Romero (2004a) boldface both disjuncts to indicate stress.

(21)   Did Mary <u>buy</u> or <u>borrow</u> the book?   (alternative question reading available)

Apart from indicating the stress on the disjunct, Han and Romero do not discuss the stress in these cases, so I will add some discussion here. Consider for comparison default stress in (22) and (23). Here each lexical XP in an argument or argument disjunct (*Mary*, *John*, *paper*, *book*) receives phrasal stress by Stress-XP, of which the final one is strengthened by NSR-I.

(22)   <u>Mary</u> or <u>John</u> finished the <u>paper</u>.

(23)   <u>Mary</u> borrowed the <u>book</u>.

When we assign such default stress in the sentences (20) and (21), there is no alternative question reading, as in (24) and (25).[4]

(24)   Did <u>Mary</u> or <u>John</u> finish the <u>paper</u>?   (yes/no-reading, no alt-reading)

(25)   Did <u>Mary</u> buy or borrow the <u>book</u>?   (yes/no-reading, no alt-reading)

This comparison shows that the stress retraction in the alternative questions in (20) and (21) must be due to a focus effect of some sort. Before addressing the suggestion of Han and Romero (2004a,b) for this focus effect, let us eliminate an obvious information structure interpretation of this focus requirement.

Alternative questions seem to presuppose (Karttunen, 1977:176 ''in the intuitive sense of the term 'presuppose''') that one of the alternatives is true. This is plausibly an instance of the more general implicature of interrogatives that there is a true answer to the question (Truckenbrodt, in press-b). Thus, the speaker asking (20) assumes that either Mary or John finished the paper. If this assumption was a requirement on the context (i.e. a presupposition), 'finished the paper' might need to be contextually given for the presupposition to be fulfilled. This givenness might conceivably lead to retraction of sentence stress to the alternatives; however, I argue against this possibility.[5] Consider the comparison in (26). Here the context is compatible with the assumption that either John or Mary will open the door, though this is not explicitly given. The wh-question carries the assumption that one of the two will open the door, as does the alternative question. This does not lead to deaccenting of the predicate in the wh-question. The alternative question again requires deaccenting, which suggests that the stress effect in alternative questions does not come from the assumption that one of the two will open the door. If it did, the wh-question in (26a), which carries the same assumption, would show the same deaccenting effect in this context. I return to another aspect of (26c) in connection with (39) and (40) below.

(26)   Max rang the bell of John and Mary's apartment. He wondered:
    a.   Which <u>one</u> of the two will open the <u>door</u>?
    b.   Will <u>John</u> or <u>Mary</u> open the <u>door</u>?   (only yes/no-q., no alt-reading)
    c.   Will <u>John</u> or <u>Mary</u> open the door?   (alt-reading)

The point that was made in the all-new context in (26) is made again in (27) for an all-given context. See Truckenbrodt (in press-a) for detailed discussion of wh-questions in all-given contexts. Observe the default stress on the final verb in (27a). The question in (27b) with the same default stress does not allow an alternative question reading. (It is infelicitous because the answer to the yes/no-question is already provided in this context.) Only (27c) with F and sentence stress on the alternatives allows the alternative question reading. If stress retraction in the alternative question were due to the assumption that someone opened the door, stress retraction should also be seen in the wh-question, which carries that same assumption. However, this is not the case.

(27)   A: Well, we know that either John finished it, or Mary finished it.
    a.   B: OK, and <u>which</u> one of the two <u>finished</u> it?
    b.   B: # OK, and did <u>John</u> or <u>Mary</u> <u>finish</u> it?   (only yes/no-q., no alt-reading)
    c.   B: OK, and did <u>John</u> or <u>Mary</u> finish it?   (alt-reading)

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[4] If the conjoined verbs carry accent, there is still no alternative question reading so long as the sentence stress remains on the object.

[5] My argument here is inspired by Jacobs (1991)'s on wh-interrogatives. Also see Truckenbrodt (in press-a, in press-b) and Hamlaoui (2011a) for related discussions.

In conclusion, the assumption carried by alternative questions (that the proposition is true for one of the alternatives) cannot plausibly account for the effects of sentence stress on the alternatives.

Let us then turn to the account of Han and Romero (2004a,b). They suggest that the focus on the alternatives comes from a derivation of alternative questions in terms of deletion. For example, (20) is to be derived by deletion as shown in (28). By assumption, this deletion requires focus and stress of the contrasting elements *John* and *Mary*. This is the effect of focus and stress that we observe in alternative questions, according to Han and Romero.

(28)   Did <u>John</u> ~~finish the paper~~ or <u>Mary</u> finish the paper?

More generally, the logic of their suggestion is: (a) by assumption, alternative questions are derived from a disjunction of clause-like constituents; where these are not fully overt, this involves deletion; (b) the deletion requires focus and thus sentence stress on the remnants; (c) therefore (a) and (b) together derive that the alternatives in alternative questions show an effect of F-marking.

I will not take issue with (a), though the account pursued here does not require deletion in many cases. However, I take issue with (b), and with the claim (c) that this account can capture the effect of focus on the alternatives.

The undeleted *finish the paper* in (28) will be called the *trigger* of deletion, and the deleted *~~finish the paper~~* will be called the *target* of deletion. The plausibility of the suggestion of Han and Romero with example (28) is derived in part from the fact that the undeleted version of (28) has the stress pattern that their explanation requires. In particular, *Mary* carries the sentence stress of the second disjunct, in which *finish the paper* is de-stressed. However, there is a likely reason why the deletion trigger *finish the paper* is unstressed in the undeleted version of (28): It is contextually given in the preceding occurrence of *finish the paper*. We cannot be sure that this carries over to the deleted version, in which this preceding occurrence of *finish the paper* is deleted.

Consider the German right-node-raising examples (29) and (30). In (29), the context question supplies the predicate *ein Papier geschrieben*, '*written a paper*'. In this case the predicate is de-stressed in the answer, because it is given by the question. In (30), however, the context question does not supply such an antecedent, and in this case, the sentence stress falls on the target of deletion, outside of the remnants of right-node-raising.

(29)   [When did they write papers?]
        Er hat am <u>Dienstag</u>, und sie hat am <u>Mittwoch</u>   ein Papier geschrieben.
        he has on Tuesday and she has on Wednesday a   paper   written

(30)   [What happened?]
        Er hat am <u>Dienstag</u>, und sie hat am <u>Mittwoch</u>   ein <u>Papier</u> geschrieben.
        he has on Tuesday and she has on Wednesday a   paper   written

Therefore, we cannot derive the stresslessness of *finish the paper* in (28) from a deletion analysis: In the deletion analysis, the antecedent VP is deleted and (unless the VP is otherwise given in the context, or assumed to be given there), we expect stress on *finish the paper* to be possible in a structure with deletion.

When we look at alternative questions with a bona fide right-node-raising derivation, as in (31), we furthermore see quite clearly that the deletion analysis cannot predict the focus effect. Thus, both (31a) and (31b) have a right-node-raising derivation, for there is no other way to derive the elliptical first conjunct. However, (31a) has an alternative question reading, and (31b) is grammatical (on the deletion derivation) but only has a yes/no-question reading. The deletion account wrongly predicts that both have alternative question readings, since both are derived by deletion. A stronger requirement is at work, namely that the alternatives in alternative questions carry F inherently.

(31)   a.   Hat <u>er</u> am <u>Dienstag</u> oder hat <u>sie</u> am <u>Mittwoch</u>   ein Papier geschrieben?   (alt-reading)
        b.   Hat <u>er</u> am <u>Dienstag</u> oder hat <u>sie</u> am <u>Mittwoch</u>   ein <u>Papier</u> geschrieben?   (no alt-reading)
              has he on Tuesday or   has she   on Wednesday a   paper written

The facts are similar in (32), for which we might either assume a right-node-raising account, or coordination of unreduced alternatives. The alternative question reading is possible only in (32a), with focal stress on the alternatives. It is not available in (32b). The argument made in regard to (31) carries over to this case: If there is a deletion derivation for (32a), there is also one for (32b), and so both are wrongly predicted to be possible alternative questions.

(32)   a.   Hat er am <u>Dienstag</u> oder am <u>Mittwoch</u>   ein Papier geschrieben?   (alt-reading)
        b.   Hat er am <u>Dienstag</u> oder am <u>Mittwoch</u>   ein <u>Papier</u> geschrieben?   (no alt-reading)
            has he on Tuesday or   on Wednesday a   paper written

What we observe in (31) and (32) is that there is a requirement at play that the alternatives in alternative questions must be F-marked, regardless of a deletion derivation.

A similar argument can be made for deletion by gapping, which is assumed by Han and Romero for (33):

(33)   Q did John drink COFfee or ~~John drink~~ TEA?

However, like right-node raising, gapping does not require focus on the remnants. An English example is shown in (34b).

(34)   a.   [Who likes whom?]
            <u>He</u> likes <u>her</u>, and <u>she</u> likes <u>him</u>.
        b.   [What is the feeling that they have towards each other?]
            He <u>likes</u> her, and she ~~likes~~ him.

Using German examples, we find, next to (35), where the trigger of deletion is backgrounded, also (36), where the trigger of deletion is focused and stressed.

(35)   [When did they write papers?]
       <u>Er</u> hat am <u>Dienstag</u> ein Papier geschrieben, und <u>sie</u> am <u>Mittwoch</u>..
       he has on Tuesday a paper   written,   and she on Wednesday
       '<u>He</u> wrote a paper on <u>Tuesday</u>, and <u>she</u> on <u>Wednesday</u>.

(36)   [What was it that he did on Tuesday and that she did on Wednesday?]
       Er hat am Dienstag ein <u>Papier</u> geschrieben, und sie am Mittwoch.
       he has on Tuesday a   paper written   and she on Wednesday
       'He wrote a <u>paper</u> on Tuesday, and she on Wednesday.'

When the sentence with the prosody of (36) is read without context, as in (37), it is grammatical. A context comparable to the one in (36) is accommodated.

(37)   Er hat am Dienstag ein <u>Papier</u> geschrieben, und sie am Mittwoch.
       'He wrote a <u>paper</u> on Tuesday, and she on Wednesday.'

Thus, deletion by gapping does not require that the trigger of deletion is de-stressed. It also does not require that the alternatives are focused and stressed.

Observe, then, that the deletion account does not predict the correct readings in bona fide cases of gapping. In (38), there is a clear difference in judgment: (38a) has an alternative question reading, while (38b) does not. (38b) is grammatical, but it only has a yes/no-question reading. The difference does not follow from the requirement that alternative questions are derived by deletion. Such a requirement wrongly predicts that (38a,b) both have an alternative question reading, because they are both derived by deletion: There is no other way to derive the two elliptical remnants that follow the disjunction.

(38)   a.   Hat <u>er</u> am <u>Dienstag</u> ein Papier geschrieben, oder <u>sie</u> am <u>Mittwoch</u>?   (alt-reading)
        b.   Hat er am Dienstag ein <u>Papier</u> geschrieben, oder sie am Mittwoch?   (no alt-reading)
            has he on Tuesday a   paper written   or   she on Wednesday
            'Has he written a paper on Tuesday or she on Wednesday?'

In (38), we observe again that there is a requirement that the alternatives in alternative questions must be F-marked, regardless of a deletion derivation. This same requirement will correctly require F on the alternatives in (19)–(21) and in (31) and (32), regardless of whether these are derived by deletion or by conjunction of smaller constituents.

I now return to an issue in connection with (26c). The context employed there is shown in (39) with a declarative continuation. The markedness of stress retraction shows that 'opening the door' is most naturally taken to be new in this context, and thus not de-stressed. Information structure focus in (39) is marked because it always requires that the 'background', the non-focused part of the scope, is contextually given. This is not fulfilled here.

(39)   Max rang the bell of John and Mary's apartment.
        a.   <u>Mary</u> opened the <u>door</u>.
        b.   (#) <u>Mary</u> opened the door.

Why is it then possible for the alternative question in (40) (= (26c)) to employ de-stressing of 'opened the door'?

(40)   Max rang the bell of John and Mary's apartment. He wondered:
        Will <u>John</u> or <u>Mary</u> open the door?

I suggest the following answer: The F-feature on the alternatives is not information structure F. If it were, (40) should be as marked as (39b), since 'open the door' is not given in this context. Instead, the F-feature on the alternatives is interpreted relative to the Q-marker as part of the interrogative interpretation. This extends suggestions of Haida (2007) and Cable (2010) for the F-feature on wh-words to the F-feature in alternative questions. The "alternatives" that the F-feature is involved in calculating in (40) are the possible answers to the question, i.e. the question meaning: {John opened the door, Mary opened the door}. Unlike information structure focus, the possible answers do not come with a givenness requirement on 'opened the door'. They come only with the weaker implicature (shared with wh-questions) that one of the answers is true, and this is compatible with the context in (40).

I suggest, then, that alternative questions carry an inherent F-feature on the alternatives, which is part of the interrogative syntax–semantics interface, as indicated in (41).

(41)   Interpretation of F on the alternatives relative to the Q-marker
        Q did [<u>John</u> or <u>Mary</u>]$_{F1}$ finish the paper?

The prosodic F-effect of this F-feature is parallel to the prosodic F-effect of information structure F: In both cases, F attracts the strongest stress in its scope-domain (typically sentence stress, with the concomitant effect of suppressing later accents). To capture it, we need to revise the formulation in (15) to (42).

(42)   Focus (prosodic effect of F)
        F attracts the strongest stress in its scope-domain (the domain of $\sim$ or of Q).

The limitation of the prosodic F-effect to the domain of the Q-marker can be seen in (43) and (44). First, the difference between (43a) and (43b) shows that the requirement of F on the alternatives extends to embedded interrogatives. The alternative question reading is available in (43b), with stress retraction (relative to the default) to the alternatives. It is not available with default stress in (43a), which only allows an embedded yes/no-question reading. (43b) is repeated with relevant structure in (44). It shows the crucial point at hand: Stress retraction within the embedded interrogative is sufficient for the alternative question reading. The later stress on *matter* in the matrix clause is derived by the application of Stress-XP to the VP [matter] and by strengthening due to the NSR-I. It need not be retracted for the alternative question reading to be possible. This shows that the domain of stress-attraction of the F in alternative questions is the domain of the Q-marker, i.e. the interrogative clause, as formulated in (42).

(43)   a.   [whether <u>John</u> or <u>Mary</u> finished the <u>paper</u>] doesn't <u>matter</u>.   (no alt-reading)
        b.   [whether <u>John</u> or <u>Mary</u> finished the paper] doesn't <u>matter</u>.   (alt-reading)

(44)   [Q-whether [<u>John</u> or <u>Mary</u>]$_{F1}$ finished the paper] doesn't <u>matter</u>.

In sum, there is evidence that the F-effect on the alternatives is inherent in alternative questions. It cannot be derived from the assumed existence of a true answer, nor from a deletion derivation. Furthermore, it is arguably

not related to information structure. I suggest that it is interpreted relative to the Q-marker as part of the interrogative interpretation. Its prosodic effect is parallel to the effect of information structure F: attraction of the strongest stress in its scope-domain. Since the scope-domain is the Q-marker here, the prosodic effect of F needs to be restated accordingly.

The semantic interpretation of the relation between Q and F in alternative questions is spelled out in Section 7.3.

3.2. Focus prosody on wh-words in Japanese

In the development of an account of Q-related F in this paper, the prosody of Japanese wh-questions is a crucial building block. The core prosodic facts from Ishihara (2003) and others are reviewed in this section: Japanese wh-words, arguably occurring in situ, show a full prosodic F-effect that we may attribute to (42). For this attribution, the presence of F in the wh-words is required. Ishihara (2003), Sabel (2006), Haida (2007) and others postulated that the feature *wh* inherently entails the presence of the feature F. Here I follow Cable (2010) who goes one step further and maintains that wh-words contain the feature F and no semantically interpreted feature *wh*. I assume that the feature F in the wh-word is the feature we otherwise call *wh*.

The prosody of Tokyo Japanese has been studied in detail by Poser (1984), Pierrehumbert and Beckman (1988), Kubozono (1989, 1993) and others; focus and wh-prosody have been studied in particular by Ishihara (2003, 2007), Deguchi and Kitagawa (2002) and Kitagawa (2007).

The default intonation of the all-accented sentence in (45a) on the following page can be seen in the first picture of Fig. 3: Each of the words shows an accent peak that triggers downstep (phonetic lowering) on the following peak. The sentence in (45b) has focus on the dative object; its intonation is shown in the second picture of Fig. 3. Two phonetic effects of the focus can be seen: (a) The focused peak is raised (relative to the downstepped height it would otherwise have); (b) the tonal height following the focus is reduced. The examples and pitch-tracks are taken from Ishihara (2003). See also Pierrehumbert and Beckman (1988), Deguchi and Kitagawa (2002) and Ishihara (2007).
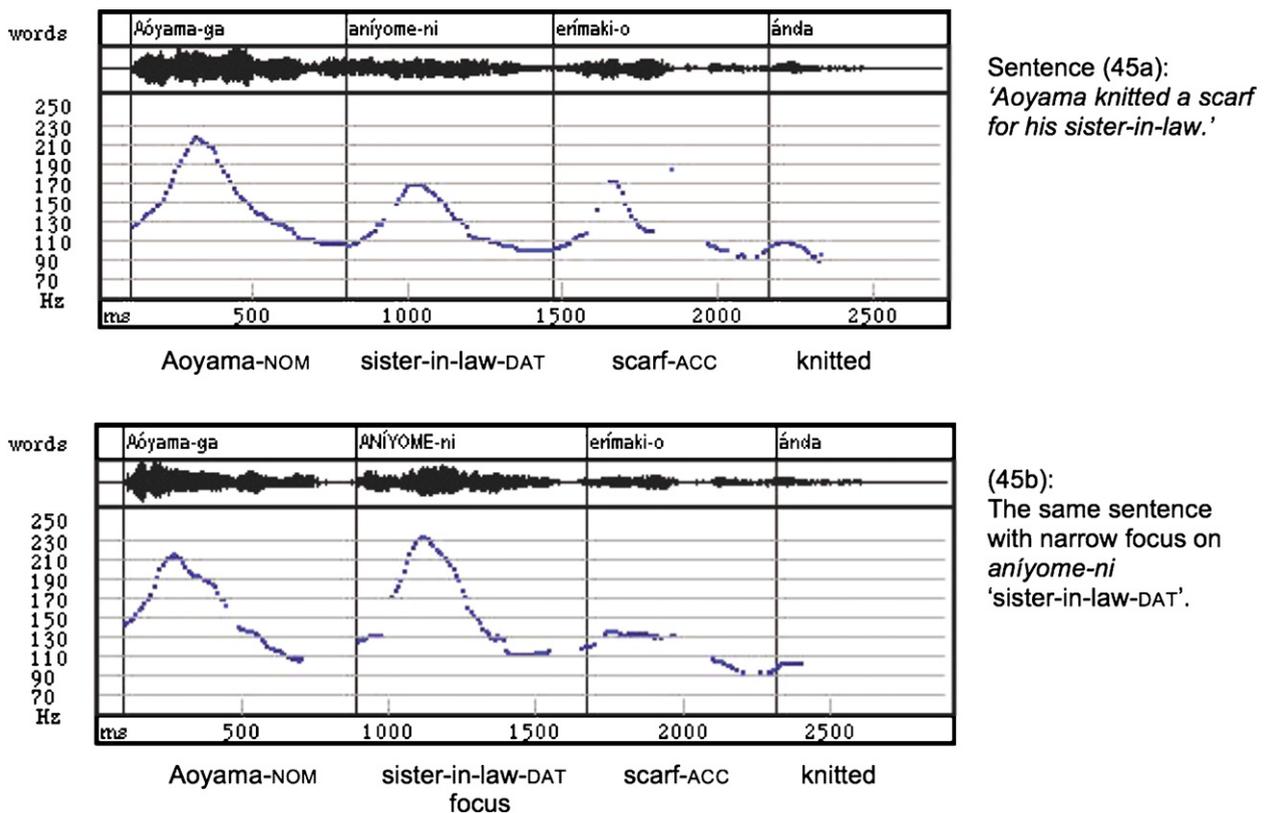
Fig. 3. F0-tracks for an all-accented sentence with and without narrow focus. The F0-tracks show raising of the tonal height of the peak in the focused word, and reduction of the tonal height following the focus. The F0-tracks are from Ishihara (2003:31).

