THE SURFACE-COMPOSITIONAL SEMANTICS OF ENGLISH INTONATION

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This paper proposes a syntax and a semantics for intonation in English and some related languages. The semantics is "surface-compositional", in the sense that syntactic derivation constructs information-structural logical form monotonically, without rules of structural revision, and without autonomous rules of "focus projection." This is made possible by the generalized notion of syntactic constituency afforded by Combinatory Categorial Grammar (CCG)—in particular, the fact that its rules are restricted to string-adjacent type-driven combination. In this way, the grammar unites intonation structure and information structure with surface-syntactic derivational structure and Montague-style compositional semantics, even when they deviate radically from traditional surface structure.

The paper revises and extends earlier CCG-based accounts of intonational semantics, grounding hitherto informal notions like "theme" and "rheme" (a.k.a. "topic" and "comment," "presupposition" and "focus," etc.) and "background" and "contrast" (a.k.a. "given" and "new", "focus", etc.) in a logic of speaker/hearer supposition and update, using a version of Rooth's Alternative Semantics. A CCG grammar fragment is defined which constrains language-specific intonation and its interpretation more narrowly than previous attempts.[*]

1. INTRODUCTION. The main claims of this paper concern the semantics of information structure—the part of sentence semantics that concerns the relation of utterance to discourse context and participant supposition concerning "common ground"—and its relation to surface grammar. The semantics is *surface-compositional* (Hausser 1984), in the sense that logical forms can be derived directly via surface-syntactic derivation, and constitute the only level of representation in the grammar. Surface compositionality follows from the fact that the semantics of intonation proposed here corresponds rule-to-rule with the syntax used to derive all other aspects of the semantics in the same surface-compositional fashion. Following Karttunen (1977) and Rooth (1985), the semantics further embodies a notion of *contrast* between the actual utterance and a set of *alternatives* afforded by the context of utterance.

1.1. INFORMATION STRUCTURE AND ITS MARKERS. Such an information-structural semantics must be grounded in the practicalities of human intercourse, and is presumably universally available in all languages. However, there is great cross-linguistic variation in the way the semantic distinctions in question are marked by grammatical devices such as syntactic construction, discourse particles, prosody, and the like (or remain unmarked).

In spoken English, information-structural distinctions are to an unusual degree conveyed by intonational prosody, which comprises a number of dimensions, including pitch contour and its alignment to syllabic boundaries, intensity, syllabic lengthening,

pausing, and so on. In other languages, some or all of the same semantic information may be conveyed by syntactic construction, morphology, and/or various discourse particles.

Across languages in general, markers of information structure are semantically and categorially among the least well-understood aspects of grammar. Semantically, almost all of their effects to which we have conscious access appear to be secondary implicatures arising from more primitive meaning elements relating to interpersonal propositional attitude, whose nature can only be inferred indirectly. The result is a confusing descriptive literature relating grammatical and intonational markers to various conflicting and overlapping semantic and pragmatic dimensions such as politeness, deixis, face, affect, commitment, and turn-taking, as well as often unformalized notions of "foregrounding", "backgrounding", and that most overloaded of terms "focus" (see Gundel 1999).

Categorially, markers of information structure are hard to identify because they are often found only in the spoken language, where they tend to be carried by elements that are hard to detect and classify. Examples are: complex prosodic events characterized by a number of interacting articulatory dimensions; ambiguous morphological affixes; unstressed and acoustically confusable monosyllabic adpositions and particles; or a combination of the above. The English intonational markers of information structure are no exception. Not only are the functional and semantic descriptions in the literature conflicting and incompatible. There is also no entirely satisfactory characterization of their acoustic, phonetic, or phonological form.

The most successful system for describing the English prosodic system is usually agreed to be the elegant autosegmental-metrical (AM) theory pioneered by Liberman (1975), and Pierrehumbert (1980), which describes contour solely in terms of a small number of compound tones defined in terms of as few as two abstract pitch-levels, high (H) and low (L), from which actual contours can be derived algorithmically. However, it remains unclear exactly how to invert the process, and map the speechwave onto such descriptions for purposes of recognition. That is because it is unclear exactly what invariants analysts are responding to when they report a particular contour in these terms (Calhoun 2010).

The present paper will follow Pierrehumbert and Hirschberg (1990) and Steedman (1990b, 1991) in arguing for a systematic relation between the semantic primitives that contribute to discourse information structure and the elementary abstract tones postulated in AM. In particular, the paper will argue that the primary function of all prosodic accents is to mark points of contrast with alternatives. It will further distinguish two families of prosodic accent types, which will be identified by their most frequently occurring members as the L+H* accent and its relatives, and the H* accent and its relatives, always bearing in mind that individual speakers may mark accent on dimensions other than pitch itself. These families of abstract accent types will be associated with a further "topic/comment" or *theme/rheme* distinction in discourse meaning. To that extent, the proposal resembles the claim in Jackendoff 1972:261 for a related discourse-semantic distinction between a "B accent" and an "A accent", together with a mechanism of "focus projection" to associate these markers with extended phrases and alternative sets (Selkirk 1984; Rochemont 1986; Selkirk 1990; Rooth 1985; Ladd 1996, 2008:218–221; Beaver et al. 2007; Beaver and Clark 2008).