(45) a. Aóyama-ga   aníyome-ni   erímaki-o   ánda
      b. Aóyama-ga   [aníyome-ni]_F   erímaki-o   ánda

          Aoyama-NOM   sister-in-law-DAT   scarf-ACC   knitted
          '*Aoyama knitted a scarf for his sister-in-law.*'

Wh-phrases remain in situ in Japanese questions.[6] (46), from Ishihara (2003), shows a minimal pair of a sentence with an indefinite object in (46a) and a wh-phrase object in (46b). In both examples all lexical words are accented.

(46) a. Náoya-ga   nánika-o   nomíya-de   nónda
          Naoya-NOM   something-ACC bar-LOC   drank
          '*Naoya drank something at the bar.*'
      b. Náoya-ga   náni-o   nomíya-de   nónda no?
          Naoya-NOM   what-ACC   bar-LOC   drank Q
          '*What did Naoya drink at the bar?*'

Their intonation is shown in Fig. 4 on the following page. The first plot shows the regular downstep among the accents in (46a). The second plot shows that the wh-phrase in (46b) is marked by focus prosody: (a) the accent is raised during focus (relative to the expectation of downstep), and (b) the following accents are reduced.[7]

Deguchi and Kitagawa (2002) and Ishihara (2003:35) have observed that the focus prosody of the wh-phrase is limited to the Q scope of the wh-phrase.

Sentence stress on wh-words in situ in wh-questions is also observed in Turkish (Göksel and Kerslake, 2005; Kornfilt, 1997). This is again parallel to the prosodic effect of information structure F.

The focus prosody on the wh-phrases in situ in Japanese and Turkish is a consistent property of wh-questions in these languages (Ishihara, 2003; Göksel and Kerslake, 2005). I follow Ishihara (2003) in analyzing this as the effect of an F-feature inherent in wh-words. I furthermore follow Cable (2010) in analyzing wh-words as carrying an interpreted F-feature but no interpreted wh-feature. In the current account, simple Japanese wh-words are then represented as [F,i], the focus feature with a referential index. This is the same feature complex (e.g. F1, equivalent to [F,1]) that is also assigned in the case of information structure F. Simple wh-words carry an additional restriction in regard to the set of elements that the referent of the index is drawn from: persons in the case of *who*, inanimate objects in the case of *what*, etc. This is omitted here.[8] The relevant elements of the Japanese question in (46b) are then shown in (47). The representation of the wh-word is [F,i], which is semantically interpreted relative to the Q-marker.

(47)   Japanese wh-questions: the wh-word carries F, interpreted relative to the Q-marker
         Q   [F,1]
             Náoya-ga náni-o   nomíya-de nónda no?
             Naoya-NOM what-ACC bar-LOC   drank Q
             '*What did Naoya drink at the bar?*'

Ishihara (2003) discusses the prosodic F-effect of information structure F and of wh-words as an effect of the attraction of sentence stress by the F-feature in the wh-word. From that perspective, we can directly subsume the prosodic F-effect of both under (42). Information structure F and Q-related F in wh-words attract the strongest stress in the scope-domain, where the scope here is the interrogative, the domain of Q. This also accounts for the limitation of this effect to the domain of the Q-marker.

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[6] Japanese *wh*-phrases can scramble. Takahashi (1993) postulates that some instances of dislocation involve *wh*-movement to Spec,CP in Japanese. Ishihara (2002) shows that Takahashi's data can also be explained in terms of a scrambling analysis of *wh*-phrases, rather than *wh*-movement. The scrambling analysis is assumed here. The dislocated *wh*-phrases at issue also show focus prosody.

[7] On further phonological and phonetic effects of focus in Japanese, see Pierrehumbert and Beckman (1988), Ishihara (2003, 2007) and others. These may be derived indirectly from a stress-attracting effect or written into the grammar directly; the issue is not relevant to the point at hand, since these effects are the same with information structure focus and wh-words in Japanese.

[8] In an earlier version of this paper, I explored the idea of representing this additional restriction as the type of an index, at least for simple cases. Thus, *when* would have an index of type temporal interval, *where* an index of type place, etc. However, as the editors of this volume pointed out to me, it is possible to place external information structure F on the restriction: *I am not interested in where Marcia left for. I just want to know when she left*. Here it seems that the external focus is on the restriction of the index: *where* = which [place]_F, *when* = which [time]_F We would not expect information structure F on the type of an index. This suggests that we are dealing with restrictions that are part of the semantic content.
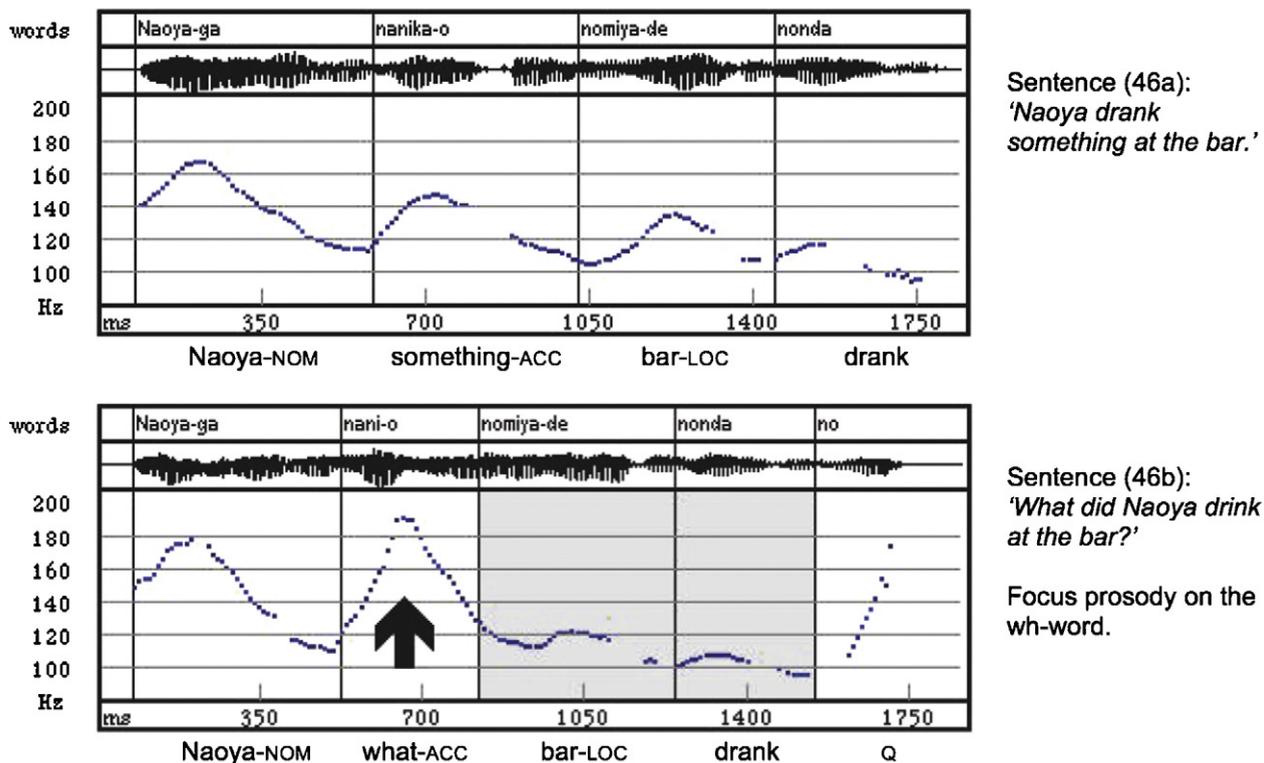
Fig. 4. F0-tracks for all-accented sentences with an indefinite object and a wh-phrase object. The second F0-tracks shows the effects of focus prosody on the wh-phrase object. The F0-tracks are from Ishihara (2003:53).

In sum, Japanese (and Turkish) wh-phrases in situ show a full effect of focus prosody on the wh-words. The domain of the effect is the interrogative clause. This is analyzed in parallel to the F-effect in alternative questions in English and German: An F-feature interpreted relative to the Q-marker attracts the strongest stress in the Q-domain. Simple Japanese wh-words are taken here to have the features [F,i].

3.3. Echo questions

I concentrate on what Sobin (1990) calls *syntactic echo-questions*, i.e. those echo-wh-questions that do not involve wh-movement. In this section, their prosody is integrated into the current account. In German, syntactic echo-questions show attraction of sentence stress to the wh-morpheme. This is analyzed as the prosodic effect of a wh-inherent F feature, as defined above in (42), in the same way as stress attraction in Japanese. The attraction of sentence stress by the wh-morpheme (rather than wh-word or wh-phrase) supports the presence of F in the wh-morpheme and provides a point of comparison for other prosodic F-effects below, where the F-feature has arguably percolated to the wh-phrase.

I begin by addressing some general properties of echo questions. Sobin (1990) argued for English, and Reis (1991, 1992, 2011) for German, that echo questions do not have a regular Q-marker: Their sentence type is the sentence type of the echoed utterance. An argument from Sobin is that, unlike other unembedded questions, they do not involve inversion in English (*Bill dates who?*). An argument from Reis (1991) involves the German modal particle *ja*. It occurs in declaratives (*Ich kenne ja Peter*, 'I know JA Peter') and is disallowed in interrogatives (*Kennst du ja Peter?* 'Do you know JA Peter?'). It is allowed in echo questions that echo a declarative with *ja* (*Du kennst ja wen?* 'You know JA whom?'). If echo questions were interrogative, i.e. if they had a Q-marker, the Q-marker would exclude *ja* here.

Often, but not always, echo questions show a specific rising intonation pattern. The reader is referred to Bartels (1999) and Truckenbrodt (in press-b) for a discussion of the semantics and discourse-relevance of this contour.

Reis (1991, 1992) shows for German that inherent sentence stress on the wh-word in situ is a consistent and inherent feature of echo questions. A German example is shown in (48). The default position of sentence stress in (48b) is not possible, not even if accent is added to the wh-word in situ. Here and throughout, examples numbered i., ii., iii. differ only in

their stress pattern. Only the first one of such a sequence is glossed. Corresponding English stress patterns are given in the translations.

(48)   i.   Peter hat <u>wem</u> die Zeitung   vorgelesen?
            Peter has whom the newspaper read
            'Peter read the newspaper to <u>whom</u>?'
    ii.   * Peter hat <u>wem</u> die <u>Zeitung</u> vorgelesen?
            'Peter read the <u>newspaper</u> to whom?'

I suggest that the consistent attraction of sentence stress is due to the wh-inherent F-feature in the wh-word. One version of this account is compatible with the perspective argued for in Reis (1992). She suggests that the wh-element is inherently F-marked in echo questions and that this F-feature has information structure interpretation. In the current theory, in which F can have information structure or interrogative interpretation, we could write a semantic denotation for an echo question operator that interprets the F-feature of the wh-word both in an interrogative dimension and in an information structure dimension. Importantly, F would still be wired into echo-questions. There is no other conceivable source for this wired-in F-feature apart from the wh-morpheme, which is an F-morpheme in the current account. The crucial point for the current paper would stand: This inherent F-feature in the wh-word attracts the sentence stress.

As Reis observes, echo questions place stronger restrictions on their context than wh-questions. I illustrate this with a comparison of the wh-question (49a) and a corresponding echo-question in the same context in (49b). The wh-question does not require givenness of the non-wh part and is therefore felicitous in this context. The corresponding echo-question does seem to require that the non-wh part of the question is given, since it is not felicitous here, as shown.

(49)   A: Maria und Paul haben Hans zum Essen eingeladen.
          'Maria and Paul have invited Hans to dinner.'

    a.   B: *(Und) was hat er <u>mitgebracht?</u>*
                and   what has he brought
                '(And) what did he <u>bring</u>?'
    b.   B: #   (Und) er hat <u>was</u> mitgebracht?
                and   he has what brought
                '(And) he brought <u>what</u>?'

This can be derived from a component of information structure interpretation of wh-inherent F in echo questions, as suggested by Reis (1992).

However, another source of the stronger givenness requirement of echo question is conceivable, as well. Jacobs (1991) (see also Truckenbrodt, in press-b) suggests that the echo-question in (49) is interpreted along the lines of 'What *are you saying* that he (Hans) brought?'. This attributes to the addressee having said that Hans brought something, which is not the case in the context in (49). Jacobs' interpretation would generate something similar to a givenness requirement of the non-wh part of the echo question, an attribution to the addressee. An advocate of this line of analysis can take different stands on the prosody of the F-feature. One possibility is that the prosody could follow from the F-feature inherent in the wh-word (here with only question-related interpretation) and from Focus. A second possibility for such an advocate would be to maintain that there is no inherent prosodic effect of the wh-word; instead, the advocate would maintain that information structure focus is assigned externally, by the regular rules of information structure marking. It just so happens (the advocate would say) that Jacobs' interpretation always makes the non-wh-marked part processed as given, and therefore information structure focus must be externally assigned to the wh-word, the only part that is not given in the echo question. Let us call this the external information structure account, or EISA. Two arguments against EISA are given in the following.

For one thing, EISA predicts parallelism between stress in the echo question and stress in a Jacobs-paraphrase, as in (50). The parallelism is predicted because the content of the echo question and of the paraphrase are the same and should therefore be treated the same by externally assigned information structure.

(50)   Hans brought a Châteauneuf.
       Hans brought <u>what</u>?
       <u>What</u> are you saying that Hans brought?

However, echo questions allow their attribution to the addressee to be fulfilled in more remote contexts, as well. Consider (51) from Reis (2011) where the speaker may initiate a conversation with this echo question. Here, the attribution to the speaker can refer to an earlier conversation. Sentence stress on the wh-word is nevertheless obligatory, as in (51i). Default stress, as in (51ii), is not possible.

(51) i.   Den   Bericht,   den   möchten   Sie   nochmals   <u>wann</u>   haben?
                the   report   that   like   you   again   when   have
                'Remind me please, the report, you would like to have it <u>when</u>?'
      ii. *   Den   Bericht,   den   möchten   Sie   nochmals   wann   <u>haben</u>?

In this case, corresponding paraphrases show different information structure assignment. (52i), which presupposes contextual givenness for the non-wh-part of the question is infelicitous if the reference is to a conversation a few days ago; (52ii) is natural under these circumstances.

(52) i. #   Der Bericht, <u>wann</u> sagten Sie (nochmal) möchten Sie ihn haben?
                'The report, <u>when</u> did you say that you would like to have it?
      ii.   Der Bericht, <u>wann</u> sagten Sie (nochmal) möchten Sie ihn <u>haben</u>?
                'The report, <u>when</u> did you say that you would like to <u>have</u> it?'

More generally, the EISA predicts what we normally expect from information structure: flexibility varying with the context. A context in which reference is made to an earlier conversation so that (52ii) is felicitous should also make (51ii) felicitous. This is not the case. The stress requirement in echo questions is more tightly wired into the sentence form. This is correctly predicted if it is traced back to the inherent F-feature of the wh-word in situ, rather than to externally assigned information structure.

The second argument relates to the exact position of the sentence stress in echo questions. First, the examples in (53) show that sentence stress is on the wh-word rather than on the wh-phrase.

(53) a. i. *   Sie   hat   [was   für   <u>Geschenke</u>]   mitgebracht?
                    she   has   what   for   presents   brought
                    'She brought what kind of <u>presents</u>?'
          ii.   Sie   hat   [was für Geschenke] mitgebracht?
                    'She brought <u>what</u> kind of presents?'
      b. i. *   Sie   hat   [wessen   <u>Mitarbeiter</u>]   kennengelernt?
                    she   has   whose   employee(s)   met
                    'She met whose <u>employee(s)</u>?'
          ii.   Sie   hat   [<u>wessen</u> Mitarbeiter] kennengelernt?
                    'She met <u>whose</u> employee(s)?'
      c. i. *   Sie   hat   [wie   vielen   <u>Leuten</u>]   <u>Geschenke</u>   mitgebracht?
                    she   has   how   many   people   presents   brought
                    'She brought how many <u>people</u> <u>presents</u>?'
          ii.   Sie   hat   [<u>wie</u> vielen Leuten] Geschenke mitgebracht?
                    'She brought <u>how</u> many people presents?'

Moreover, as Reis (1991) points out, it is not just the wh-word, but the syllable carrying the wh-morpheme that receives sentence stress in German echo questions. The German wh-morpheme, orthographically ''w-'', phonologically [v-], can easily be isolated due to (a) its occurrence in all German wh-words (with the exception of the C-head *ob* 'whether') and (b) a frequent (not complete, not always semantically transparent) alternation with a definite/demonstrative d-morpheme, similar to the English alternation in *where*/*there*, *when*/*then*. In German: *w-arum*/*d-arum* 'why'/'because-of-this', *w-ann*/*d-ann* 'when'/'then', *w-er*/*d-er* 'who'/'that one' etc. German has a number of polysyllabic wh-words that carry word stress on a syllable different from the one that includes the wh-morpheme, in normal use in wh-questions. Examples are shown in (54a). When they occur in echo questions, the sentence stress is not attracted to their normally stressed syllable, but instead to the syllable that includes the wh-morpheme. This is indicated in (54b).

(54) a. German wh-words with   b. Sentence stress in echo questions
         non-wh-stress

      wa<u>rum</u> ('why')   . . . <u>wa</u>rum . . .
      wo<u>mit</u> ('with what')   . . . <u>wo</u>mit . . .
      wo<u>für</u> ('for what')   . . . <u>wo</u>für . . .
      inwie<u>fern</u> (lit: 'inhowfar')   . . . in<u>wie</u>fern . . .

(55a) shows the use of one of these in an embedded question. Only the default stress within the wh-word is possible here. In the use of this wh-word in an echo question in (55b), only the stress pattern in which stress shifts to the syllable with the wh-morpheme is possible.

(55) a.   Maria   weiß   [wo<u>für</u>/*<u>wo</u>für   Hans   das   <u>Holz</u>   gekauft   hat]
           Maria   knows what-for   Hans   the   wood   bought   has
           'Maria knows for what Hans has bought the wood.'
      b.   Hans   hat   es   *wo<u>für</u>/√<u>wo</u>für   gekauft?
           'Hans has   it   what-for   bought.'
           'Hans bought it for WHAT?'

Important for assessing the hypothesis of overlaid information structure focus is that information structure focus can never achieve the word-internal stress shift to the wh-morpheme. Imagine, for example, a conversation among three people. Person A says what Hans bought the wood for. Person B then utters the echo-question (55b). Person A didn't understand the echo-question, and so Person C clarifies:

(56) B   möchte   wissen   [wo<u>für</u>/*<u>wo</u>für   Hans   das   Holz   gekauft   hat]
      B   wants   know   what-for   Hans   the   wood   bought   has
      'B wants to know what Hans has bought the wood for.'

Here, stress can retract from all other elements of the sentence, since they can be taken to be contextually given. The element *für* 'for' is given just like the rest of the sentence. In particular, B has signalled in his echo-question that she, too, had understood this part of A's preceding utterance. Yet the stress cannot shift away from 'für' to the wh-morpheme. This shows that the location of the sentence stress in echo questions is not determined by external information structure, since external information structure cannot trigger the word-internal stress-shift.

I therefore suggest that the inherent stress effect stems from the wh-inherent F-feature in echo questions. Assuming that this F-feature does not percolate to the wh-word or the wh-phrase, the location of the stress effect on the wh-morpheme is correctly predicted. Examples are shown in (57).

(57)   F in echo-wh-questions

       a.   DP   b.   DP   c.   PP
              | /\ |
              D   D   NP   P
              | | | /\
        [F,i]<u>w-as</u>   [F,i]<u>w-es</u>sen   N   D   P
                                                   | | |
                                               Mitarbeiter [F,i]<u>wo</u> -für
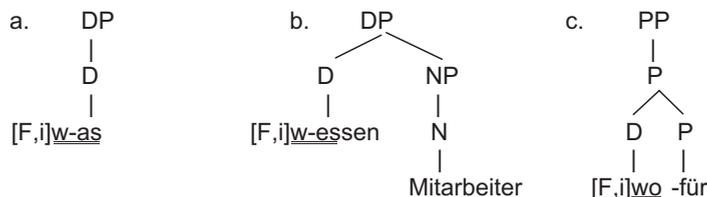
For the prosodic account, we need to adjust the formulation of Focus to include echo questions. For concreteness, let us follow Dayal (1996) and assume that echo questions have a scope-marker that differs from the regular Q-marker. I call it EQ. (42) is then revised as in (58).

(58) Focus (prosodic effect of F)
      F attracts the strongest stress in its scope-domain (the domain of $\sim$ or of Q or of EQ).

Since there are no embedded echo questions (Reis, 1991), i.e. EQ always has utterance scope, we cannot assess the limitation of the stress effect to the inside of EQ in the same way we did with the squiggle and with Q.

The main consequences of the discussion of echo questions are: First, echo questions provide an additional case (next to alternative questions and Japanese wh-questions) in which we see a full prosodic F-effect from an F-feature that is related to questions in some way (here: because it stems from a wh-word). Second, the location of the F-effect in the wh-morpheme supports the analysis in which the wh-morpheme is the source of the F-feature. This is captured, following Cable (2010), by taking F to be the feature that lexically distinguishes wh-words from other words. Third, it will be relevant to the discussion of percolation of F below that echo questions do not involve percolation of the F-feature: The prosodic F-effect here is tied to the wh-morpheme.

4. The prosody of English and German wh-questions

Regular English and German wh-questions differ from the cases discussed so far in showing much reduced prosodic effects on the wh-words in comparison to the cases discussed so far. We want to understand (a) what property of wh-questions makes them different from the preceding cases? (b) Why do they still show some prosodic F-effects? (c) What can we learn about the syntax and semantics of wh-questions from the prosodic observations?

In the current section the reduced prosodic F-effects are reviewed. Section 4.1 addresses single-wh-questions and Section 4.2 addresses multiple-wh-questions. In Section 4.3, the observations are structured in terms of hypotheses about the relation of the prosodic F-effects to syntactic movement. The picture is expanded in the following Section 5, which provides prosodic evidence for a specific agreement relation underlying movement (Chomsky, 2000, 2001 and later work).

4.1. The prosody of single-wh-questions with wh-movement

Haida (2007) observes that single-wh-questions in German do not show an effect of attraction of either sentence stress or accent on the fronted wh-word. This result is confirmed in Truckenbrodt (in press-a), where it is placed in the context of a detailed understanding of the stress pattern of questions in controlled contexts (see also Jacobs, 1991 and Hamlaoui, 2011a). It is maintained for English, as well (cf. *I wonder who called?*). For both languages, the perspective of Bresnan (1971) is adopted and confirmed, that wh-words in single-wh-questions are, and act prosodically like, pronouns: They are inherently unaccented (cf. *He likes her.*), and are here taken to be accent-rejecting, though they can be accented by F (cf. *Who likes who? He likes her, and I like you*).

An additional argument is provided in the following. Consider first (59) and (60), which will be compared with the crucial case (61) below. In (59i), the subject, containing the lexical NP *Peter*, can be accented and the verb unaccented, even though both are new. The lexical NP receives accent by Stress-XP. Understanding the stresslessness of the verb here requires some understanding of the interaction of movement and stress by Bresnan (1971); see also Truckenbrodt and Darcy (2010), Truckenbrodt (in press-a). At least in certain cases of movement, the stress of a moved element counts for stress-purposes as though the moved element was in its original position. In the case at hand, the accent on the subject *Peter* in Spec,CP in (59i) also counts towards the VP for Stress-XP, since it originates inside of VP. The verb need not be accented because the VP, at some level, contained the accented subject *Peter*. For completeness, I point out that the stress pattern in (59ii) is also possible in a context that does not involve standard narrow focus. The second comparison case is that of an indefinite subject pronoun in (60). The pronoun is unaccented in the acceptable stress pattern (60ii). Importantly, (60i) is not possible: It would be possible, in parallel to (59i), if the pronoun could carry accent, since this accent would then also count towards the VP for purposes of Stress-XP. We can conclude that carrying accent is not an option for the pronoun. (Another way to make the pronoun in (60i) accented is to assign focus to it. However, this is not possible in the context in (60), since (a) the verb would then be in the background of such a focus, and would therefore need to be contextually given and (b) an alternative to the pronoun would be required. Neither (a) nor (b) is supported by the context, however.)

(59)   A: Ich war am Bahnhof.
             'I was at the train station.'
       B.   i.   Aha, <u>Peter</u> ist angekommen.
                  PRT   Peter is arrived
                  'I see, <u>Peter</u> has arrived.'
            ii.   Aha, <u>Peter</u> ist <u>angekommen</u>.   (If his arrival was expected)
                  'I see, <u>Peter</u> has <u>arrived</u>.'

(60) A: Ich war am Bahnhof.
        'I was at the train station.'
    B. i. # Aha, <u>jemand</u>   ist angekommen.
                    <small>PRT</small>   someone is arrived
                    'I see, <u>someone</u> has arrived.'
      ii.   Aha, <u>jemand</u>   ist <u>angekommen</u>.
                   'I see, someone has <u>arrived</u>.'

Consider then the test-case in (61). It patterns with the inherently unaccented pronoun in (60), not with the inherently accented name in (59). In particular, if the wh-word were inherently accented, (61i) would be possible: Just as in (59i), the inherent accent would count towards the VP for S<small>TRESS</small>-XP and the verb would be allowed to remain stressless. This is not the case. (The only remaining way to derive (61i) in principle would then be to assign information structure F to the wh-word. However, this is ruled out in the same way as subject focus in (60i): (a) the verb in the background of the focus is not contextually given and (b) a suitable contrast for the wh-word would be required. Neither (a) nor (b) is supported by the context.)[9]

(61) A: Ich war am Bahnhof.
        'I was at the train station.'
    B: i. # <u>Wer</u> ist angekommen?
               who is arrived
               `<u>Who</u> has arrived?'
      ii.   Wer ist <u>angekommen</u>?
               'Who has <u>arrived</u>?'

The point of this section is highlighted in (62).

(62) In single-wh-questions, a fronted wh-word is inherently unaccented.

Notice that wh-words rather than more complex wh-phrases must be employed for these observations. In *what <u>pictures</u> did you show to <u>John</u>*, the wh-phrase [<small>DP</small> what [<small>NP</small> <u>pictures</u>]] is accented on *pictures* due to S<small>TRESS</small>-XP. Given this independently assigned accent in the wh-phrase, we cannot use it to test whether its nature as a wh-phrase brings an accent requirement with it or not.

4.2. Multiple-wh-questions in English and German

In a footnote Chomsky (1995:387) discussed the examples in (63), among others, and notes that ''the *wh*-phrase in situ has focal stress (. . .); the preferred cases degrade when that property is removed.''

(63) a. *who saw what*
    b. *who did you persuade to do what*

Consider this effect in a minimal comparison. English examples showing the unaccented nature of a wh-word in single-wh-questions are given in (64). These examples also review that (non-wh) pronouns in object position reject accent. The stress required of VP by S<small>TRESS</small>-XP falls on the verb instead here.

(64) a. I <u>know</u> [*who* <u>likes</u> her]
    b. I <u>wonder</u> [*what* she <u>gave</u> to you]

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[9] It used to be believed that the subject-accenting property (with unaccented verb) that is exploited for the comparison in (59)–(61) was specific to certain verbs. However, we know since Jäger (2001) that all verbs have this property, though some require that an independent topic is provided in the sentence. Otherwise, certain subjects are construed as sentence topics, which prevents them from carrying the only stress in the sentence. See also Kratzer and Selkirk (2007).

(65) shows the focus effect of wh-words in situ in multiple-wh-questions, in minimal comparison to the examples in (64), which similarly have pronouns in object position. In (65), however, the final words must be accented. If we were right about them being inherently like pronouns in the preceding section, the only way for them to be accented in (65) is that they are F-marked here. (I will return to the accent that is marked on the first of the two wh-words later in this section.)

(65) a. I <u>know</u> [<u>*who*</u> likes <u>*who*</u>]
      b. I <u>know</u> [<u>*what*</u> she gave to <u>*whom*</u>]

I follow Haida (2007) in analyzing this as a prosodic effect of F that is inherent in wh-words or wh-phrases, i.e. a prosodic effect of Q-related F. Haida maintains that the inherent prosodic effect is that of attracting accent. In (63) and (65), the sentence stress would then be added by NSR-I since the accent on the wh-word is the final accent. While Haida does not demonstrate with examples that the effect pertains to the level of accent, it is easy to show that Haida is right (see also Truckenbrodt, in press-a). Consider the English examples in (66) and the German examples in (67) and (68). They show that the focus effect observed in (63) and (65) is not one of attraction of sentence stress by the wh-word in situ. If it were, sentence stress would be on the wh-word in situ, and the final constituent (*concert, party*) would be unaccented.

(66) a. I <u>know</u> [<u>*who*</u> saw <u>*who*</u> at the <u>concert</u>]
      b. I <u>know</u> [<u>*what*</u> she gave to <u>*whom*</u> to the <u>party</u>]

(67) A: *Maria, Hans und Peter haben viele Gäste eingeladen.*
          'Maria, Hans and Peter invited many guests.'
      B: <u>*Wer*</u> *hat* <u>*wem*</u> *etwas* <u>*mitgebracht*</u>?
          who   has   whom   something   brought
          'Who brought something for whom?'

(68) A: *Ich möchte einen Überblick über die Konferenzteilnehmer haben.*
          'I want to have an overview of the participants of the conference.'
          <u>*Wer*</u> *hat* <u>*wo*</u> *ein* <u>*Zimmer*</u> *reserviert?*
          who   has   where   a   room   reserved
          'Who made a reservation for a room where?'

Rather, the inherent property of the wh-word in situ in a multiple-wh-question is that it attracts accent (here: single underlining). Where the clause contains a later accent assigned by Stress-XP, as in (66), this later accent is strengthened to sentence stress by the NSR-I. Where the accent on the wh-word in situ is the last accent, as in (63) and (65), it is strengthened to sentence stress by the NSR-I. The inherent prosodic F-effect is highlighted in (69).

(69) A wh-phrase in situ in a multiple-wh-question inherently attracts accent.

Haida (2007) points out a related interesting contrast in German. Wh-words are also used as indefinite expressions in German, in which case they behave like pronouns in rejecting accent (and thus sentence stress). I analyze them here as indefinite pronouns. They contrast minimally with wh-words in situ, which attract accent. The indefinite *was* in (70a) is unaccented, while the wh-word *was* in (70b) is accented.

(70) a. Wer   hat   *was*   <u>gesehen</u>?
          who   has   something   seen
          'Who <u>saw</u> something?'
      b. <u>Wer</u>   hat   <u>was</u>   gesehen?
          who   has   what   seen
          'Who saw <u>what</u>?'

In the current account: The indefinite object pronoun in (70a) is accent-rejecting. The stress required by Stress-XP in VP is therefore assigned to the verb. In (70b) the inherent accent on the wh-word in situ is due to the inherent F-effect of the wh-word in situ. The final VP *[was gesehen]* therefore carries accent (on the wh-word) and need not be accented on the verb. The NSR-I strengthens the final accent, the one on the wh-word.

An additional question is whether the first wh-word in a multiple-wh-question is also accented. This is less easy to assess. For one thing, we cannot investigate this in the position of sentence stress, since it will always be followed by at

least one accented element, the second wh-phrase. For another, the intuitions are not entirely clear here. However, there is a noticeable tendency to accent the first wh-word in multiple-wh-questions, as well. Not too much will be made of this here, because of the less-than-entirely clear nature of the facts. What is quite clear, however, is the contrast between accented wh-words in situ in multiple-wh-questions and unaccented fronted wh-words in single-wh-questions.

In summary, a wh-word in situ in a multiple-wh-question shows an inherent requirement of carrying accent, as formulated in (69). Following Chomsky and Haida, this is seen as an effect of F, and in particular, an effect of Q-related F. It is different from the full prosodic effect of F in (42) that we saw in Japanese and in alternative questions. It is also different from the behavior of a fronted wh-word in single-wh-questions, which is unaccented. We also saw that the first wh-word in a multiple-wh-question shows a tendency for being accented.

4.3. Preliminary analysis of the reduced prosodic F-effects of English and German wh-questions

In comparison to the cases discussed in Section 3, English and German wh-questions thus show noticeably reduced prosodic F-effects. For developing a preliminary understanding of them, let us introduce some background with a discussion of the prosody of multiple focus. Schwarzschild (1999) notes that multiple focus requires an accent on each focus. In his example (71), the verb *dissed* would not normally need to be accented (in our terms: Stress-XP is satisfied for the VP if *Sue* is accented; the verb therefore need not normally be accented). The observation that it requires accent in the context of (71) shows that both foci require accent.

(71)   John cited Mary but he DISSED$_{F1}$ SUE$_{F2}$.

We can also see this effect in the way that it overrides the ban on accenting pronouns:

(72)   Who likes who? He$_{F1}$ likes her$_{F2}$, and I$_{F3}$ like you$_{F4}$ . . .

Schwarzschild's formulation that each focus requires accent is adopted here.[10] This requirement must be in addition to the requirement of Focus in (58), which requires attraction of sentence stress with its concomitant suppression of the following accents in (73).

(73)   a.   Who introduced who to Sue?
               [John$_{F1}$ introduced Mary$_{F2}$ to Sue] and [Bill$_{F3}$ introduced Jane$_{F4}$ to Sue]
         b.   John only [introduced Bill$_{F1}$ to Sue$_{F2}$ on Wednesday]

Thus, we revise (58) as in (74) to clarify that it is enough if one of the F-marked constituents carries sentence stress. Furthermore, we add the constraint in (75), following Schwarzschild (1999).

(74)   Focus
         Some F attracts the strongest stress in the scope-domain of F (the domain of $\sim$ or of Q or of EQ).

(75)   Accent-F
         Each F-marked constituent must contain an accent (phrasal stress).

In (71), (72) and (73), then, each F-marked constituent receives accent by Accent-F. In addition, Focus requires that one of the F-marked constituents attracts the strongest stress in the scope-domain (here the sentence). This triggers stress-retraction in (73). Where multiple constituents are F-marked, the rightmost F is chosen for sentence stress, since this has the advantage that NSR-I can be satisfied at the same time. The effect of Stress-XP on later XPs is sacrificed to meet these demands of Focus (stress-attraction to F) and NSR-I (the last stress is the strongest). If there is only a single focus, the effect of Accent-F is hidden by the stronger effect of Focus.

With this, let us return to English and German wh-questions. We can now reason about their reduced prosodic F-effects at two levels: lack of effects of Focus and lack of effects of Accent-F. The following discussion structures the terrain. A more detailed analysis is developed later in the paper.

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[10] See Selkirk (2005) for a different suggestion based on different examples and see Kabagema-Bilan et al. (2011) for comparison and discussion.