However, the present theory differs from these precedents in two important respects. First, it identifies the theme/rheme distinction as marked by particular species of word-based accents, rather than by more extended contours. Second, the projection of

theme/rheme marking onto prosodic phrases and information-structural interpretations is achieved entirely by surface-syntactic derivation, rather than by any autonomous focus-projection mechanism.

It is important to be clear about the exact scope and limits of this claim. The claim is that, when speakers of English assign prosodic accent to a word, they do so on the basis of a number of elements of discourse-semantics, of which the most important is contrast. It is surface-syntactic derivation that projects such semantic elements to the the level of the intonational phrase, together with all the other kinds of semantic content, such as word-meaning, negation, and quantifier scope.

1.2. TONES AS ABSTRACT CATEGORIES. The fact that these discourse markers are identified with the abstract tone types of the AM theory like L+H* and H* should not be taken as a claim that F_0 pitch contour is the only relevant phonetic dimension, or that it is relevant for all speakers. It has been known since the work of Meyer-Eppler (1957) and Denes (1959) that pitch contour can be detected in whispered speech, from F_1 and F_2 (Higashikawa and Minifie 1999; Nicholson and Teig 2003). It is also evident that (at least) lengthening, alignment to syllabic boundaries, and height relative to declination are also involved, even to the extent of entirely excluding F_0 pitch variation in some speakers (Liberman and Pierrehumbert 1984; Ladd and Schepman 2003; Calhoun 2006, 2010; Katz and Selkirk 2011).

The reason for continuing to use the AM pitch-accent typology in this very abstract way, rather than using more neutral terms like Jackendoff's A and B, or Calhoun's R and T accents, is, first, that many speakers of many different dialects—particularly professional speakers such as lawyers and broadcasters (Pitrelli 2004)—do in fact use F_0 pitch as a principal prosodic marker. (The speaker who prepared the sound files for the examples discussed in this paper is one such.) Such pitch accents can also be successfully used in speech synthesis to convey information-structural distinctions (Prevost and Steedman 1994; Cassell et al. 1994). Second, the AM notation is abstract enough to allow capture of significant generalizations over a large number of other, quite different, theme/rheme tunes involving *other* less fugitive AM accent types. (For example, L* is identified below as a rheme accent, like H*, while L*+H is a theme accent, like L+H*). It is thereby possible to identify a number of further dimensions of discourse meaning that are systematically marked in English prosody, independent of speaker-dependent variation in their realization.

It has proved remarkably hard to define objective acoustic invariants that discriminate these two accents. One reflex of this difficulty is that annotators trained using the ToBI definitions of the Pierrehumbert tones (Silverman et al. 1992) show quite poor inter-annotator reliability on the L+H*/H* distinction (Syrdal and McGory 2000; Wightman 2002). Part of the problem seems to lie with the instructions in the ToBI annotation manual (Beckman and Hirschberg 1999). One distinguishing characteristic of the L+H* accent is that the rise to the pitch maximum is *late*, beginning no earlier than onset of the vowel in the accented syllable. H* accents typically begin to rise earlier, in many cases much earlier. Calhoun (2006, 2010) has shown using both elicitation and recognition studies that the H*/L+H* distinction involves a number of other factors, including relative height and lengthening, of which she claims relative height to be the most important. The definition of L+H* in the manual as "a high peak target on the accented syllable which is immediately preceded by relatively sharp rise from a valley in the lowest part of the speaker's pitch range" does not make this entirely clear and may contribute to dubious classification, as shown in Taylor's TILT analysis of annotation in

ToBI corpora (2000:1710, fig.4).

Recent work in the ToBI framework has begun to address this problem, by introducing an "alternate" tier of annotation to allow multiple annotation (Veilleux et al. 2006; Brugos et al. 2008). However, multiple annotation merely exposes the problem, rather than solving it. Faute de mieux, the instructions to ToBI annotators remain pitch-track based, and the system is very fairly characterized by Beckman et al. (2005) as "an ongoing research program, rather than a set of 'rules' cast in stone." (The scare quotes are theirs.)

Not surprisingly, studies using ToBI-annotated corpora that have attempted either to show consistent acoustic differences between the H* and L+H* accents as annotated (e.g. Taylor 2000:1711, fig.5), or to correlate the annotators' accent labels with consistent discourse functions (e.g. Hedberg and Sosa 2006), have often proved inconclusive or contradictory (see Steedman 2007 for some discussion). Other studies that have used experimental materials generated according to ToBI guidelines have raised related questions concerning tone identification (e.g. Ito and Speer 2008; Welby 2003, although in these particular cases the L+H*/H* confound is sufficiently systematic to make the results still interpretable). Yet other studies have admitted quite unnatural-sounding materials. Sound files for all of the examples in this paper are accordingly made available.[1]

A further reason for difficulty in interpreting the studies that do show systematic differences (e.g. Watson et al. 2008) is the absence of consensus as to exactly what semantic distinctions the tones mark, and what dimension should therefore be controlled experimentally (see Calhoun 2006 for a review).

The study in Katz and Selkirk 2011 is unusual in manipulating the context of utterance so as to control information structure in read sentences. This is done in order to investigate phonetic correlates of an information-structural distinction between what the authors call "contrastive focus" and "discourse-new" status of referring expressions. Contexts supporting contrastive focus readings are those which include explicit mention of the members of a set of alternative potential referents of the same type. Contexts not including an explicit mention of such alternatives support discourse-new readings. The sentences read for elicitation included two successive referring expressions. The contexts came in three species, supporting the referential patterns *focus-new, new-focus*, and *new-new* for each sentence.