First, wh-words in English and German wh-questions sometimes show the effect of Accent-F, but they never show the effect of Focus on the wh-words: Inherent attraction of sentence stress (with its concomitant suppression of following accents in the scope-domain) is never found for wh-phrases in English and German single- and multiple-wh-questions. In this regard, they differ from all cases discussed above: information structure F, Q-related F in alternative questions, Q-related F in Japanese wh-words, and F in the wh-word in echo questions. Notice that these latter cases all involve F-features in situ. Recall also that the stress requirement of Focus is a relation between the F-marked constituent and its scope. A likely source for the different prosodic behavior of English and German wh-questions is that they show a different relation between the scope-marker Q and the Q-related F-feature: A wh-phrase has moved to Q. This correlates with a preemption of the requirement of Focus. This is a striking result. Notice that it is interesting and at first unexpected that a surface relation of movement is established only for one wh-phrase, but that this also exempts further wh-phrases associated with the same Q from showing the effects of Focus (_who_ saw _who_ at the _concert_?). I formulate this at a descriptive level in (76).

(76)   Morphosyntactic movement of one F-feature to the Q-marker preempts the prosodic requirement of Focus for all F-features associated with that Q-marker.

The idea that F-movement and F-prosody are alternatives was previously formulated by Hiraiwa and Ishihara (2002, 2012) in their discussion of Japanese focus clefts. They observe that focus prosody is found on focused constituents in situ, but not on focused constituents in Japanese focus clefts, which they argue involve syntactic movement. They discuss this result in terms of two alternative ways of focusing: Focusing by movement and focusing by focus prosody.

Let us then turn to the effects of Accent-F. We see the effects of Accent-F in English and German wh-phrases on the wh-phrases in situ in multiple-wh-questions. We do not see them on the moved wh-phrase in single-wh-questions (_who arrived_?) where we saw the original pronominal nature of a wh-word, not overlaid by prosodic F-effects. I will suggest below that the semantic function of Q-related F is to relate a referential index such as the index on who_1 to the interpretation of the Q-marker. I will also suggest that the tendency for accent on the first wh-word in multiple-wh-questions (_who_ saw _who_ at the _concert_?) may be for uniformity reasons with the second wh-phrase. This leads to the following perspective: Wh-phrases in situ require the F-feature for their semantic interpretation. The F-feature is not dispensable here, and therefore leads to an effect of Accent-F. On the other hand, the moving wh-phrases have a different way of connecting their interpretation to Q, which is correlated with overt movement to Q. Therefore, their F-feature is semantically dispensable, and can be deleted. This picture is summed up in (77).

(77)   If the role of F is to connect the interpretation of a wh-word to the Q-marker, this is required for wh-words in situ in multiple-wh-questions, where we see evidence of F by its Accent-F effects. The absence of these effects on moving wh-words suggests that these have a different way of connecting to the Q-marker semantically, so that the F-feature is superfluous and deleted in this case.

In sum, single-wh-questions (_who arrived_?) show absence of prosodic F-effects on the fronted wh-phrase. Multiple-wh-questions (_who_ saw _who_ at the _concert_?) show accenting on the wh-words but no inherent attraction of sentence stress. When we distinguish prosodic F-effects in terms of Focus (attraction of strongest stress in the Q-domain = attraction of sentence stress) and Accent-F (accenting on the focus) we obtain two movement-related generalizations. First, movement of one wh-phrase to Q exempts all wh-phrases from Focus. Second, the moving wh-phrase seems to connect to Q in a way that makes the semantic function of F superfluous, so that its F can be deleted.

5. Prosodic evidence for probe-goal agreement in wh-movement

5.1. Wh-phrases vs. wh-words: percolation of F and syntactic agreement with Q

In this section prosodic observations are discussed that provide evidence for the relevance of an agreement relation between Q ('probe') and the wh-phrases ('goals'). The observations concern where prosodic F-effects pertain to a wh-phrase and where they pertain to a wh-word.
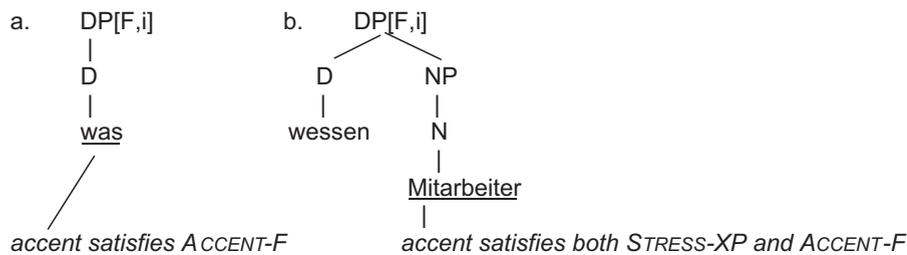
Consider wh-in situ in multiple-wh-questions in (78). In the presence of a complex wh-phrase, the wh-word need not be accented. It is sufficient that the wh-phrase carries an accent.

(78)   a.   A: Maria hat viele Leute auf ihre Geburtstagsfeier eingeladen.
              'Maria invited many people to her birthday party.'
              B: (Und) _wer_ hat [was für _Geschenke_] mitgebracht?
                   and who has what for presents   brought
              'And _who_ brought what kind of _presents_?'

b.   A: Es waren viele Leute auf dem Betriebsfest.
     'There were many people at the office party.'
     B: (Und) <u>wer</u> hat [wessen <u>Mitarbeiter</u>]   kennengelernt?
          and   who has whose   employee(s)   met
     'And <u>who</u> has met whose <u>employee(s)</u>?'

c.   A: Es waren viele Leute auf der Betriebsfest.
     'There were many people at   the office party.'
     B: (Und) <u>wer</u> hat [wie vielen <u>Mitarbeitern</u>] <u>Geschenke</u> mitgebracht?
          and   who has how many   employees   presents   brought
     'And <u>who</u> has brought how many <u>employees</u> <u>presents</u>?'

Compare this with the wh-phrases that consist only of the wh-word in (63), (65), (66), (67), (68) and (70b), where accent is required on the wh-word. For reasons of consistency, we want to assume that the F-feature that triggers this accent is also present in (78) and requires an accent there. This means, however, that the F-feature in (78) must have percolated up to the wh-phrase. If it were still on the wh-word, it would trigger accent on the wh-word. We would then wrongly expect an obligatory accent both on the wh-word (due to ACCENT-F) and on the NP (due to STRESS-XP). Assuming the F-feature has percolated to the wh-phrase as in (79b), its accent requirement is fulfilled by the accent on the NP (*Mitarbeiter* in (79)), which is independently required by STRESS-XP. This correctly predicts that the wh-word does not require accent in this case. For the single-wh-words in situ in (63), (65), (66), (67), (68) and (70b), we cannot tell from their prosody whether the F-feature is on the wh-word or on the wh-phrase. However, since we have evidence from (78) that there is percolation of F to the wh-phrase with the second wh-phrase in a multiple-wh-question, we assume that percolation also applies in the one-word wh-phrases, so that their structure is as in (79a).

(79)   F in multiple-wh-questions in situ:

a.   DP[F,i]   b.   DP[F,i]
         | /   \
         D   D   NP
         | | |
        <u>was</u>   wessen   N
        / |
       /   <u>Mitarbeiter</u>
                                              |
     accent satisfies ACCENT-F   *accent satisfies both STRESS-XP and ACCENT-F*

I conclude that the F-feature has percolated from the wh-word to the wh-phrase in the wh-phrase in situ in multiple-wh-questions. This is another striking result. It is striking, particularly since the wh-phrase at hand is not undergoing wh-movement. Percolation of the wh-feature (here: F) to the wh-phrase is otherwise only assumed for moving wh-phrases, where the feature at the top of the phrase must enter into feature-matching configurations at its landing site. For further analysis, let us explore the scope of the phenomenon with other instances of F.

First, we have seen in echo questions that the prosodic F-effect there is located on the wh-morpheme, i.e. there is clearly no percolation of F to the wh-phrase. In this regard, the examples in (53) minimally contrast with those in (78).

Second, the effect of F-percolation does not seem to be obtained in Japanese wh-questions. Shin Ishihara (p.c.) tells me that it does not seem to be possible to place the Japanese focus prosody (sentence stress) on the noun that accompanies a wh-word in a non-contrastive context as in (80).[11]

(80)   [Mary invited Bill to her birthday party.]

a.   Bill-wa   <u>ikutu(-no)</u>   purezento-o   katta no?
     Bill-TOP   how.many-GEN   present-ACC   brought Q
     'How many presents did Bill bring?'
b.   # Bill-wa   ikutu-no   <u>purezento-o</u>   katta no?

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[11] The quantifier *ikutu* 'how many' carries optional genitive, as indicated. The structure that is most closely related to the English 'how many presents' has the genitive case appearing on the quantifier: In this case the order of quantifier and noun is fixed. The structure without overt genitive also allows the inverse order *purezento-o ikutu*, lit. 'present how-many'. In all these cases, however, the focus prosody is found on the wh-quantifier *ikutu-(no)* and not on the noun, according to Shin Ishihara.

It is clear that more empirical work on this issue is required. However, I proceed on the assumption that this case points in the right direction, i.e. that there is no percolation of the F-feature in Japanese wh-questions.

I also point out that neither information structure F nor Q-related F in alternative questions show a tendency for the F-feature to percolate from a head to a phrase.[12] Thus, the prosodic F-effects in (81) are located on the verb. If the F-feature were to percolate to the VP, we would not see its prosodic effects on the verb, but on the object, where the stress would independently be preferred by STRESS-XP.

(81)   a.   info structure F: $\sim$ John [$_{VP}$ [$_V$ <u>likes</u>]$_F$ Mary].
       b.   alternative question: Q did John [$_{VP}$ [$_V$ buy or <u>borrow</u>]$_F$ the book]?

We see, then, that percolation of F to the wh-phrase is specific to F-features connected to a Q that triggers wh-movement: The cases that do not involve wh-movement, i.e. echo questions, Japanese wh-questions, and F in situ in other instances, do not show percolation of F. Strikingly, however, the formation of a wh-phrase is not limited to the moving wh-phrase. The prosody shows formation of a wh-phrase (percolation of F) also in the second wh-phrase of a multiple-wh-question.

I suggest connecting this to a conception explored in Chomsky (2000, 2001) and much following work: That syntactic movement is preceded by an abstract step of agreement between the scope-marker and the moving element. Though this agreement relation is normally thought to obtain only with the moving wh-phrase, we have an empirical reason, in the observation at hand, to follow Miyagawa (2010) in maintaining that the agreement relation that precedes wh-movement targets not only the moving wh-phrase but also the non-moving wh-phrases in situ that are associated with the same Q-marker.[13] This provides us with a structural relation as the basis for F-feature percolation to the wh-phrase: *The agreement relation with the Q-marker in English and German wh-questions is correlated with F-percolation to the phrase*.

This agreement relation is often construed as being more general, so that it also applies to the relation between Q and wh-phrases in Japanese (see e.g. Miyagawa, 2010). Relevant to the point at hand is a more narrow agreement relation, one that connects Q with wh-words in English and German, though not in Japanese and not in English and German echo questions. I propose to call this *l-agreement*, where the "l" stands for "lexical". This terminological choice is justified below.

Furthermore, it is sensible to correlate the absence of a FOCUS effect in English and German wh-questions with l-agreement rather than with the movement process: L-agreement connects the Q-marker to all wh-phrases in the cases we discussed. If exemption from FOCUS is correlated with l-agreement, it correctly exempts all wh-phrases from FOCUS, not just the one that moves. Furthermore, in the domain of phenomena discussed here, l-agreement is always correlated with movement of one wh-phrase. The correlations are listed in (82a,b). For orientation, (82c) also lists the prosodic F-effect that we assume to be independent of l-agreement: ACCENT-F.

(82)   a.   L-agreement: Connects Q with wh-phrases in English and German:
              - overt movement of one F-marked phrase (here: wh-phrase)
              - no application of FOCUS (attraction of sentence stress) to any F-marked phrase
              - F-percolation to the phrase for all agreeing instances of F (all wh-phrases)
       b.   No l-agreement: Information structure F, alternative questions, Japanese wh-questions, echo questions:
              - no overt movement of one F-marked phrase
              - application of FOCUS (attraction of sentence stress to one F-marked phrase)
              - no F-percolation
       c.   L-agreement or not: ACCENT-F requires accent on F

5.2. Additional support for the role of l-agreement

There is an interesting prosodic distinction between the multiple wh-questions in (83)–(85) and the one in (86) with long-distance construal across another wh-phrase. (83)–(85) conform to the observation from above: The wh-phrase in situ requires accent but does not require sentence stress. However, the long-distance construal in (86) is not possible with the same prosodic pattern: see (86a). It requires sentence stress on the second wh-word in situ as in (86b). The formal distinction is that another wh-phrase that is not construed with the highest Q-marker is intervening in (86) but not in (83)–(85).

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[12] Selkirk (1995) employs a mechanism of focus feature percolation in which F does percolate from a head to its projection. This is a theory-internal mechanism that does not bear on the stress-patterns in (81). The results achieved by that mechanism are analyzed here in terms of STRESS-XP. They are analyzed in yet other terms in Kratzer and Selkirk (2007) and Selkirk (2011).

[13] Miyagawa suggests this in connection with an F-feature that he suggests is merged on the Q-marker. As will be seen below, the current account construes the relation the other way around: in terms of a Q-feature that is copied onto the F-feature in the wh-phrase.

(83) <u>Wer</u> hat <u>wem</u> ein <u>Geschenk</u> gegeben?
who has whom a present given
'<u>Who</u> gave <u>whom</u> a <u>present</u>?'

(84) <u>Wer</u> hat gesagt, dass du <u>wem</u> ein <u>Geschenk</u> gegeben hast?
who has said that you whom a present given have
'<u>Who</u> said that you gave <u>whom</u> a <u>present</u>?'

(85) <u>Wer</u> hat gefragt, ob du <u>wem</u> ein <u>Geschenk</u> gegeben hast?
who has asked whether you whom a present given have
'<u>Who</u> asked whether you gave <u>whom</u> a <u>present</u>?'

(86) i. * <u>Wer</u>^{1} hat gefragt wer^2 <u>wem</u>^{1} ein <u>Geschenk</u> gegeben hat?
who has asked who whom a present given have
'<u>Who</u>^{1} has asked who^2 gave <u>whom</u>^{1} a <u>present</u>?'
ii. <u>Wer</u>^{1} hat gefragt wer^2 <u>wem</u>^{1} ein Geschenk gegeben hat?
'<u>Who</u>^{1} has asked who^2 gave <u>whom</u>^{1} a present?'

The distinction is mirrored in a distinction concerning F-percolation to the wh-phrase. In (87)–(89), the (i)-versions provide evidence for the possibility of F-percolation to the wh-phrase. (The (ii)-versions are possible as well. I assume that the noun *Mitarbeitern* is processed as contextually given in these.) In (90), we expect (correctly) from (86) that sentence stress must be retracted to the wh-word or wh-phrase. Both (90i,ii) have sentence stress on the assumed wh-phrase. The ill-formedness of (90i) shows that F-percolation to the assumed wh-phrase is not possible in this case. The long-distance construal is possible only where the sentence stress is placed on the second wh-word in situ, as in (90ii). This shows that F does not percolate to the assumed wh-phrase in this case: Its prosodic effect is tied to the wh-word.

(87) i. <u>Wer</u> hat was für <u>Mitarbeitern</u> ein <u>Geschenk</u> gegeben?
who has what for employees a present given
'<u>Who</u> has given what <u>employees</u> a <u>present</u>?'
ii. <u>Wer</u> hat <u>was</u> für Mitarbeitern ein <u>Geschenk</u> gegeben?
'<u>Who</u> has given <u>what</u> employees a <u>present</u>?'

(88) i. <u>Wer</u> hat gesagt dass du was für <u>Mitarbeitern</u> ein <u>Geschenk</u> gegeben hast?
who has said that you what for employees a present given have
'<u>Who</u> has said that you gave what <u>employees</u> a <u>present</u>?'
ii. <u>Wer</u> hat gesagt dass du <u>was</u> für Mitarbeitern ein <u>Geschenk</u> gegeben hast?
'<u>Who</u> has said that you gave <u>what</u> employees a <u>present</u>?'

(89) i. <u>Wer</u> hat gefragt, ob du was für <u>Mitarbeitern</u> ein <u>Geschenk</u> gegeben hast?
who has asked whether you what for employees a present given have
'<u>Who</u> has asked whether you gave what <u>employees</u> a <u>present</u>?'
ii. <u>Wer</u> hat gefragt, ob du <u>was</u> für Mitarbeitern ein <u>Geschenk</u> gegeben hast?
'<u>Who</u> has asked whether you gave <u>what</u> employees a <u>present</u>?'

(90) i. * <u>Wer</u>^{1} hat gefragt, wer was^1 für <u>Mitarbeitern</u> ein Geschenk gegeben hat?
who has asked who what for employees a present given has
'<u>Who</u> has asked who gave what <u>employees</u> a <u>present</u>?'
ii. <u>Wer</u>^{1} hat gefragt, wer <u>was</u>^{1} für Mitarbeitern ein <u>Geschenk</u> gegeben hat?
'<u>Who</u> has asked who gave <u>what</u> employees a <u>present</u>?'

In short, so long as no wh-phrase intervenes, things are as described in (82a): The wh-phrase in situ in multiple-wh-questions attracts accent rather than sentence-stress, and it allows percolation of F to the wh-phrase. However, after an intervening wh-phrase, things become as in Japanese wh-questions or in echo questions, and as described in (82b): There is no F-percolation, and the wh-word invokes Focus, i.e. it requires sentence stress.

We can approach this phenomenon in terms of l-agreement: The intervening wh-phrase blocks l-agreement here. Consequently, l-agreement does not exempt the final wh-word in (86) from attracting sentence stress; furthermore, l-agreement does not require F-percolation from the final wh-word to a wh-phrase in (90). The observation therefore supports the approach in terms of an agreement relation. I will show in Section 6.6 how the current account captures this blocking effect.

6. Syntactic account

In this section syntactic hypotheses and interface hypotheses are formulated for the distinctions in (82). They are formulated in pursuing the perspective that the F-features that lead to the observed prosodic distinctions are semantically interpreted. The syntactic hypotheses formulated in this section are also the front end of the semantic interpretation spelled out in Section 7.

6.1. The lexical basis for l-agreement

Putting aside Japanese for the moment, we can characterize the occurrence of l-agreement in English and German as in (91).

(91)   *L-agreement* for F-related elements requires that an F-related scope-marker is a lexical item and the agreeing F-feature also comes out of the lexicon as part of a lexical item.

The assumptions about English and German scope-markers that enter into this conception are summed up in (92). The phonetically empty Q is a lexical scope-marker, as suggested by its category C and by the existence of a lexical overt C-head *whether*. Rooth's ∼ scope-marker does not share these properties in English. It has no syntactic consequences, no overt correlate, and it is not tied to a specific syntactic category. It occurs anywhere in the phrase marker (cf. (13) and many other cases in the literature where this flexibility is crucial). I conclude that it is not a lexical item. Similarly, the postulated scope-marker EQ for echo questions arguably has no syntactic category. It is always attached to the root, which in German, may be a variety of expressions (Reis, 1991) such as a finite CP or an unembedded infinitival expression with directive meaning as in *Peter wecken! Wen wecken?* 'Wake up Peter! Wake up who?' or an elliptical DP as in *Hey, Dein Triceps! Mein was?* 'Hey, your triceps! My what?' or an elliptical PP as in *Nieder mit wem?* 'Down with who?'. It furthermore has no visible syntactic consequences beyond the absence of wh-movement and it has no overt lexical correlate in English and German. I conclude that it is not a lexical item.

(92)   English and German scope-markers:
          Q: lexical item; category C, overt correlate ‚whether'
          ∼: no lexical item; no syntactic category, no overt lexical correlate in English/German.
          EQ: no lexical item; no syntactic category, no overt lexical correlate in English/German.

The assumptions about English and German F-features that enter into (91) are summed up in (93): wh-words carry a lexical F-feature in the form of the wh-morpheme. Other F-features of the account (on information structure F and Q-related F in alternative questions) are taken to be features that do not come out of the lexicon.

(93)   English and German lexical items with F-features
          wh-words: overt wh-morpheme lexically spells out F
          information structure F feature: not lexical, no overt morpheme
          F-feature on alternatives in alternative questions: not lexical, no overt morpheme

Applying (91) to the elements in (92) and (93), we obtain that l-agreement in English and German holds between the lexical element Q and the lexical F-feature of wh-words, i.e. in the cases we describe as (single or multiple) wh-movement, as desired. All other cases involve either a non-lexical scope-marker (EQ in echo questions) or a non-lexical F-feature (F-marked alternatives in alternative questions) or both (information structure F with non-lexical ∼ and non-lexical F). In this way (91) separates the English and German cases showing lexical agreement in (82a) and those not showing it in (82b). I will return to Japanese. In an obvious way, the definition in (91) motivates the name *l-agreement* or *lexical agreement*.

This account predicts that l-agreement and overt movement of F-marked phrases is always accompanied by a lexical F-related morpheme in the moving phrase. Next to the wh-morpheme, these may take the form of wh-phrase suffixes like Tlingit -sá (Cable, 2010) or the form of focus particles like Gurune -ta that accompany overt movement of fronted object wh-phrases and fronted object focus (Haida, 2007). In Italian (Rizzi, 1997) and Hungarian (Kiss, 1998) focus movement, the exhaustive meaning accompanying focus movement can be taken as an indication of the presence of an F-exhaustivity morpheme on the moving F-marked phrase.

6.2. L-agreement and percolation

I turn to the role of l-agreement for feature percolation. It seems that l-agreement is a relation between the Q-marker and syntactic XPs, the wh-phrases:

(94)   L-agreement is a relation between Q and XPs.

For the F-features in the wh-words to enter into this agreement relation, they therefore need to percolate up to an XP: This ties feature percolation to the process of l-agreement. I assume that feature percolation occurs only where it is forced in this fashion.

6.3. What does F do? What does l-agreement do?

In a nutshell, I will suggest the following content of the l-agreement relation in this section: (a) the Q-marker has a single referential index (e.g. [Q,3]); (b) [Q,3] agrees with [F,3] in referential index and attracts syntactic movement of [F,3]; (c) the Q-feature is copied onto the F-feature, optionally replacing it ($[F,i] \rightarrow [F_Q,i]$ or $\rightarrow [Q,i]$). These suggestions are motivated by the semantic account below. I outline central considerations here to illustrate the motivation.

I begin by addressing the semantic role of the F-features. I adopt from von Stechow (1991) and Beck (2006) that question meanings are calculated in the same semantic 'dimension' as focus alternatives: this dimension is the *focus semantic value* of Rooth (1992), in contrast to the normal meaning, the *ordinary semantic value*. The implementation of Rooth's theory by Kratzer (1991) leads Beck (2006) to a conception of F in which F in [F,i] makes sure that the referential index [i] is connected to the dimension of the focus semantic value. Here I adopt this conception. I furthermore extend it to F in wh-words and wh-phrases. In the interpretation of questions, connecting a referential index [i] to the focus semantic value amounts to connecting it to Q in a particular way.[14] For example, Japanese 'who' is represented here as [F,i], where [i] is the referential index of this pronoun and F connects its interpretation to Q, i.e. makes it into a wh-pronoun, essentially.

In this conception, I represent percolation of F as percolation of an interpreted F-feature. For example, English *who* is represented as $wh_{[F,i]}$-$o_{[i]}$ with a referential index [i] and a separable co-indexed feature complex [F,i] that can percolate, as in (95).

(95)   Percolation of the content of the wh-morpheme [F,i] in English and German:
         $[wh_{[F,1]}$-$ose_1 \; sister] \rightarrow [whose_1 \; sister]_{[F,1]}$

Wherever it percolates to, [F,i] will make sure that [i] is connected to the focus semantic value, i.e. to Q. In (96), for example, the percolated feature [F,1] will make sure that the index [1] on *whose_1* is interpreted relative to the Q-marker. Likewise, the percolated [F,2] makes sure that the index on *whose_2* is interpreted relative to the Q-marker. To the extent that we have prosodic evidence for these F-features (on wh-phrases in situ) I am interested in an account in which they are semantically required for the interpretation: for connecting referential indices to the interpretation of the Q-marker.

(96)   Q [whose_1 sister]$_{[F,1]}$ likes [whose_2 brother]$_{[F,2]}$

Where we have evidence for the absence of the F-features (on moved wh-phrases) the F-feature is to come out as superfluous and can be deleted. For these cases we want to assume an independent way of construal with Q. I model this

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[14] It will be helpful in the following to cast the function of F as making a connection to Q (or the scope-marker more generally). As explained in Section 7, this is a specific kind of connection to a specific kind of meaning: It always relates to set-formation at the level of the scope-marker, and the F-feature always marks the position at which the members of that set vary.

independent connection to Q on a suggestion in Beck (2006).[15] I also follow Beck in interpreting all wh-phrases in situ. Beck (2006) does not employ F-features for the interpretation of wh-words. Instead, she employs a different mechanism for connecting the index of wh-words to the Q-marker: co-indexing with the Q-marker by a referential index. Beck (2006) assumes that this can take place for an arbitrary number of indices: $Q_{1,2}$ whose$_1$ sister likes whose$_2$ brother. From the perspective of the current account, we can say that co-indexing avoids the need to invoke an F-feature for making the connection to the Q-marker. Building on this, I employ referential co-indexing in a restricted fashion: I assume that it applies only to the moving wh-phrase, for which we have evidence that it does not require F. This referential co-indexing will be one aspect of l-agreement in the current account.

I suggest, then, that Q has a single referential index, [Q,i]; that one aspect of l-agreement is to make sure that this referential index is identical to the referential index of a wh-phrase and that this is the wh-phrase undergoing movement to the Q-marker.

(97) *L-agreement, referential co-indexing, and overt movement*
      The Q-marker of English and German wh-questions carries a single referential index: [Q,i].
      L-agreement enforces sharing of this index with the [F,i] feature on an XP (i.e. a wh-phrase).
      Sharing of this referential index entails overt movement to [Q,i].

In (98), for example, l-agreement for the referential index has targeted *whose brother* in both examples. This is, then, the wh-phrase that must move to the Q-marker.

(98)
   a.   [Q,1] John introduced [whose$_1$ brother]$_{[F,1]}$ to Sue
   b.   [Q,1] John introduced [whose$_1$ brother]$_{[F,1]}$ to [whose$_2$ sister] $_{[F,2]}$

Notice that referential co-indexing is co-indexing (mediated by an XP) of the two lexical features in l-agreement: Q and F.

Referential co-indexing prepares the ground for the prosodically relevant F-deletion on moving wh-phrases, to which I return.

Consider for now the non-moving wh-phrases in multiple-wh-questions like the second wh-phrase in (98b). These, too, are in an l-agreement relation, since they show F-percolation and absence of the strong prosodic effects of Focus (i.e. no attraction of sentence stress). I postulate that l-agreement also copies the Q-marker onto the F-features, creating F$_Q$ from F. (99) shows this in the form of the derived subscripts FQ, which stands for F$_Q$. The arrows with solid lines show l-agreement for the referential index and copying of the Q-marker. The arrow with dashed lines shows l-agreement that only involves copying of the Q-marker.

(99)
   a.   [Q,1] John introduced [whose$_1$ brother]$_{[FQ,1]}$ to Sue
   b.   [Q,1] John introduced [whose$_1$ brother]$_{[FQ,1]}$ to [whose$_2$ sister]$_{[FQ,2]}$

In this account, F$_Q$ is an interpreted object different from F. Let us say that an index [i], interpreted relative to an assignment g, is normally interpreted in the "first dimension" as g(i), and that [F,i] is interpreted in the "second dimension" as g(F)(i). Then, [F$_Q$,i] is interpreted in a "third dimension" as g(F$_Q$)(i). The third dimension, like the second, is calculated relative to the focus semantic value; however, the third dimension is specific to relations of l-agreement (here: Q-markers triggering wh-movement and the wh-phrases associated with them). Since the third dimension is independent from the second dimension, the two dimensions will allow for interleaving, as discussed in Section 6.6. Another difference between F and F$_Q$ is as follows. The focus semantic value of [[Bill]$_{[F,1]}$ arrived] is to be "x arrived": i.e. we want to eliminate [Bill] when we calculate alternatives. Without turning F into F$_Q$, the focus semantic value of [[whose$_1$ sister]$_{[F,1]}$ arrived] would wrongly also be "x arrived", discarding 'whose sister'. For calculating the question meaning, however, we must not discard the content of the F-marked phrase. Marking the percolated F-feature on the wh-phrase with Q has the effect of coding this distinction and making sure that *whose sister* is not discarded. Importantly, the basic semantic function of F is similar in all cases: Whether [F,i] (discarding *Bill*) or [F$_Q$,i] (not discarding *whose sister*), the F-feature semantically makes sure that the index [i] is related to a focus semantic value.

I subsume F-deletion under l-agreement as well. So far, Q may copy itself onto F, turning [F,i] into [F$_Q$,i]. I suggest that in this process Q also has the option of replacing F entirely, turning [F,i] into [Q,i] (instead of into [F$_Q$,i]). Deletion of F entails

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[15] Other models exist, such as Karttunen (1977), since moving wh-phrases have traditionally been taken to be interpreted in their moved position.

absence of prosodic F-effects. We see this only on the moving wh-phrase. In the current account, this is because the moving wh-phrase has an independent way of connecting to Q: referential co-indexing. The formulation in (100), which sums up what is added to (97), makes sure that the process of F-replacement by Q only occurs where F is not needed semantically: in the case of referential co-indexing, i.e. on the moving wh-phrase. Notice that the formation of F_Q brings together the two lexical features that are in l-agreement, Q and F.

(100)　*L-agreement, F_Q, and F-deletion*
　　　　L-agreement copies the Q-marker onto the agreeing F-features, turning [F,i] to [F_Q,i].
　　　　Optionally, l-agreement with [Q,i] may instead turn [F,i] to [Q,i] ('F-deletion').

The optionality of F-deletion in (100) now leaves room for the two options in (101): accent (i.e. presence of F) on the initial wh-phrase, as observed in multiple-wh-questions like (101a), or no accent (i.e. F-deletion) on the initial wh-phrase, as observed in single-wh-questions like (101b).

(101)　a.　Q_3 [who$_3$]$_{\mathbf{FQ},3}$ saw [whom]$_{\mathbf{FQ},4}$ at the concert
　　　　b.　Q_3 [who$_3$]$_{\mathbf{Q},3}$ arrived

We can make sense of the different preferences with (102).

(102)　a.　Prefer uniformity (e.g. all links to Q are through F_Q or none)
　　　　b.　Prefer F-deletion where F is redundant.

Uniformity in (102a) is relevant to the multiple-wh-question (101a). Here, all links to Q can be uniformly established through F_Q-features, and so all links to Q are uniformly established through F_Q-features. The F-feature in the first wh-phrase is thus retained and turned into F_Q. This path is chosen in (101a) because of uniformity, even though the link that F_Q establishes to Q on who$_3$ is additionally present due to the referential co-indexing of who$_3$ with Q_3 by index [3].

In the single-wh-question in (101b), uniformity is not an issue. The choices here are (a) leaving F undeleted, and having two semantic connections of the wh-phrase to the Q-marker (one through the referential index [3], one through F_Q); or (b) eliminating the semantic redundancy by deletion of F. Among these, (102b) states a preference for deletion of the redundant F. This choice is illustrated in the indices in (101b), where the F-feature has been replaced by Q.

The table in (103) gives an overview of the account. In all examples the F-features of the direct object are the ones of interest.

(103)

		why no l-agr.?
Information structure F $\sim_C$ John introduced Bill$_{F3}$ to Sue	**no l-agreement→** - no F-percolation - no movement - F attracts strongest stress 　by Focus	$\sim$, F not lexical
Alternative question Q did John introduce [Bob or Bill]$_{F3}$ to Sue		F not lexical
Japanese question and E./G. echo question Q/EQ John introduced who$_{F3}$ to Sue		EQ not lexical (for Japanese, see below)
Intervening wh-phrase blocks l-agreement Q who$_{FQ1}$ asked Q_2 who$_2$ introduced who$_{F3}$ to Sue		intervening element
English/German single-wh-question Q_3 [who$_3$]$_{[Q,3]}$ did John introduce to Sue	redundant F deleted → no effect of Accent-F	**l-agreement→** - percolation 　of all F - movement of 　one F - no prosodic 　Focus effect
English/German multiple-wh-question Q_3 [who$_3$]$_{FQ,3}$ introduced [who$_4$]$_{FQ,4}$ to Sue	[F_Q,4] needed, [F_Q,3] retained for unifor- mity → effects of Accent-F on both	

The following subsections address further central aspects of the syntactic account, before Section 7 shows details of the semantics of Q-related F.

6.4. Overt movement and stress

Why does Japanese not have overt wh-movement? Earlier suggestions have tried to link this issue either to the presence of head-final question particles in Japanese, or to the presence of such particles in wh-questions in principle. Kayne (1994) suggested that head-final complementizers result from movement of IP to Spec,CP: [CP C IP] → [CP IPi C ti]. As Kayne notes, movement of IP to Spec,CP blocks wh-movement if the landing site of IP is identical to the landing site of wh-phrases: Spec,CP. See Kayne (1994) for the history of his suggestion and for languages that might be problematic for his account. See Richards (2010) for a recent stand that languages with no overt complementizers on the left do not have overt wh-movement.

Cheng (1991) observed for a range of wh-in situ languages that they have a yes/no question particle for main clauses. She hypothesized that these languages also have a question particle for wh-questions (though optional or covert in many cases) and postulates complementary distribution between the presence of such a wh-particle and overt wh-movement. According to her Clause Typing Hypothesis, wh-questions must be marked as such, which can be done either by a question particle or by overt wh-movement. Cheng sees overt wh-movement as triggered by this requirement. Japanese, which employs final question particles in wh-questions, fits well into the typology of Cheng.

The current account enters a new element into this debate: [Q,i] is the trigger of l-agreement and overt movement. Japanese wh-questions do not employ [Q,i], but unindexed [Q], which does not trigger overt movement in the current account. With this, I implement a version of Cheng's Clause Typing Hypothesis as follows, differing from Cheng in details. I follow Chomsky (2008) in the assumption that there is no Spec-head agreement in addition to probe-goal agreement. However, I assume a related mechanism: head-to-Spec movement. [Q,i], a C-head, moves from C to Spec,CP. There it constitutes an XP and enters into l-agreement with other XPs, forcing F-percolation in the wh-phrases. Formally, l-agreement is then a relation among two lexical elements mediated by two XPs. [Q,i] in Spec,CP then attracts one of the agreeing wh-phrases to Spec,CP, which substitutes into [Q,i]. ([Q,i] must therefore always be phonetically empty.) With this, the current version of the Clause Typing Hypothesis takes the following shape: Wh-interrogatives must be clause-typed with [Q] or [Q,i], both lexical C-heads. This follows without further ado because [Q] or [Q,i] distinguish wh-questions from other clause types. Where the lexical entry is [Q], it will remain in C and often be visible as an overt question particle. Where it is [Q,i], it will be a phonetically empty lexical head that moves to Spec,CP and attracts a wh-phrase there. Therefore, Q particles ([Q]) and wh-movement ([Q,i]) are in complementary distribution. This account does not require, but is compatible with, adding Kayne's suggestion that IP moves to Spec,CP in C-final languages: Languages that move IP to Spec,CP cannot employ [Q,i] in Spec,CP and must therefore have [Q] in C.

L-agreement also has an important consequence in stress assignment. It is formulated in (104) as a revision of the constraint FOCUS:

(104)   FOCUS
          F-features must be ''visible'' to their scope-marker (a) by l-agreement with the scope-marker or (b) by one of them carrying the strongest stress in the domain of the scope-marker.

6.5. Tlingit

Cable (2010) works out a detailed account of Tlingit wh-questions. He shows that in Tlingit, wh-phrases are suffixed by -sá, a Q-particle in the analysis of Cable. An example is shown in (105).

(105)   [[aadóo   yaagú]   sá]   ysiteen?
            who   boat   SA   you.saw.it
          'Whose boat did you see?'

Cable proposes to abandon the classical assumption of wh-feature percolation to the wh-phrase. He suggests that English and German do not have wh-feature percolation but instead a silent version of the Q-particle -sá in Tlingit.

The prosodic observations reviewed above do not support the hypothesis that English and German are like Tlingit in employing a Q-particle. We have an indication from echo questions that the F-feature resides in the wh-morpheme.

We took this F-feature in the wh-word from Cable's analysis of wh-words. However, in multiple-wh-questions, we have prosodic evidence that the same F-feature is no longer in the wh-word but located on the wh-phrase. This supports the classic view of feature percolation to the wh-phrase. It is surprising, from the point of view of Cable's analysis, that the attachment of the postulated Q-particle in English and German makes the prosodic F-effect disappear from the wh-word, and at the same time makes it reappear on the wh-phrase. This seems to be feature percolation instead.[16]

In the current account, the natural class consisting of percolated F-features in English or German wh-phrases and Tlingit -sá is captured at the semantic level. I suggest that we are dealing with a feature combination $[F_{(Q)},i]$ in both cases and I suggest that this feature combination has the effect of connecting the index $[i]$ to the interrogative interpretation. In Tlingit, I suggest that -sá introduces $[F,i]$, and that this binds the referential index of the wh-word $[i]$ under c-command, in parallel to binding of pronouns under c-command. This allows for an arbitrary distance between the wh-word and -sá, in contrast to the local relation constrained by percolation in English (see footnote 16). The example (105) is then indexed as in (106).