These authors' definitions of focus and new are not the same as the present definitions of theme and rheme. However, all of the contrastive foci in their target sentences appear to be likely to be interpreted in context as themes under present definitions, and all of their discourse new targets, as rhemes. Although Katz and Selkirk's results do not permit any conclusions about a putative L+H*/H* difference in elicited pitch contour (2011:788), they did find a strong increase in average elicited duration of contrastive foci in comparison to discourse-new (2011:793,tbl.2—cf. Büring to appear).[2]

These uncertainties concerning the empirical basis for the AM distinctions have led some critics to argue that they are illusory. However, the prevalence of ambiguity and paraphrase in the rest of the grammar—for example as exhibited by the existence of homophonous words like "bear" in English—does not cause us to similarly question the categorial distinction between noun and verb. The reason for our continued faith in such categories seems to have something to do with our conviction that there is an

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[1] See http://homepages.inf.ed.ac.uk/steedman/soi.html.

[2] To further pursue the putative L+H*/H* distinction would require looking at further aspects of the elicited contours, of the kinds discussed by Calhoun, notably alignment.

important semantic distinction behind them.

The present paper accordingly attempts to address the uncertainties in the phonological accounts of intonation structure by advancing our understanding of the discourse semantics that it conveys, inspired by the reflection that our understanding of syntactic structures (and the acquisition of language-specific grammars by children) depends on access to some important insights into the meanings that they convey.

It follows that this paper stands or falls empirically on the correctness of its account of information structural semantics, for example by delivering all and only the attested readings arising from non-final accent, or the "association with focus" of particles like "only". It does not depend on the AM distinctions between the corresponding phonological markers, which are often (particularly by non-native speakers) so reduced as to be completely ambiguous, and are here used only to aid comparison with the soundfiles and the reader's intuitions concerning the intended semantic distinctions.

1.3. OUTLINE. The remainder of the article is divided into three main sections. In section 2, many of the diverse discourse meanings and functions that have been attributed to the intonational tunes of English, related to such dimensions as politeness, deixis, affect, commitment, turn-taking, and the like, are argued to arise indirectly, via inference from more primitive components of literal meaning distinguished along four dimensions, namely: (i) *contrast*, (ii) *information-structural role*, (iii) *claimed presence in (or absence from) the common ground*, and (iv) *claimed speaker/hearer agency*. This section is deliberately informal, intended to provide intuitive motivation for what follows, and orientation to a very diverse and conflicted descriptive literature.

In section 3, a formal semantics for these elements is sketched, building on the Alternative Semantics of Rooth (1992), Schwarzschild (1999), and Büring (2003). A further claim is that indirect speech acts, including those arising from intonation, have their effect not via invocation of a "Cooperative Principle," of the kind proposed by Grice (1975), or of attendant maxims, including the "super-maxim" or "Principle of Relation" (to which Sperber and Wilson (1986) reduce Grice's other maxims), nor from the literal expression of rhetorical relations of Mann and Thompson (1987) and Green and Carberry (1999), but rather from a more primitive principle of maintenance of consistency in the hearer's representation of shared context or common ground. (This idea is in turn related to that of truth- or belief- maintenance as it is used in artificial intelligence (see Gärdenfors 1992 for reviews), to which these other notions appear to be reducible, although the general problem of commonsense reasoning of course remains open.)

Section 4 is the core of the paper, in which the alternative semantics of information structure is extended and integrated with a base-generative theory of grammar proposed in Steedman (2000b) (hereafter, *SP*) for the standard bounded and unbounded syntactic and semantic phenomena of English. This theory is used to unify intonation structure with surface-syntactic derivational structure, and to subsume information structure to surface-compositional logical form of the kind proposed in Steedman (2012) (hereafter, *TS*) for standard word-meaning and quantification. By linking information structural scope to syntactic derivation, this account solves an an open problem for standard alternative semantics accounts first noticed by Wold (1996). Section 5 reviews some further ramifications, and draws some conclusions.

2. I NTONATION AND INFORMATION STRUCTURE.

2.1. A CCENTS. The term "accent" is here restricted to what Bolinger (1986) and Ladd (1996) call "primary" accents. Primary accents are distinguished from other maxima that arise from the alignment of lexical stress with the metrical grid treated in section 5.2.3. Primary accents have *more* pitch excursus, intensity, delay, or whatever a given speaker uses to mark accent than would be predicted from their grid position (Calhoun 2006, 2010). While there is still no objective measure to distinguish the two varieties, it is the primary accents that are perceived as emphatic or "contrastive," in a sense to be defined later.

Accents, however they are realized phonetically, are widely assumed to be properties of the *words* that they fall on, as is suggested by their informal reflection in the orthography by devices applying to the word itself, such as italicizing, underlining, capitalizing, and the like. The present claim is that, in English, accents contribute to the meaning of words and phrases along three independent dimensions, namely: (i) *contrast* with other meaning elements, (ii) *information structural role* with respect to the discourse context, and (iii) claims concerning relations to *the common ground*. We will consider these dimensions in turn.