(106)   Q [[aadóo$_i$ yaagú] sá$_{[F,i]}$]   ysiteen?

In sum, the prosodic observations support an analysis in terms of feature percolation for English and German, rather than Cable's suggestion of attachment of a silent -sá suffix. In the current account, the shared semantic function of percolated F-features on the wh-phrase and the attachment of -sá in Tlingit is to establish the semantic connection between the referential index of the wh-word and the Q-marker by way of the feature combination $[F,i]$.

6.6. Interleaving

The current section briefly reviews the predictions of the current account about interleaving structures. The cornerstones are:

(A) Moving wh-phrases are co-indexed with the Q-marker. This has the semantic consequence that the connection is not semantically interfered with by intervening scope-markers:

(107)   Who$_i$ does only $\sim$ John think that Mary likes t$_i$?
         What$_i$ do you know Q how to fix t$_i$?

(B) Wh-questions have a level of interpretation separate from F-interpretation, since they involve I-agreement. The I-agreeing Q-marker is Q_i. L-agreeing wh-phrases are F_Q (or Q if they fall under (A)). An I-agreeing wh-phrase is unselectively interpreted relative to the next higher Q_i.

(C) The other cases relevant here involve a scope-marker that interprets F (Q_{ALT} in alternative questions, EQ for echo questions, $\sim$ for information structure focus,) and an F-marked constituent (alternatives, wh-word not part of I-agreement, information structure F). The F-marked constituent is unselectively interpreted relative to the next higher scope-marker that interprets F (Q_{ALT}, EQ, or $\sim$).

Thus, only moving wh-phrases are specifically connected to a scope-marker. All connections mediated by F and F_Q are unselective, but are sorted into those involving F and those involving F_Q. The meanings concerning F and those concerning F_Q do not interfere with each other. Therefore interleaving of (B) with (C) is possible, but interleaving within (B), and within (C) is not possible.

Beginning with (C), the ban on interleaving $\sim$-operators is inherited from Rooth's focus interpretation. F must be interpreted relative to the next higher squiggle. Whether this is correct is a complex issue (see Beck, 2006 for discussion, see also Krifka, 1991), but I leave Rooth's account unchanged here. Echo questions are not allowed internal focus that includes the question word in its scope. This is not explored here, but it seems reasonable, given the general difficulties with imposing additional information structure focus in echo questions (Reis, 1992). Alternative questions and information structure focus must not be interleaved, since both involve interpretation of F. This captures that alternative questions show robust intervention effects for intervening focus-sensitive elements across languages, as shown in Beck and Kim

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[16] Cable (2010) notes that Tlingit -sá can mark wh-phrases as constituents that dominate the wh-word at arbitrary distances in the structure, whereas the path between a wh-word and the wh-phrase is very restricted in English and German. He proposes that the locality requirement is imposed on English due to an agreement relation between the Q-particle and the wh-word, which holds in English but not in Tlingit.

(2006). An example from them is given in (108). The alternative question reading of (108a) goes away with the intervening squiggle-operator required by *only* in (108b). The missing alternative question reading is paraphrased in (108c).

(108)   a.   Does John like Mary or Susan?   (alt-reading)
        b.   Does only John like Mary or Susan?   (no alt-reading)
        c.   Is it Mary or Susan who only John likes?

(109) shows the structure of (108b) in the current account. The intention is to assign F1 on *John* for interpretation relative to *only* $\sim$ and F2 on the alternatives relative to Q_{ALT}. However, since F-interpretation is unselective, both F-features will be interpreted relative to their respective next higher F-operators, which is in both cases *only* $\sim$. The intended construal of the alternatives with Q_{ALT} is not achieved.

(109) Q_{ALT}-does only $\sim$[John$_{F1}$ like [Mary or Susan]$_{F2}$]

The current account here represents the suggestion of Beck and Kim (2006) that alternative questions show intervention effects for focus-sensitive operators, since the interpretation of the alternatives invokes the focus semantic value. In the current account, the focus semantic value is invoked because of the presence of Q-related F on the alternatives.

Interleaving the other way around is predicted not to be possible either. I believe that this is correct. An example from the editors is given in (110). Here all F-features get interpreted relative to Q_{ALT} so that F1 cannot get the intended construal relative to $\sim$.

(110)   A: Do you want tea or coffee?
        B: Tea, please.
        A: (Turning to C) How about you? # $\sim$[Q_{ALT} Do you$_{F1}$ want [tea or coffee]$_{F2}$]

The intervening effect of the verum focus in (19b) is of the same kind.

I turn to interleaving of (C) and (B). I begin with wh-questions (F$_Q$) in the scope of information structure F. This is easily possible, as is illustrated in the examples (111a,b) from Beck (2006:31f) and (111c) from the editors. ((111b) is German.) Here F is interpreted in the scope of the closest $\sim$, but F$_Q$ is interpreted in the scope of the closest Q_i, with the correct results.

(111)   a.   I only $\sim$ [wonder Q_1 who$_1$ Bill$_{F,2}$ invited]
        b.   Ich habe mich   nur $\sim$ [gefragt [Q_1 wen$_{FQ,1}$ Luise$_{F,2}$ wo$_{FQ,3}$ gesehen hat]]
             I   have myself only   asked   who.acc Luise   where   seen   has
             'I only wondered where Luise saw who.'
        c.   I know which problem Anna assigned to which student. Now tell me:
             $\sim$ Q_1 [which problem]$_1$ did Bertha$_{F,2}$ assign to [which student]$_{FQ,3}$?

The inverse case in (112)–(114), with $\sim$ having the narrower scope of the two, is also not excluded in the current account. Here, F is again interpreted relative to the closest $\sim$ and F$_Q$ relative to the closest Q_i. This is Beck's case of an intervention effect with wh-in situ in German. For English, Pesetsky (2000) observed that such structures are well-formed unless they are added to an otherwise tolerated superiority-violation.

(112) Q_1 who$_{FQ,1}$ did only $\sim$[John$_{F2}$ introduce to whom$_{FQ,3}$]?

(113)   ?? Q_1 wen$_{FQ,1}$ hat nur $\sim$[der Hans$_{F1}$ wem$_{FQ,3}$ vorgestellt]?
             who   has only det Hans   whom   introduced
        'Who did only Hans introduce to whom?'

(114)   * Q_1 wen$_{FQ,1}$ hat nur $\sim$ [Luise$_{F,2}$ wo$_{FQ,3}$ gesehen]
              who   has only   Luise   where seen
        'Whom did only Luise see where?'

If we want to extend Beck's suggestion to the current account for ruling these cases out, we would need to postulate that $\sim$ resets the calculation of both F and F$_Q$. On the other hand, it is open to the current account to adopt another

suggestion for these intervention effects from the literature (see Tomioka, 2007; Hamlaoui, 2011b; Mayr, 2010). I leave the matter open here.

Interleaving of wh-questions and alternative questions is predicted to be fine. This is borne out, as shown in (115). F-interpretation of the alternatives takes scope with the F-interpreting Q_{ALT}. F_Q-interpretation of the second wh-word is not disturbed by Q_{ALT} and is construed with the F_Q-interpreting Q_1.

(115) Q_1 $\underline{\text{wer}}_{\textbf{FQ,1}}$ hat gefragt Q_{ALT} ob $\underline{\text{wer}}_{\textbf{FQ,2}}$ [$\underline{\text{Kaffee}}$ oder $\underline{\text{Tee}}$]$_{\textbf{F3}}$ möchte.
       who has asked   whether who   coffee or   tea   wants
       '$\underline{\text{Who}}$ has asked whether $\underline{\text{who}}$ wants $\underline{\text{coffee}}$ or $\underline{\text{tea}}$?'

I turn to interleaving within (B). The current account blocks interpretation of an l-agreeing wh-phrase across another Q_i. In (116a) the last wh-word is l-agreeing (with whichever Q-marker). It will unselectively be interpreted relative to the closest Q-marker Q_2. In a first step, this is a very much desirable result. It rules out l-agreement with long-distance construal in (86) and (90), the cases of blocking by an intervening wh-phrase. The blocker in the current account is the intervening Q_i that would inevitably interpret the l-agreeing wh-phrase. (I assume that yes/no-questions employ a different Q-marker. This will correctly separate (86) and (90) from (85) and (89).) In a second step, then, we want the non-l-agreeing representation in (116b) to lead to long-distance construal.

(116) a. Q_1 $\underline{\text{wer}}_{\textbf{FQ,1}}$ hat gefragt Q_2 wer$_2$ $\underline{\text{wem}}_{\textbf{FQ,3}}$ ein $\underline{\text{Geschenk}}$ gegeben hat?
       b. Q_1 $\underline{\text{wer}}_{\textbf{FQ,1}}$ hat gefragt Q_2 wer$_2$ $\underline{\text{wem}}_{\textbf{F,3}}$ ein Geschenk gegeben hat?
           who   has asked   who whom a present   given has
           'Who has asked who gave whom a present?'

The representation in terms of F (without l-agreement) on the final wh-word has the correct effect that this wh-phrase does not get interpreted by the lower Q_2. We need to make a special assumption to allow it to be interpreted relative to the upper Q_1. This special assumption is that, exceptionally, Q_1 interprets both F_Q and F in this case. I see it as a welcome feature of the current account that it requires this additional assumption. It reflects, to my mind, the marginal way in which such long-distance construal is possible at all.

The account in terms of F correctly predicts that an intervening focus, as in (117), will block the long-distance construal: [F,2] would wrongly get interpreted relative to Q_1, which must exceptionally interpret F for the long-distance construal of [F,4] to work. Notice that there is no such blocking effect in the otherwise parallel case in (111b), where all wh-phrases participate in l-agreement.

(117) * Ich habe
         I   have
       nur ∼ gesagt, Q_1 $\underline{\text{wer}}_{\textbf{FQ,1}}$ $\underline{\text{gestern}}_{\textbf{F,2}}$ gefragt hat Q_3 wer$_3$ $\underline{\text{wem}}_{\textbf{F,4}}$ ein Geschenk gegeben hat.
       only said   who   yesterday asked has   who whom a present given   has
       'I have only[1] said $\underline{\text{who}}$[2] asked $\underline{\text{yesterday}}$[1] who gave whom[2] a present.'

In summary, the account allows co-indexing relations at a distance for moving wh-phrases. For non-moving wh-phrases it allows only unselective binding, sorted by F (no l-agreement) and F_Q (l-agreement). The predictions of the account are appropriate as far as they were explored here.

7. Semantic interpretation

This section spells out the semantic interpretation of the current account. It builds on a syntactic representation with l-agreement represented in English and German wh-questions, as discussed above.

7.1. Wh-indefinites and basic rules of interpretation

In German, a range of wh-words are also used as indefinites (Haspelmath, 1997; Haida, 2007; Gärtner, 2009, see also Kratzer and Shimoyama, 2002 for the more complex Japanese case). The current account leads to a promising approach to this alternation. I suggest that a lexical rule of German creates indefinites from certain wh-words by removing the feature [F,i], the feature that percolates in wh-phrase formation. Thus, if *wer* 'who.NOM' is represented as *w[F,i]-er[i]*, then the indefinite pronoun *wer* 'someone.NOM' is represented as *wer[i]* (without [F,i], the content of the wh-morpheme). This has

the right consequences: Without the inherent F-feature, the semantic connection to interrogatives is lost. Further, all prosodic F-effects are lost, and the accent-rejecting nature of the pronoun emerges (see the contrast in (70)). Finally, the resulting element has the characteristics with which Heim (1982) represents indefinite expressions: an interpreted index with a condition attached. In Heim's account the index is interpreted by an assignment. An assignment is a function from syntactic indices to individuals (or semantic values of another type.) The existential quantification of indefinites does not come out of the indefinite expressions. It comes from existential quantification over the assignment (existential closure). This will be the starting point for the semantic formalization here.

A simple version of existential closure, sufficient for the purposes of this paper, is given in (118a). (118b) spells out a standard version of extensional function application. (118c) says that the meaning of a syntactic index [i] under the assignment g is g(i), i.e. the semantic value (e.g. individual) that is assigned to [i] by g. (118b) spells out a simplified extension of the verb 'called' that we will use. It is simplified insofar the temporal information is not spelled out here.

(118)   *Basic rules of interpretation:*
      a. $[\![\alpha]\!] = \lambda w\ \exists g\ [\![\alpha]\!]^{w,g}$ existential closure
      b. $[\![\alpha,\beta]\!]^{w,g} = [\![\alpha]\!]^{w,g}([\![\beta]\!]^{w,g})$ function application (where [α,β] is [α β] or [β α])
      c. $[\![i]\!]^{w,g} = g(i)$ interpretation of syntactic index i
      d. $[\![called]\!]^{w,g} = \lambda x\ called'(w)(x)$ simplified meaning of *called*

With this, we can interpret 'someone called' as shown in (119). Here and below I ignore the conditions attached to the indices, which in (119) is the information that the referent of 'someone' is a person. (119b) shows the parts of (119a) that are interpreted. We interpret (119b) according to the rules in (118). In (119c), we apply the rule of existential closure, in (119d) function application, and in (119e) the meaning of *called*. By lambda-conversion, this works out to (119f).

(119)   a.   Someone$_3$ called.
      b. $[\![3\ called]\!]$
      c. $= \lambda w\ \exists g\ [\![3\ called]\!]^{w,g}$ existential closure
      d. $= \lambda w\ \exists g\ [\![called]\!]^{w,g}([\![3]\!]^{w,g})$ function application
      e. $= \lambda w\ \exists g\ [\lambda x\ called'(w)(x)](g(3))$ meaning of *called*
      f. $= \lambda w\ \exists g\ called'(w)(g(3))$

This is the desired result. We have assigned an existentially quantified interpretation to an element that carries an index. This interpretation also assigns the required meanings for German indefinites when they are converted from wh-words by removal of [F,i].

7.2. Semantics of information structure F

(120a) shows a representation of a focused sentence, modified from Rooth (1992). The focused constituent is indexed with an F-feature, here with an accompanying referential index "3" for the implementation of Rooth's alternative semantics following Kratzer (1991) and Beck (2006). The sentence is in the scope of the squiggle operator, which carries a syntactic index 'C' for the contextual alternatives (not: complementizer). In the alternative semantics of Rooth (1992), we want (120a) to be identical to the ordinary meaning of this expression (120b) (omitting all the focus structure) provided that (120c) holds: the set of contextual alternatives g(C) is to be a subset of the *focus semantic value*, which represents the set of possible alternatives in the alternative semantics of focus.[17]

(120)   a. $[\![\sim_C Mary\ introduced\ [Bill]_{F3}\ to\ Sue\ ]\!]^{w,g}$
      b. $= [\![Mary\ introduced\ Bill\ to\ Sue\ ]\!]^{w,g}$
      c.   provided that $g(C) \subseteq [\![Mary\ introduced\ [Bill]_{F3}\ to\ Sue\ ]\!]^{w,g,\mathbf{f}}$
      d.   i.e. that $g(C) \subseteq \{\ \lambda w'\ introduced'(w')(m, x, s)\ |\ x \in D\ \}$

(120d) shows what we want the focus semantic value to amount to. We want to replace the focused [Bill]$_{F3}$ with a variable and compute the set of such alternatives in which the variable ranges over different values. Kratzer (1991) proposed to derive the focus semantic value by way of a special variable assignment *h* for designated F-related variables in addition to the standard variable assignment *g* for standard variables. Such a special variable assignment *h* is adopted

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[17] As indicated here, I will define the extension of the focus semantic value as a set of intensions. This simplifies the calculations under the current assumptions, but is not otherwise crucial.

in Beck (2006). Following Beck (2006), we can write the set in (120d) as in (121). Here and throughout, I take ''2'', ''3'' and ''4'' to be indices typed to values that are individuals, and I take A to be the set of all assignments. In (121), h ranges over different values in the alternatives, and for each value of h, h(3) in the position of the focus is some individual.

(121) $\{ \lambda w'\ introduced'(w')(m, \mathbf{h}(3), s) \mid \mathbf{h} \in A \wedge \mathbf{h}\ is\ total\}$

I here employ a minimally modified version of this in which I construe h as a function of the standard assignment g when applied to the feature F. Thus, while g(3) is an individual, g(F) is itself a variable assignment (namely the h of Kratzer and Beck), and g(F)(3) is an individual. A bit more formally, let $g, g' \dots \in A$. Then $g(3), g'(3) \dots \in D$, but $g(F), g'(F) \dots \in A$ and g (F)(3), $g'(F)(3) \dots \in D$. I extend this to F_Q below, such that $g(F_Q) \in A$ and $g(F_Q)(3) \in D$. In this way, g will interpret [3] as the individual g(3), g will interpret [F,3] as the individual g(F)(3), and g will interpret $[F_Q,3]$ as $g(F_Q)(3)$.
    With this, I define a focus semantic value, to be employed by both $\sim$ and Q, as in (122).

(122)   *Focus semantic value*
         Where $f \in \{F, F_Q\}$:
         $[\![\alpha]\!]^{w,g,f} = \{\lambda w'\ [\![\alpha]\!]^{w',g'} \mid g'(f) \in A \wedge g'(f)\ is\ total \wedge g' = g\ for\ all\ other\ indices\}$

Applied to example (120), the focus semantic value in (123a) here comes out as shown in (123b), which amounts to (123c).

(123)   Example of focus semantic value
         a. $[\![$ Mary introduced Bill$_{F3}$ to Sue $]\!]^{w,g,F}$
         b. $= \{ \lambda w'\ [\![$Mary introduced Bill$_{F3}$ to Sue $]\!]^{w',g'} \mid g'(F) \in A \wedge g'(F)\ is\ total \}$
         c. $= \{ \lambda w'\ introduced'(w')(m, [\![$ Bill$_{F3}$ $]\!]^{w',g'}, s) \mid g'(F) \in A \wedge g'(F)\ is\ total \}$

Now we need an additional rule that replaces the focus in (123c) with an appropriate interpretation that amounts to different values in different members of the set. In the case at hand, this needs to be g'(F)(3), so that we achieve the form in (121), except here with g'(F) instead of *h*.
    This is the point in the interpretation where the F-feature 'makes the connection to the scope operator'. This was a much-simplified way of putting things earlier in the paper. F always makes a connection of a very specific kind to a very specific kind of interpretation: There is always set-formation by the focus semantic value, and the position of F is always the position in which the members of the set vary. In the current account, this specific connection is made by interpreting [F,i] as g(F)(i), i.e. g interprets both the F-feature and the index.
    The rules that interpret $[\![$ Bill$_{F3}$ $]\!]^{w',g'}$ in (123c) are given in (124), in parallel to the definitions in Beck (2006).