2.1.1. A CCENT AND CONTRAST. In English (and very many other languages), primary accents mark the interpretations of words as contributing to the distinction between the speaker's actual utterance and other things that they might be expected to have said in the context to hand, as in the Alternative Semantics of Karttunen (1976), Karttunen and Peters (1979), Wilson and Sperber (1979), Rooth (1985, 1992), and Büring (1997b), as it is deployed in Steedman 1990b, 1991, 2000a, 2007, and below.

This is to say that all accents in English are *contrastive*. For example, in response to the question "Who was that lady I saw you with last night?", the word that distinguishes the following answer from other possible answers is "wife", so the following intonation is appropriate.[3]

(1) That was my W IFE .
                 H*   LL%

The set of alternative utterances from which the actual utterance is distinguished by the tune is in no sense the set of all those appropriate to this context, a set which includes indefinitely many things like "Mind your own business," "That was no lady," and "Lovely weather we're having." The alternative set is rather a set of propositions which the speaker *defines by the form of the utterance*, in this case as a set of propositions of the form "The one we are talking about was X".

The above should not be taken to imply that such alternative sets are confined to things that have been mentioned, or that they are mentally enumerated by the participants—or even that they are bounded sets. While a distinction is often assumed between "contrastive focus", where the alternative set is known and bounded, and "noncontrastive focus", where it is unknown and/or unbounded, the observations of Bolinger (1961), Cutler (1977), and much subsequent work including Breen et al. 2010, make it seem unlikely that such a distinction is semantically or phonologically real.[4]

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[3] The notation for tunes is Pierrehumbert's (see Pierrehumbert and Hirschberg 1990 for details, including intuitively accessible idealized graphical representations of all the prosodic contours discussed here, some of which are not intuitively obvious from the notation (1990:281). See Liberman and Pierrehumbert (1984) and Calhoun (2010) for discussion of the complex and varied ways in which these patterns are realized and distinguished in acoustic terms, not all of which use pitch as such.

[4] See Gussenhoven (2007) for a dissenting view.

In terms of Halliday's 1963; 1967a; 1967b given/new distinction, accents are markers of "new" information, although the words that receive accent may have been recently mentioned, and they might better be thought of as markers of "not-given" information (cf. Prince 1981). The latter locution seems a little cumbersome, as does the related "contextually bound/unbound" distinction of Hajičová and Sgall (1988), so the term "contrast" will be used to refer to this property of English words bearing accents, denoting Vallduví and Vilkuna's "kontrast", rather than the narrower (and contested) sense of "contrastive focus" mentioned above.[5]

PROJECTION. Rooth (1985) noted that the "projection" of focus or contrast in this sense onto constituents which include the accented word, like *my* WIFE in (1), appears to be immune to the "island" effects that limit syntactic extraction and universal quantifier scope inversion. His evidence rests in part on the fact that certain "focus particles", notably "only" in English, "associate with focus" in the sense that their contribution to the meaning of the sentence depends on the position of accent. For example, (2a) seems to mean that the speaker introduced Bill and no one else to Sue, whereas (2b) seems to mean that they introduced Bill to Sue and to no one else. Clearly, these interpretations have different truth conditions.

(2) a. I only introduced BILL to Sue.
    b. I only introduced Bill to SUE.

This association between "only" and the accented item appears to be insensitive to intervening island barriers:

(3) a. They only asked whether I knew the woman who chairs the ZONING board.
    b. #Which boards did they ask whether you knew the woman who chairs?

(4) a. The committee only recommended that JOHN should be appointed.
    b. At least one committee member recommended that each/every candidate should be appointed. $(\geq 1 \, \forall / \# \forall \geq 1)$

Rooth also points out (1996:283) that in this respect, focus resembles the indefinites and other nonuniversal quantifier determiners, which also appear to take wide or narrow scope regardless of islands:

(5) a. Every committee recommended that *one candidate* should be appointed.
    $(1\forall / \forall 1)$
    b. Every committee member asked whether I knew the woman who chairs *some governing board*. $(\exists \forall / \forall \exists)$

On the basis of the same island-immunity of wide-scope readings, *TS* argues that indefinites should not treated as existential quantifiers at all, but should rather be interpreted strictly in situ as terms denoting individuals—specifically, dependent individuals in the case of narrow-scope existential readings, and free individuals in the case of (so-called) wide scope existential readings, in a sense to be explained below. The present paper argues for a similarly strict in situ theory of contrast.

PRINCE'S TAXONOMY OF GIVENNESS. The requirements within the nounphrase for accent and non-accent in terms of alternative sets are somewhat subtle (Prince 1981;

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[5] In Steedman 2000a and earlier work, this property was regrettably referred to as "focus", following the "narrow" phonological sense of Selkirk (1984), and Rochemont and Culicover (1990). However, this term invites confusion with the "broad" sense intended by Hajičová and Sgall (1988) and Vallduví (1990), which is closer to the term "rheme" as used in the present system, and in Steedman 2000a and Vallduví and Vilkuna 1998. This usage has caused considerable confusion—e.g. Pulman 1997b:85—and is avoided here, except when referring to the work of others using the term.

Rooth 1992; Schwarzschild 1999; Büring 2003). (6a), with its phrase-final pitch accent, can be uttered "out-of-the-blue"—that is, without any prior context-setting utterance, and without the hearer needing to accommodate some such setting. It merely contrasts an individual with a pink Cadillac with some set of alternatives, regardless of whether they own a Cadillac, or anything pink, or even (local statutes permitting) whether they are men.

(6) a. Anna married a man with a pink CADILLAC
     b. Anna married a man with a PINK Cadillac.
     c. Anna married a man with a PINK CADILLAC.

On the other hand, an utterance like (6b) cannot be uttered out-of-the-blue in the sense defined above, and is only appropriate to a discourse context where all the alternatives can be distinguished by the color of their Cadillac, as when someone has asked "Did Anna marry the man with the red Cadillac?" (cf. Schwarzschild 1999:146). Under such circumstances, the Cadillac-owning property is, in the terms of Prince 1981:236, not merely given, but "evoked."[6]

If it isn't the case that all alternatives have been textually restricted to Cadillacs, as when the question was "Did Anna marry the man with the red Buick?", then "Cadillac" must get an accent, as in (6a). However, the mere presence of an owner of a red car among the alternatives under discussion after the latter question is still not enough to force an accent on "pink," as in (6c). If the property of having a Cadillac is enough to uniquely distinguish the individual in question (that is, if there is no one around with a Cadillac of any other color), then the claim that the property *pink* is given will be accommodated, and (6a) will also work as an answer. (On the other hand, if an accent *is* applied in such a context, as in (6c), then the implied contrast will also be accommodated, since it is not inconsistent to accomodate an alternative set of individuals distinguished in that way.)

However, it is by no means the case that deaccented material to the right of a non-final accent is always evoked in Prince's sense. In examples like the following, the adjunct merely performs Prince's function of "anchoring" the (new) referent to some other given discourse referent via a default property of guys, namely that one meets them:[7]

(7) Anna married some GUY she met.

As a consequence, (7), unlike (6b), can be uttered out-of-the-blue.

Thus, under the present theory, as for Rooth 1992, extension to specific alternative sets arises from a combination of semantic and pragmatic factors.

2.1.2. ACCENT AND INFORMATION STRUCTURE. A second dimension of Information Structure, on which the literal meanings of the various accent types are further distinguished, has been identified in the literature under various names. Here we distinguish "theme" and "rheme" components of the utterance, using these terms in the sense of Bolinger (1958, 1961), rather than Halliday.

THEME VS. RHEME. We can begin to analyze the notions of theme and rheme in terms of the the more primitive concept of common ground, originating with Stalnaker (1979).

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[6] The function of evoked unaccented nouns seems to be very much like that of the pronoun "one" in examples like the following:

(i) She married a man with a PINK one.

"One" refers to an entity of an evoked type, just as the unaccented noun "Cadillac" does in (6b).

[7] See discussion of "superman sentences" (82), below. In contrast to evoked properties (see note 6), anchoring adjuncts can often simply be omitted entirely.

This notion is related to various notions of mutual belief, or "co-presence" proposed by Lewis (1969), Schiffer (1972), Cohen (1978), Clark and Marshall (1981), Cohen and Levesque (1990), Hobbs (1990), Jacobs (1991), Clark (1996), Ginzburg (1996), Poesio and Traum (1997), Pulman (1999), Thomason (2000, 2001), and Stone (1998, 2004).[8]

The present paper follows Stalnaker and Thomason in assuming that common ground consists in *a set of propositions that a given conversational participant supposes to be mutually agreed to for the purposes of the conversation.* This set of supposedly agreed suppositions is *distributed* in the sense that it exists in multiple copies, each private to one participant, and each developing independently. It should not be thought of the set of propositions that all participants actually believe. In fact, it is an extremely small set of propositions, and each participant's version of it may be (somewhat) different, and all are constantly changing. The way that one participant's version of common ground is changed is by some participant *claiming* either that someone supposes (or fails to suppose) some element to already be common ground, or that someone makes (or fails to make) a new element common ground, whether or not they actually do so.

In the simplest case, the speaker's claims about the common ground are consistent with the hearer's current version of it. The first examples below are of this simple kind, where the speakers' claims are so unobtrusive as to do little more than veridically update the common ground. However, the speaker may also make claims about contents of the common ground which the hearer recognises as false, giving rise, as we shall see, to indirect effects.

In these terms, we can informally define theme and rheme as follows:

(8) a. A theme is a part of the meaning of an utterance that the speaker claims some participant in the conversation supposes (or fails to suppose) *already is* in common ground;

b. A rheme is a part of the meaning of an utterance with which the speaker claims some participant in the conversation *updates* (or fails to update) common ground.

This opposition is reminiscent of Gussenhoven's 1983:201 opposition between SELECTION versus ADDITION of items to the background, and to Brazil's 1975; 1978; 1997 opposition between REFERRING TO and PROCLAIMING elements of common ground. The present proposal differs from theirs in treating common ground as involving update, and in including the further dimensions of *speaker/hearer agency* in acting upon the common ground, and *success or failure* of such actions.[9]

Pierrehumbert and Hirschberg's account of H* and L+H* is also related. H* is associated by them with both "new" information or contrast, and update rhematic function, in present terms (1990:289-290). L+H* is associated with Jackendoff's B accent, as "a particular instantiation of the open proposition [i.e. theme] with an item chosen from a salient scale".[10]

This second dimension of information structure, and two of the prosodic contours that distinguish theme and rheme, are illustrated by the following minimal pair of dialogs, in which in each case the preceding discourse including the *wh*-question in Q establishes

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[8] It seems likely that the notion of Relevance can also be reduced to a notion of common ground in the sense in which that term is used here, although Sperber and Wilson (1986) seem to resist such interpretations.