(124)   *Interpretation of F*
         a. $[\![\alpha_{\mathbf{F,i}}]\!]^{w,g} = g(F)(i)$ if defined
         b. $[\![\alpha_{\mathbf{F,i}}]\!]^{w,g} = [\![\alpha]\!]^{w,g}$ otherwise

(124a) is the interpretation relative to a focus semantic value. In (123c), for instance, it assigns the desired g'(F)(3). However, we do not want the replacement with a variable assignment in the calculation of the *ordinary* semantic value, the normal meaning, in (120b). We want instead for the ordinary meaning of [Bill]$_{\mathbf{F3}}$ to be the meaning of [Bill] (unfocused). In the current account, the ordinary semantic value is distinguished by setting g(F) to Ø, so that the domain of g(F) is empty. This is written $[\![\alpha]\!]^{w,g[F \to \varnothing]}$. In this ordinary semantic value, (124a) is undefined, and therefore (124b) identifies the meaning of [Bill]$_{\mathbf{F3}}$ with the meaning of [Bill]. With this, we can write the general rule of interpreting the scope of the focus $\sim$ in the current format as in (125). (126) is a sample illustration of how (125) works.

(125)   *Interpretation of $\sim$*
         $[\![\sim_C \alpha]\!]^{w,g} = [\![\alpha]\!]^{w,g[F \to \varnothing]}$ provided that $g(C) \subseteq [\![\alpha]\!]^{w,g,F}$

(126)   a. $\lambda w\ \exists g\ [\![\ \sim_C$ Mary introduced Bill$_{\mathbf{F3}}$ to Sue $]\!]^{w,g}$ [interpretation of:]
         b. $= \lambda w\ \exists g\ [\![$ Mary introduced Bill$_{\mathbf{F3}}$ to Sue $]\!]^{w,g[F \to \varnothing]}$
               provided that $g(C) \subseteq [\![$ Mary introduced Bill$_{\mathbf{F3}}$ to Sue $]\!]^{w,g,F}$ [$\sim_C$]
         c. $= \lambda w\ \exists g\ introduced'(w)(m, [\![$ Bill$_{\mathbf{F3}}$ $]\!]^{w,g[F \to \varnothing]}, s)$ provided that $g(C) \subseteq$
               $\{ \lambda w'\ introduced'(w')(m, [\![$ Bill$_{\mathbf{F3}}$ $]\!]^{w',g'}, s) \mid g'(F) \in A \wedge g'(F)\ is\ total \}$
                                                                                [ordinary and focus semantic value]

d.   = λw introduced′(w)(m, b, s) provided that g(C) ⊆
       { λw′ introduced′(w′)(m, g′(F)(3), s) | g′(F) ∈ A ∧ g′(F) is total }   [F]
e.   = λw introduced′(w)(m, b, s)
       provided that g(C) ⊆ { λw′ introduced′(w′)(m, x, s) | x ∈ D }

In sum, we have adopted the alternative semantics of Rooth (1992), but with calculation of the focus semantic value in terms of a special assignment function, as suggested by Kratzer (1991). The particular suggestions stay close to those of Beck, though I employ g(F) instead of *h*.

7.3. Semantics of alternative questions

For the purposes of this paper, we want to derive question meanings as sets of possible answers (Hamblin, 1973). While question meanings are ultimately more complex in interesting ways (Karttunen, 1977; Groenendijk and Stokhof, 1982; Heim, 1994) the Hamblin-meanings calculated here can be turned into more complex question meanings with additional operators, as shown in Sharvit (2002). I adopt from von Stechow (1991) and Beck (2006) that the meaning of questions is calculated in terms of focus semantic values rather than ordinary semantic values. The set-formation mechanism that is employed to calculate alternatives in information structure focus is then also employed in calculating the set of possible answers. In both cases, the positions of F or *wh* are the positions in which we want the sets to range over different values.

The meaning of a Q-marker for alternative questions is defined in (127).

(127)   <u>*Q-marker for alternative questions*</u>
        $[\![Q_{ALT}\ \alpha]\!]^{w,g} = Atoms(\{p \mid p \in [\![\alpha]\!]^{w,g,F} \wedge [p \rightarrow \lambda w\ \exists g\ [\![\alpha]\!]^{w,g[F \rightarrow \varnothing]}]\})$

It is defined in terms of the focus semantic value ($[\![\alpha]\!]^{w,g,F}$) and the ordinary semantic value ($[\![\alpha]\!]^{w,g[F \rightarrow \varnothing]}$). The function *Atoms* is explained with a specific example. The example at hand is (128a), and the focus and the ordinary semantic values of the complement of Q_{ALT} are shown in (128b) and (128c), respectively.

(128)   a. $[\![Q_{ALT}\ did\ [John\ or\ Mary]_{F3}\ call?]\!]^{w,g}$
        b.   *focus semantic value of complement of* Q_{ALT}:
              $[\![[John\ or\ Mary]_{F3}\ called]\!]^{w,g,F} = \{\lambda w\ called′(w)(x) \mid x \in D\}$
        c.   *ordinary semantic value of complement of* Q_{ALT}:
              $\lambda w\ \exists g\ [\![[John\ or\ Mary]_{F3}\ called]\!]^{w,g[F \rightarrow \varnothing]} = \lambda w\ \exists g\ [\![John\ or\ Mary\ called]\!]^{w,g}$
              $= \lambda w\ called′(w)(j) \vee \lambda w\ called′(w)(m)$

With the meaning of Q_{ATL} in (127), the meaning of (128a) is (129a), which is identical to (129c). This, however, includes unwanted propositions like *John and Mary called, John and Bill called*, etc., and the role of *Atoms* is to eliminate these: I define *Atoms* as a function that takes a set and returns a subset of it in which all members that asymmetrically entail another member of the set are eliminated.[18]

(129)   a.   Atoms({p | p ∈ {λw called′(w)(x) | x ∈ D}
                        ∧ [p → λw called′(w)(j) ∨ λw called′(w)(m)]})
        b.   = Atoms({λw called′(w)(x) | x ∈ D ∧
                        [λw called′(w)(x) → (λw called′(w)(j) ∨ λw called′(w)(m))]})
        c.   = Atoms({λw called′(w)(j), λw called′(w)(m), λw called′(w)(j + m), λw called′(w)(j + b), ...})
        d.   = {λw called′(w)(j), λw called′(w)(m)}

The definition of Q_{ALT} shows that we can define Q_{ALT} in terms of the ordinary semantic value and the focus semantic value, where the focus semantic value and F are interpreted identically to information structure F. Some empirical support for employing a distinct interpretation for Q_{ALT} from the Q-marker of wh-questions will be seen momentarily.

Von Stechow's motivation for employing the focus semantic value in interrogatives was to provide a natural class of semantic types of standard *or* and *or* in alternative questions, though they still have different meanings in von

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[18] For example *John and Mary called* as well as *John and Bill called* are eliminated since they asymetrically entail *John called*, which is also a member of the set. On the other hand *John called* and *Mary called* do not entail one another.

Stechow's account. Different semantic means from standard *or* are also employed for interpreting the disjunction in alternative questions in Romero and Han (2003) and Beck and Kim (2006). The current suggestion completes what von Stechow started, since it uses the focus semantic value and the standard meaning of *or* for the disjunction in the alternatives. Beck and Kim (2006) discuss whether the alternatives in alternative questions are a hidden wh-phrase. The evidence that they assemble point to a negative answer. Here I address two of the arguments of Beck and Kim.

Predicates like *surprise* embed a wh-question but not a yes-no-question, as shown in (130a,b) (cf. d'Avis, 2002; Grimshaw, 1979). They do not embed alternative questions (cf. (130c)), which suggests that the alternatives are not equivalent to a wh-phrase. In fact, the minimally different (130d) is possible under *surprise*.

(130)   a.   I was surprised who attended.
        b. *   I was surprised whether Bill attended.
        c. *   I was surprised whether Bill or George attended.
        d.   I was surprised which of the two attended.

In the current account one may say that exclamative interpretation of interrogative clauses (such as under *surprise*) is inherently tied to the Q-marker [Q,i]. In the current account [Q,i] is specific to wh-questions, while yes/no-questions and alternative questions employ different Q-markers.

(131)   Exclamative interpretation of a Q-marked clause requires the Q-marker [Q,i].

Another case discussed by Beck and Kim involves mixed association with the same Q-marker. Multiple-wh-questions of course allow multiple association of two wh-phrases with the same Q-marker, as in '*Who likes what?*'. Is it possible to associate a wh-phrase and a disjunction of alternatives with the same Q-marker as well? The issue is then whether '*Who likes tea or coffee?*' can have the reading of '*Who likes what?*' (assuming tea and coffee are the two options). Beck and Kim report results that are not conclusive but nonetheless suggest that the intended reading is at least restricted. Here, I add a prosodic observation that suggests that such association is not possible. Consider (132). Recall from the discussion of (39) and (40) that this context does not make *open the door*, here *die Tür öffnen* contextually given. It is thus accented in (132a). In (132b), the interpretation of F on the alternatives does not require givenness of *die Tür öffnen*, since this F is interpreted relative to the Q-marker. The crucial case is then shown in (132c). (The judgments are the same if accent is added to the initial wh-word.) (132c.i) shows the expected accentuation of the construal of the disjunction with the Q-marker, as in (132b). This is not possible in this context. The only felicitous accentuation of this sequence of words in this context is as in (132c.ii). This shows that the alternatives cannot be associated with a Q-marker that also has a wh-phrase associated with it.

(132)   Max klingelte bei Hans und Maria. Er fragte sich:
        'Max rang at Hans and Maria's. He wondered:'
   a.   <u>Wann</u> wird <u>wer</u> die <u>Tür</u>   öffnen?
        when   will who the door open
        'Who will open the door when?' (lit.: '<u>When</u> will <u>who</u> open the <u>door</u>?')
   b.   Q Wird [der <u>Hans</u> oder die <u>Maria</u>]$_F$ die Tür   öffnen?
           will   DET Hans or   DET Maria   the door open
        'Will <u>Hans</u> or <u>Maria</u> open the door?'

   c.   i.   # Wann wird der <u>Hans</u> oder die <u>Maria</u> die Tür   öffnen?
                    when will DET Hans or   DET Maria the door open
                'When will <u>Hans</u> or <u>Maria</u> open the door?'
        ii.   Wann wird der <u>Hans</u> oder die <u>Maria</u> die <u>Tür</u> öffnen?
                'When will <u>Hans</u> or <u>Maria</u> open the <u>door</u>?'

The current account predicts that such mixing of alternative questions with wh-questions is not possible: Q$_{ALT}$ invokes the ordinary semantic value to interpret the alternatives. The Q-marker for wh-questions (see below) must crucially not invoke the ordinary semantic value, since it is not defined for wh-words. Therefore, only one or the other Q-marker can be chosen. Whichever one is chosen allows only the corresponding F-marked elements in its

scope: F-marked disjunction (with defined ordinary semantic value) or wh-word (with undefined ordinary semantic value).

In sum, the F-feature on the alternatives is semantically interpreted by the rules that also interpret information structure F. No special rule for the interpretation of the disjunction is required. A special Q-marker for alternative questions was postulated.

7.4. Semantics of Japanese wh-questions

I turn to wh-questions, beginning with Japanese wh-in situ without percolation of wh. I employ the Q-marker in (133).

(133)   *Q-marker for Japanese and Turkish wh-questions*
$$\llbracket Q\ \alpha \rrbracket^{w,g} = \llbracket \alpha \rrbracket^{w,g,F}$$

I represent Japanese *who* as the feature composition [F,i], where *i* is an referential index of type individual. I omit the person specification. I follow Beck (2006) and Cable (2010) in the claim that wh-words are assigned a focus semantic value, but no ordinary semantic value. This can be made to follow from a minimal revision of the definitions in (124), given in (134). The minimal revision is to make the presence of α optional in (134a). This leaves intact the interpretation of [Bill]$_{F,3}$ where α = [Bill]. However, (134a) can now also interpret the wh-word *who* in Japanese, with the feature composition [F,3] which is here not attached to any meaningful constituent α. As desired, the ordinary semantic value of the wh-word [F,i] is undefined, as in the account of Beck (2006). It is not defined by (134a) because the domain of g(F) is empty, nor is it defined by (134b) because the F-feature is not attached to an independently meaningful α.

(134)   *Interpretation of F (revised)*
   a. $\llbracket (\alpha)_{F,i} \rrbracket^{w,g} = g(F)(i)$ if defined
   b. $\llbracket \alpha_{F,i} \rrbracket^{w,g} = \llbracket \alpha \rrbracket^{w,g}$ otherwise

(135) illustrates with a mock-Japanese question. The Q-marker is interpreted in (135b). The focus semantic value is interpreted in (135c), and the wh-word [F,3] is interpreted in (135e).

(135)   a. $\llbracket Q\ who\ called\ \rrbracket^{w,g} = \llbracket Q\ [F,3]\ called\ \rrbracket^{w,g}$
   b. $= \llbracket\ [F,3]\ called\ \rrbracket^{w,g,F}$
   c. $= \{\ \lambda w'\ \llbracket\ [F,3]\ called\ \rrbracket^{w',g'} \mid g'(F) \in A \wedge g'(F)\ is\ total \wedge g' = g\ for\ all\ other\ indices\}$
   d. $= \{\ \lambda w'\ called'(w')(\llbracket\ [F,3]\ \rrbracket^{w',g'}) \mid g'(F) \in A \wedge g'(F)\ is\ total \wedge g' = g\ for\ all\ other\ indices\}$
   e. $= \{\ \lambda w'\ called'(w')(g'(F)(3)) \mid g'(F) \in A \wedge g'(F)\ is\ total \wedge g' = g\ for\ all\ other\ indices\}$
   f. $= \{\ \lambda w'\ called'(w')(x) \mid x \in D\}$

The F-feature on the Japanese wh-word accounts for the prosodic F-effect on Japanese wh-words that was seen above.

In sum, a minimal revision provides us with a unified rule of F-interpretation that can interpret both F on wh-phrases in Japanese and information structure F.[19] A Q-marker for Japanese wh-questions was postulated.
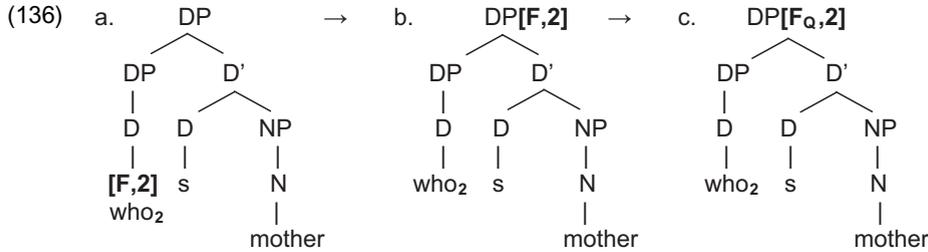
7.5. Semantics of English and German wh-questions

More complexity is postulated in the analysis of languages in which the wh-feature percolates to a wh-phrase and overt movement occurs. I employ the lexical specification *[[F,i], [i]]* for the English wh-word *who* and its German counterpart. It consists of two morphemes, the wh-morpheme [F,i] and the separate referential index [i].[20]

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[19] Notice that (134) also helps ensure that non-wh-foci and wh-words are not used interchangeably. The account follows Beck (2006) and Cable (2010), who argue that a wh-phrase only has a focus semantic value. The wh-phrase therefore cannot be associated with the focus operator ~, which demands both semantic values. Further, following Cable (2010), a non-wh-focus cannot function as a wh-phrase because its ordinary value would not be interpreted. This can be blocked by a Principle of Full Interpretation (see Cable (2010:75) for a formulation).

[20] Japanese has a wh-morpheme, do-(/da-), and alternations of it comparable to English wh-en/th-en. However, while German is exceptionless in the presence of such a morpheme, and English is exceptionless if we allow its presence in *how* in word-final position, Japanese has some wh-words that do not have this morpheme, in particular *nani* 'what' and *itsu* 'when'. Similarly, Turkish also has no wh-morpheme used in all wh-words: *kim* 'who', *ne* 'what', *hangi* 'which'. It is possible that the grammatical need for a morphemic content [F,i] that can separate and percolate on its own stabilizes the consistent morphological separation in the lexicon.

With this, the content of the wh-morpheme [F,i] can percolate up to a wh-phrase from its lexically inserted form in (136a) to (136b). There, it will be found by the probe Q as a goal and an l-agreement relation is established by copying Q onto the F-feature, as in (136c).

(136)

```
     a.       DP            →    b.     DP[F,2]      →    c.     DP[FQ,2]
          ┌────┴────┐                ┌────┴────┐               ┌────┴────┐
         DP        D'               DP        D'              DP        D'
          |      ┌──┴──┐             |      ┌──┴──┐            |      ┌──┴──┐
          D     D     NP             D     D     NP            D     D     NP
          |     |      |             |     |      |            |     |      |
        [F,2]   s      N           who₂   s      N           who₂   s      N
        who₂           |                          |                          |
                |   mother                     mother                     mother
              mother
```

The l-agreeing wh-morpheme $[F_Q, i]$ receives a related but different semantic interpretation from [F,i]. For one thing, it does not invoke g(F), the 'second dimension' but $g(F_Q)$, the 'third dimension'. Since g(F) is independent of $g(F_Q)$ and vice versa, the two can enter into interleaving structures, as discussed in Section 6.6. There is another crucial difference: Attachment of F to a constituent α is to calculate a focus semantic value in which the meaning of α is discarded, as in (134a). Applied to (136b), this would wrongly discard the meaning of 'whose sister' and amount to the meaning of 'who' instead. It is therefore crucial that the percolated F-features receive the Q-feature, becoming F_Q, so that they can invoke a separate rule of interpretation for F_Q that does not discard the meaning of the elements below F_Q. This rule is given in (137).

(137) *Interpretation of F_Q*
$$[\![\alpha[\mathbf{F_Q}, \mathbf{i}]]\!]^{w,g} = [\![\alpha]\!]^{w,g[i \to g(F_Q)(i)]} \text{ (undefined where } g(F_Q)(i) \text{ is undefined)}$$

The Q-marker of English and German wh-questions carries a single referential index. It is interpreted by (138), which invokes the "third dimension", interpretation relative to $g(F_Q)$. This dimension is invoked both for the interpretation of the index on the Q-marker, and for the interpretation of any wh-phrases in situ that can connect to this by their F_Q-feature.