[9] Gussenhoven also identifies a dimension of *(relevance) testing*, while Brazil identifies further dimensions of *dominance, control, questioning*, and *social control*. These dimension are excluded from the present system, in which the relevant effects are claimed to emerge as indirect entailments or implicatures of a literal meaning confined to attributing agency and success in supposition and update over the common ground.

[10] It is not clear what the notion of scale adds to the present relation of simple contrast between *Manny* and *Arnim* in (9) and (10), but the general idea is similar.

a context limiting the range of alternative sets that can be evoked in the response A:[11]

(9) Q: I know EMMA will marry ARNIM. But who will marry MANNY?
   A: (ANNA) (will marry MANNY).
      H*   L+H*   LH%

(10) Q: I know EMMA will marry ARNIM. But who will ANNA marry?
   A: (ANNA will marry   ) (MANNY).
      L+H*   LH%   H*   LL%

The claim, as in Steedman 1991, 2000a, is that the L+H* LH% tune is one of several discussed below that mark the theme or topic in English, while H* LL% and H* are among the tunes that mark English rheme or comment. Themes of this kind with contrastive accent are called "contrastive topics" (*CT*) by Büring 2003, while what are referred to here as rhemes are called "foci" (*F*).[12]

Switching the two tunes within either of the two responses, even while keeping the position of the two accents the same, makes the answers quite hard to comprehend (Liberman and Pierrehumbert 1984 and much subsequent literature):

(11) Q: I know EMMA will marry ARNIM. But who will marry MANNY?
   A: #(ANNA will marry   ) (MANNY).
      L+H*   LH%   H*   LL%

(12) Q: I know EMMA will marry ARNIM. But who will ANNA marry?
   A: #(ANNA) (will marry MANNY).
      H*   L+H*   LH%

To say this much is not to claim that wh-questions *uniquely determine* a responder's theme and rheme and the associated intonation contours. The speaker may choose to establish their *own* theme and rheme *by the form of their response*, as in the following alternative to (10):

(13) Q: I know EMMA will marry ARNIM. But who will ANNA marry?
   A: (ANNA   ) (will marry MANNY).
      L+H* LH%   H*   LL%

Since the fact that we are talking about *Anna marrying* as opposed to *Emma dating*, upwardly entails that we are talking about *Anna* as opposed to *Emma*, the hearer can to accomodate the speaker's decision that Anna (as opposed to someone or anybody else) is the theme and marrying Manny (as opposed to someone or anybody else) is the rheme.[13]

Thus, as in the case of contrast, the theme of an utterance also is partly speaker-determined, rather than purely context-based. It is therefore to be distinguished from the discourse-pragmatic notion of "question under discussion" (QUD), as it is used by Ginzburg (1996), Roberts (1996), and Büring (2003)), which (as Roberts (2012a) makes clear) is a distinct notion of intersentential discourse structure. rather than of intrasentential information structure. The QUD in Roberts' discourse-pragmatic sense may limit, but does not fully determine, the speaker's semantic information structure.[14]

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[11] Earlier papers on intonation in CCG frameworks mark the internal boundary in examples like (9A) as an L intermediate boundary. However, such a boundary would not normally be detectable in the pitch track, and the present paper does not assume the existence of any such inaudible boundaries—see discussion of rule (71) below.

[12] Lambrecht and Michaelis (1998) call such "marked" or "contrastive" themes "ratified topics", while von Fintel (1994) calls them "Sentence Topics."

[13] Cf. Rooth (2005). We shall return to the question of speaker-defined information structure in connection with criticisms by Joshi (1990) and Pulman (1997a) of earlier versions of the present proposal.

[14] For example, out-of-the-blue warnings like "Your TROUSERS are on fire!" are licensed whatever question

It will be convenient for the time being to refer respectively to these two information-structural functions of pitch accents and related prosodic markers as the "thematic" and "rhematic" function, and to indicate their scope in sentences with θ and ρ. The position of the accent or accents within the theme and rheme phrases coincides with those words which contribute contrast, and distinguishes the uttered theme or rheme from any others that are contextually consistent.[15]

A great deal of the huge and ramifying literature on information structure can be summarized as distinguishing the two dimensions corresponding to the background/contrast and theme/rheme distinctions outlined above, although this consensus may have been obscured by the numerous superficially differing nomenclatures that have been applied.[16]

2.1.3. ACCENT AND REALIZATION IN COMMON GROUND. There is one further dimension of discourse meaning along which the accent types are distinguished about whose interpretation there has been much less agreement in this literature. It concerns whether or not some participant *supposes the theme already to be present in common ground*, or *succeeds in making the rheme so present*. We will exploit an ambiguity of the English language in referring to these two achievements as *realization* on the part of some participant with respect to the common ground.