(138) *Interpretation of indexed Q-marker* (English and German wh-questions)
$$[\![Q_i \, \alpha]\!]^{w,g} = [\![\alpha]\!]^{w,g[i \to g(F_Q)(i)], F_Q}$$

The mechanism for relating the index i to the third dimension is parallel in (137) and (138): The interpretation of α in both rules must identify g(i) with $g(F_Q)(i)$. When [i] is encountered within α, it is interpreted as g(i), which is then identical in value to $g(F_Q)(i)$ by the constraints in (137) and (138).

(139) shows the syntactic steps preceding interpretation for a single-wh-question. Percolation of [F,j] to the DP is crucial for l-agreement to identify i = j. It also replaces F with Q instead of adding Q to it. Recall that this represents the absence of a prosodic F-effect in this case. Of the moved (I assume copied) constituent DP[Q,3], the features [Q,3] are interpreted in Spec,CP (but not on the wh-phrase), while everything else (the DP and what it dominates) is interpreted in situ (but not in Spec,CP). This includes the referential index of the wh-phrase.

(139) a. [Q,i] $wh_{F,j}$-o_j called   lexical
      b. [Q,i] [wh-o_j][F,j] called   percolation of [F,j] to the DP
      c. [Q,3] [wh-o_3][Q,3] called   l-agreement makes i = j, here also
                                               replaces F with Q
      d. [wh-o_3][Q,3] [wh-o_3][Q,3] called   movement
      e. ~~[wh-o_3]~~[Q,3] [wh-o_3]~~[Q,3]~~ called   stricken-through = not interpreted

(140) shows the semantic interpretation of this case. [Q,3] is here written as Q_3. Q_3 is interpreted by (138) in (140b). The focus semantic value is calculated in (140c). (140d,e) show how the Q-marker interpretation of the index plays out in the result: As written out in (140d), the requirement in (140c) that g(3) = g(F)(3) is inherited by g′, which is identified with g for all indices except F, and thus also for index 3. This identity allows for substitution of g′(3) with g′(F)(3), as shown in (140e). The result is equivalent to the simpler representation in (140f).

(140) a. $[\![Q_3 \, who_3 \, called]\!]^{w,g}$
      b. $= [\![who_3 \, called]\!]^{w,g[3 \to g(F_Q)(3)], F_Q}$

c. $= \{ \lambda w' \; [\![\; who_3 \; called \;]\!]^{w',g'} \mid g'(F_Q) \in A \wedge g'(F_Q) \text{ is total } \wedge$
$g' = g[3 \to g(F_Q)(3)] \text{ for all other indices}\}$

d. $= \{ \lambda w' \; called'(w')(g'(3)) \mid g'(F_Q) \in A \wedge g'(F_Q) \text{ is total } \wedge g'(3) = g'(F_Q)(3) \}$

e. $= \{ \lambda w' \; called'(w')(g'(F_Q)(3)) \mid g'(F_Q) \in A \wedge g'(F_Q) \text{ is total } \}$

f. $= \{ \lambda w' \; called'(w')(x) \mid x \in D \}$

(141) shows steps in the syntactic derivation of a multiple-wh-question. The first wh-phrase shares the index 3 with the Q-marker. The percolated F-feature of this wh-phrase is not semantically required, but assumed to be present for reasons of uniformity: Optional replacement with Q is assumed not to have taken place. It is instead marked as F_Q by l-agreement. In this case, the structure that results from l-agreement is identical to the structure that is interpreted.

(141)   a. $[Q,i] \; wh_{F,j}\text{-}o_j \; called \; [wh_{F,4}\text{-}o_4\text{-}s \; mother]$ lexical
      b. $[Q,i] \; [wh\text{-}o_j][F,j] \; called \; [who_4\text{-}s \; mother][F,4]$ percolation
      c. $[Q,3] \; [wh\text{-}o_3][F_Q,3] \; called \; [who_4\text{-}s \; mother][F_Q,4]$ l-agreement

The interpretation is shown in (142). Highlighted in grey is the interpretation of the co-indexing on Q. The calculations otherwise show the effect of the interpretation of $[F_Q,3]$ and $[F_Q,4]$.

(142)   a. $[\![Q_3 \; [who_3]_{[FQ,3]} \; called \; [who_4\text{-}s \; mother]_{[FQ,4]}]\!]^{w,g}$

      b. $= [\![[who_3]_{[FQ,3]} \; called \; [who_4 - s \; mother]_{[FQ,4]}]\!]^{w,g[3 \to g(F_Q)(3)],F_Q}$

      c. $= \{ \lambda w' \; [\![[who_3]_{[FQ,3]} \; called \; [who_4\text{-}s \; mother]_{[FQ,4]}]\!]^{w',g'} \mid g'(F_Q) \in A \wedge g'(F_Q) \text{ is}$
$\text{total } \wedge g' = g[3 \to g(F_Q)(3)] \text{ for all other indices}\}$

      d. $= \{ \lambda w' \; called'(w')([\![who_3]\!]^{w',g'[3 \to g'(F_Q)(3)]}, [\![who_4\text{-}s \; mother]\!]^{w',g'[4 \to g'(F_Q)(4)]})) \mid$
$g'(F_Q) \in A \wedge g'(F_Q) \text{ is total } \wedge g'(3) = g'(F_Q)(3)\}$

      e. $= \{ \lambda w' \; called'(w')(g'(F_Q)(3), \iota\{x \mid mother'(w')(x, g'(F_Q)(4))\}) \mid g'(F_Q) \in A$
$\wedge g'(F_Q) \text{ is total}\}$

      f. $= \{ \lambda w' \; called'(w')(y, \iota\{x \mid mother'(w')(x,z)\}) \mid y,z \in D\}$

(142b) shows the interpretation of the Q-marker, (142c) the expansion of the focus semantic value, (142d) the interpretation of the features $[F_Q,3]$, and $[F_Q,4]$ on the wh-phrases according to (137). The referential indices [3] and [4] in the wh-phrases are interpreted as $g'(3)$ and $g'(4)$ (i.e. as regular indices). The change in the assignment due to the percolated F_Q-features, however, makes sure that g' is such that $g'(3) = g'(F_Q)(3)$ for the first wh-phrase and $g'(4) = g'(F_Q)(4)$ for the second wh-phrase. The result is shown in (142e), which is equivalent to (142f). This calculation did not rely on the elements in grey. In the step from (142d) to (142e), these also make sure that $g'(3) = g'(F_Q)(3)$, though this information need not be used because it is already ensured by the feature combination $[F_Q,3]$ as just discussed.

In sum, the interpretation of English and German wh-questions requires a Q-marker that interprets its index, and a rule for interpreting the percolated and l-agreeing F_Q features. Both rely on the same mechanism for connecting an index [i] to the F_Q-interpretation: identifying $g(i)$ ('first dimension') with $g(F_Q)(i)$ ('third dimension'). This has the effect that an index [i] lower in the structure is tied to the focus semantic value relative to F_Q.

7.6. Multiple scope-markers and interleaving

(143) shows interleaving of information structure F and l-agreeing wh-phrase (F_Q) interpretation. The calculation for the crucial part of the meaning of (143) is shown in (144).

(143)   Ich habe mich   nur $\sim_C$ [gefragt $[Q_1$ wer$_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]]
       I   have myself only   asked   who.NOM DET.ACC Luise   whom   introduced has
       'I only wondered who introduced <u>Luise</u> to whom.'

The crucial aspect is that, for any g, g(F) is manipulated independently of $g(F_Q)$: g(F) is one assignment and $g(F_Q)$ is a different assignment. Because of this, the focus semantic value relative to F (for information structure F and Q-related F without l-agreement) and the focus semantic value relative to F_Q (for l-agreeing interrogative interpretation) do not interfere with each other, and the expected compositional result can be obtained. The demonstration employs a co-indexed first wh-phrase without the redundant (but uniform) F-marking. The steps in (144) are: (a): squiggle-interpretation; (b): focus semantic value for F; (c): meaning of *gefragt*, 'asked' (twice);

(d): Q-marker (twice); (e): focus semantic value for F_Q (twice); (f) meaning of *introduced* and its arguments (twice); (g) simplification.

(144) a. $[\![\sim_C$ [gefragt [Q_1 wer$_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]]$]\!]^{w,g}$

b. $= [\![$gefragt [Q_1 wer$_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]$]\!]^{w,g[F\to\varnothing]}$

provided that $g(C) \subseteq [\![$gefragt [Q_1 wer$_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]$]\!]^{w,g,F}$

c. $= \lambda x\ ask'(w)(x)[\![[Q_1$ wer$_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]$]\!]^{w,g[F\to\varnothing]}$

provided that $g(C) \subseteq \{\lambda w'\ \lambda x\ ask'(w')(x)[\![[Q_1$ wer$_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$

vorgestellt hat]$]\!]^{w',g'} \mid g'(F) \in A \wedge g'(F)$ is total $\wedge\ g' = g$ for all other indices$\}$

d. $= \lambda x\ ask'(w)(x)[\![wer_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]$]\!]^{w,g[F\to\varnothing][1\to g(FQ)(1)],FQ}$

provided that $g(C) \subseteq \{\lambda w'\ \lambda x\ ask'(w')(x)[\![wer_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$

vorg. hat]$]\!]^{w',g'[1\to g'(FQ)(1)],FQ} \mid g'(F) \in A \wedge g'(F)$ is total $\wedge\ g' = g$ for all other indices$\}$

e. $= \lambda x\ ask'(w)(x)\{\lambda w''\ [\![wer_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$ vorgestellt hat]$]\!]^{w'',g''} \mid g''(FQ) \in A$

$\wedge\ g''(FQ)$ is total $\wedge\ g'' = g[F\to\varnothing][1\to g(FQ)(1)]$ for all other indices$\}$

provided that $g(C) \subseteq \{\lambda w'\ \lambda x\ ask'(w')(x)\{\lambda w'''\ [\![wer_1$ die $\underline{Luise}_{F,2}$ $\underline{wem}_{FQ,3}$

vorgestellt hat]$]\!]^{w''',g'''} \mid g'''(FQ) \in A \wedge g'''(FQ)$ is total $\wedge\ g''' = g'[1 \to g'(FQ)(1)]$

for all other indices$\} \mid g'(F) \in A \wedge g'(F)$ is total $\wedge\ g' = g$ for all other indices$\}$

f. $= \lambda x\ ask'(w)(x)\{\lambda w''\ introduce'(w'')(g''(FQ)(1), l(uise), g''(FQ)(3)) \mid g''(FQ) \in A$

$\wedge\ g''(FQ)$ is total $\}$ provided that $g(C) \subseteq \{\lambda w'\ \lambda x\ ask'(w')(x)\{\lambda w'''\ introduce'(w''')$

$(g'''(FQ)(1), g'(F)(2), g'''(FQ)(3)) \mid g''(FQ) \in A \wedge g''(FQ)$ is total$\} \mid g'(F) \in A \wedge g'(F)$ is total $\}$

g. $= \lambda x\ ask'(w)(x)\{\lambda w''\ introduce'(w'')(x, l(uise), y) \mid x,y \in D\}$ provided that $g(C) \subseteq$

$\{\lambda w'\ \lambda x\ ask'(w')(x)\{\lambda w'''\ introduce'(w''')(x, z, y) \mid x,y \in D\} \mid z \in D\}$

Long-distance construal of a wh-phrase is repeated in (145a). Recall that the lowest wh-phrase, construed with the upper Q-marker, is nevertheless not part of l-agreement with that Q-marker (due to the intervening wh-phrase). Therefore, l-agreement does not copy the Q-feature onto the F-feature, i.e. the wh-phrase is interpreted with a regular F-feature. The lines below (145a) show that there are two instances of F_Q-interpretation here. (I return to the bracketed Q in a moment). The lower one is invoked by Q_3 by the semantic interpretation of indexed Q in (138). I assume F-deletion on who$_3$ and interpretation relative to the index 3.

(145) a. Q_2 who$_{[FQ,2]}$ wonders Q_3 who$_3$ gave whom$_{[F,4]}$ the newspaper

$\qquad\qquad\qquad\qquad\qquad\quad F_Q$ ———————————————

$\qquad F_{(Q)}$ ═══════════════════════════════

b. Upper Q-marker: instead of $[\![Q_i\ \alpha]\!]^{w,g} = [\![\alpha]\!]^{w,g[i\to g(FQ)(i)],FQ}$

employ $[\![Q_i\ \alpha]\!]^{w,g} = [\![\alpha]\!]^{w,g[i\to g(FQ)(i)],F(Q)}$

c. $\{\lambda w\ wonder'(w)(g(FQ)(2))\{\lambda w'\ give'(w')(g'(FQ)(3), g(F)(4), n) \mid g'(FQ) \in A$

$\wedge\ g'(FQ)$ is total$\} \mid g(F_{(Q)}) \in A \wedge g(F_{(Q)})$ is total$\}$

d. $\{\lambda w\ wonder'(w)(g(FQ)(2))\{\lambda w'\ give'(w')(g'(FQ)(3), g(F)(4), n) \mid g'(FQ) \in A$

$\wedge\ g'(FQ)$ is total$\} \mid g(F) \in A \wedge g(FQ) \in A \wedge g(F)$ is total $\wedge\ g(FQ)$ is total$\}$

e. $\{\lambda w\ wonder'(w)(x)\{\lambda w'\ give'(w')(y, z, n) \mid y \in D\} \mid x,z \in D\}$

(145a) is not part of the grammar written here, narrowly construed, since there is no scope-marker interpreting the F-feature [F,4]. However, this structure can be accommodated with some wiggling. This involves allowing the upper Q-marker to simultaneously take on F_Q- and F-interpretation. As indicated by "$F_{(Q)}$" on the subscript in (145a,b), it will thus interpret both F_Q and F simultaneously. Letting the notation "$F_{(Q)}$" run through the system of interpretation above, we obtain (145c), which still employs the notation "$F_{(Q)}$". (The meaning of *the newspaper* is here shortened to *n*.) The "$F_{(Q)}$" notation is resolved as in (145d), i.e. $g(F_{(Q)}) \in A$ is identified with $[g(F) \in A \wedge g(FQ) \in A]$ and likewise for the requirement that the function is total. With this, (145d) resolves to the desired (145e). Observe also that (145c) crucially employs $g(F)(4)$, though this occurs in a part of the interpretation otherwise taken on by g'. However, $g'(F)$ $(4) = g(F)(4)$ here, since the expansion of the focus semantic value under Q_3, which introduces g', requires that $g' = g$ for all values except $g'(FQ)$.

As discussed, the account predicts that no information structure F can intervene between the upper Q-marker and the wh-phrase with long-distance construal. Thus, (146) is correctly predicted to be ungrammatical. The lines below the example indicate the F_Q-interpretation relative to Q_3 and the exceptional F-and-F_Q-interpretation relative to Q_1, with the F-component required to interpret [F,4] on the last wh-phrase. The additional focus [F,2] on $[gestern]_{F,2}$, 'yesterday' in (146) is now also interpreted relative to Q_1 because of the exceptional F-interpretation relative to Q_1. It cannot be interpreted relative to the focus semantic value of the higher squiggle-operator that accompanies *nur* 'only'. Interpreted relative to Q_1, however, it does not receive an interpretation of its content 'yesterday' in the ordinary semantic value and is ruled out by the requirement of full interpretation (see fn. 19).

(146)   * Ich habe nur ~ gesagt,
              I   have   only   said
           Q_1 wer$_{FQ,1}$ gestern$_{F,2}$ gefragt hat Q_3 wer$_3$ wem$_{F,4}$ ein Geschenk gegeben hat.
              who   yesterday asked has   who whom a   present   given   has
                                                        F_Q————————————————————————————————————
           $F_{(Q)}$ ═══

'I have only[1] said who[2] asked yesterday[1] who gave whom[2] a present.'

In summary, the following perspective was spelled out in the semantic account. Rooth's squiggle-operator marks the scope of information structure focus, different Q-markers mark the scope of interrogatives. All these scope-markers invoke the focus semantic value. It induces formation of a set. The members of the set are alternatives in information structure focus, and the possible answers in interrogative semantics. In both cases, F marks an index that takes on different values for the members of the set. This perspective was spelled out in some detail for alternative questions, Japanese wh-in-situ and English and German wh-movement and multiple-wh questions. In English and German wh-questions, syntactic l-agreement (coindexing of the moving wh-phrase with the Q-marker, conversion of F to F_Q) provides the input to the semantic interpretation.

8. Conclusion

Interrogatives show prosodic F-effects because F is employed both for information structure focus and in the syntax and semantics of interrogatives, where this feature is otherwise called [wh].

There is evidence that alternative questions carry F inherently on the alternatives and echo-questions carry F (without percolation) inherently on the wh-morpheme, similar to Japanese (and Turkish) wh-in-situ questions. In these cases, the current account postulates the regular feature F as part of the syntax and semantics of the different question types, with a full prosodic effect of F.

In wh-questions that involve wh-movement, the moving wh-phrase is special in showing the absence of prosodic F-effects. It is postulated that it carries a special relation to the Q-marker (here: coindexing as part of l-agreement) that makes the use of F superfluous, since the Q-marker relates the relevant index to the focus semantic value.

In multiple-wh-questions with movement of only one wh-phrase, we find reduced prosodic F-effects on the wh-phrase in situ and prosodic evidence for percolation of F to the top of the wh-phrase in situ. This is here analyzed in terms of the relation of l-agreement between the scope-marker [Q,i] and the wh-phrases. L-agreement copies Q onto the percolated F-feature, deriving F_Q with different prosodic and semantic properties than F. In the account developed here, l-agreement between F_Q and Q is a substitute for attraction of the strongest stress by F within Q. The presence of F_Q is still prosodically noticeable in the weaker effect of attraction of accent on the wh-phrase in situ (shared with F in multiple-focus constructions).

In the semantic interpretation, the scope-markers of information structure focus (Rooth's squiggle-operator) and different interrogative scope-markers invoke the focus semantic value. It calculates the set of alternatives in information structure focus and the set of possible answers in interrogatives. Across the two cases, F (or F_Q) marks an index in which the members of the set vary.

The focus semantic value of F and the focus semantic value of F_Q (differing in detail) are calculated separately and can be interleaved. On the other hand, it seems that two focus semantic values of F (even if one is information structure use, the other interrogative) cannot be interleaved, nor can two focus semantic values of F_Q be interleaved. This is predicted by unselective interpretation of F (and, separately, of F_Q) relative to the next higher operator interpreting F (or, for other operators, F_Q).

Acknowledgements

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