This dimension of intonational meaning is illustrated by the following minimal pair of utterances:

(14) a. You put my TROUSERS in the MICROWAVE!
                    H*   H*   LL%
       b. You put my TROUSERS in the MICROWAVE?
                    L*   L*   LH%

In the first of these, the speaker marks the proposition as becoming common ground. The nature of this claim makes it work as a bald assertion of the speaker's supposition, although of course world knowledge about trousers and microwaves may make it act indirectly as a mild protest or accusation (among other possibilities). In the second example, the speaker marks the proposition as *not* becoming common ground. (Notice that this does not exclude the possibility that in fact both speaker and hearer know the fact in question). The effect in context is typically to make the utterance imply something like "Surely you didn't put my trousers in the microwave?" , "I can't believe you put my trousers in the microwave," or "You didn't put my trousers in the microwave, did you?".

We shall see later exactly how this works, but it is worth noting that the absence from common ground denoted by low accents like L* is more than mere logical negation. While someone who utters (14b) claims that the proposition fails to become common ground, there is a presupposition that someone, somewhere, *thinks it should be*.[17]

is under discussion, including none at all.

[15] A reviewer has drawn attention to Constant 2006 and Wagner 2008, who reject any distinction between theme/*CT* and rheme/*F* in favor of an account based on nested multiple foci (that is, rhemes) and the assumption that *CT/F* interpretations arise from unpronounced focus operators analogous to "only" and "also", discussed in section 4.3.2, among some other assumptions. We return briefly to this account in section 5.1.2 below.

[16] See discussion of figure 1 in Kruijff-Korbayová and Steedman 2003, which summarizes the terminology and its lines of descent, along with some contiguous influences from formal semantics.

[17] The effect of the L* accents is reminiscent of Freud's 1925 observations concerning the significance of negation in psychoanalysis, where denial of a proposition is often evidence of its relevance: "Thus the content of a repressed image or idea can make its way into consciousness, on condition that it is *negated*. Negation is a way of taking cognizance of what is repressed . . .".

2.2. BOUNDARIES. The scope or phrasal extent that the themes and rhemes marked in this way are projected onto is determined by the effect of prosodic *boundaries* in derivations. In contrast to accents, we will assume boundary tones to be autonomous string elements, independent of the words with which they coarticulate (which may include quite distant accents), as is suggested by their realization in the orthography via independent string elements, such as punctuation.

Boundary tones contribute a further component of prosodic meaning, concerning the role of speaker or hearer as *agents* of supposition or update with respect to the common ground.

2.2.1. BOUNDARIES AND SPEAKER-HEARER AGENCY. The claim is that boundaries fall into two classes, respectively distinguishing the speaker or the hearer as the one who is claimed to either succeed or fail in supposing/causing the theme/rheme to be common ground. For example, with the LL% boundary in (14a) the speaker claims *they* make the proposition common ground, while by using the LH% boundary tone in (14b) they claim the proposition to *not* be made common ground *by the hearer*.[18]

According to the present theory, the questioning illocutionary force of the latter utterance stems from the fact that if the speaker claims that the hearer does not make the proposition common ground, then (whether or not the hearer is in fact already aware of the proposition), some further action on the hearer's part to maintain consistency of common ground is called for. The further implicature of question force arises from real-world knowledge about a specific act of putting trousers in a microwave, and the fact that a good way for the hearer to make good on a supposed failure to make that true fact common ground is not just to confirm it, but to explain *why* they did it. This of course is what the speaker is trying to get them to do, and accounts for the indirect accusatory force of such utterances.

Gussenhoven (1983:201) and Gunlogson (2001, 2002) talk in this connection of the speaker or hearer being "committed to" a proposition (see discussion in Šafářová 2005, who regards the relevant dimension as "uncertainty"). The present paper argues that all of these notions are entailments of to claims of speaker/hearer agency in supposition concerning, or update to, the common ground.[19]

The various species of boundary can combine freely with the various species of accent, and it is instructive to consider the effect of exchanging the boundaries in (14):

(15) a. You put my TROUSERS in the MICROWAVE?
                      H*   H*   LH%

      b. You put my TROUSERS in the MICROWAVE!
                      L*   L*   LL%

For Standard American English (SAE) speakers, (15a) is only appropriate as an echo question (Ladd 2008:113-4). If someone has already announced that they put your trousers in the microwave, then it is appropriate for you to claim that the hearer succeeds in making the proposition common ground. This rather redundant utterance therefore has the effect of calling for further confirmation by the hearer, and hence may entail disbelief, despite its declarative form. (Nilsenová (2006) makes a related point concerning final rise declaratives in SAE).[20]

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[18] Pierrehumbert and Hirschberg consider boundaries such as LH% as composed of two tones, the phrasal tone L and the boundary tone proper H%. They interpret H% boundaries as indicating that the phrase so bounded is to be interpreted "with respect to subsequent utterance" or as "forward referring" (1990:305-306).

[19] In Steedman 2000a, this dimension of speaker/hearer supposition was referred to more vaguely as "ownership".

[20] British English (BE) speakers use the H*LH% contour more widely, to mark out-of-the-blue yes-no

With the quite rare intonation contour (15b), on the other hand (which would often be realized with the H+L* variant of the L* accent) the speaker claims they themselves *fail* to make the proposition common ground. The implication is that they are having difficulty in reconciling themselves to the fact, so that in many contexts it carries the further implicature of displeasure at the action.

2.3. UNMARKED THEMES VS. ALL-RHEME UTTERANCES. In many cases, there is only one theme in play, and it is known to all participants. In these cases, the theme typically lacks accent. For example, the following responses to the questions in (9) and (10) are possible:

(16) Q: I know Emma will marry ARNIM. But who will marry MANNY?
   A: (ANNA)$_\rho$ (will marry Manny)$_\theta$.
      H*   LL%

(17) Q: I know EMMA will marry ARNIM. But who will ANNA marry?
   A: (Anna will marry)$_\theta$ (MANNY)$_\rho$.
                              H*   LL%

Such unaccented themes are referred to as "unmarked". Sentences with unmarked themes are ambiguous as to the information-structural division into theme and rheme, and it is assumed here as in earlier papers that the following answers, including the "all-rheme" utterance (18c) that is appropriate to the "out-of-the-blue" context, are not phonologically distinct from (17).[21]

(18) a. Q: What will Anna do?
         A: (Anna will)$_\theta$ (marry MANNY)$_\rho$.
                              H*   LL%
      b. Q: What about Anna?
         A: (Anna)$_\theta$ (will marry MANNY)$_\rho$.
                              H*   LL%
      c. Q: What's new?
         A: (Anna will marry MANNY)$_\rho$.
                              H*   LL%

In English, rheme accents including those in all-rheme utterances can in some cases occur non-finally, just in case the post-accent material is established or can be accommodated as background given the subject (Bolinger 1972a). For example, the following all-rheme example succeeds as an out-of-the-blue rheme to the extent that calling is accepted as a characteristic or default activity of distant mothers:

(19) Q: What's new?
   A: (Your MOTHER called)$_\rho$.
               H*   LL%

questions, including those which constitute indirect requests.
   (i) a. Is your MOTHER home ?
                H*   LH%
        b. Can you pass the SALT ?
                          H* LH%
Such requests sound aggressive to SAE speakers. The difference appears to reflect different, possibly conventionalized, cultural attitudes towards the propriety of claims about others' success in establishing common ground.
   [21] That is not to deny the possibility of phonetic differences, but merely to claim that any that exist are not categorial.

This all-rheme utterance seems indistinguishable in contour from an answer to the question "Who called?".[22]

It is presumably the difficulty of accomodating any parallel presupposition that causes most hearers to reject a similar intonation contour for examples like the following, discussed in rather different terms in Ladd 2008:245:[23]

(20) #JESUS wept

Schmerling (1976:41-2) famously contested Bolinger's claim by reporting the following different ways in which the deaths of two ex-presidents were announced to her in the early '70s, by her mother and her husband, respectively:

(21) a. Truman DIED.
      b. JOHNSON died.

Schmerling's point was that Truman's death came at the end of a widely reported illness, and was widely expected, whereas Johnson's death a few weeks later came when his health was not a public concern, and was unexpected. Since Truman's death was in that sense "predictable", and Johnson's was not, Schmerling claimed that Bolinger would predict that the contours would be reversed.[24]

This claim was indignantly denied by Bolinger (1977:10-1; cf. 1989:431), who noted that under the circumstances described, it was legitimate for the speaker to assume Truman to be *discourse*-predictable in the sense of being already common ground, hence unaccented, and that the alternatives in view were his dying or not. By contrast, it was equally legitimate to assume that Johnson was not common ground, and to further assume (or, more likely, affect heartlessly to assume) that dying is is a characteristic activity of ex-presidents from whom one hasn't heard for a while.[25]

In present terms, (21b) is an all-rheme utterance entirely parallel (apart from the dismissive character of the presupposition) to (19). Related all-rheme non-final accented utterances can have additional unaccented final adjuncts, as in:

(22) JOHNSON died yesterday.

However, the possibility of such subject-accented all-rheme utterance in English is in other respects very restricted, as Bolinger pointed out. It does not appear to extend to fully transitive examples like the following, which seems to be acoustically identical to (16), and has the same pitch contour as (19), but cannot be uttered out-of-the-blue:[26]

(23) Q: What's new?
     A: #(ANNA married Manny)$_\rho$.
              H*   LL%

In particular, lexically-headed referential objects, including proper names, and other referential arguments such as PPs, seem to be entirely incompatible with such utterances, to which we return in section 4.2.[27]

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[22] Cf. note 21.

[23] Ladd suggests that one factor contributing to the difference between (21)b and (20) is the involvement of an unaccusative verb in the former. However, examples like (19) show that this intonation pattern is not in fact limited to unaccusatives.

[24] Somewhat inconsistently, Schmerling separately makes the very Bolingerian claim (1976:93) that the difference was whether the president in question could be assumed to be "on the addressee's mind."

[25] Zubizarreta 1998:69 makes essentially the same point concerning (21a).

[26] The following alternative seems equally inappropriate out-of-the-blue:

(i) A: #(Anna MARRIED Manny)$_\rho$.
                H*   LL%

[27] Apparent exceptions like the following transitives appear to depend on the involvement of Prince's deictic *anchoring* function—see section 2.1.1:

2.4. ALL-THEME UTTERANCES. We have seen that all-rheme "out-of-the-blue" utterances are widespread. Somewhat surprisingly, "all-theme" utterances are also common in English.

The use of the L*+H accent in marking an all-theme utterance as not supposed to be common ground is vividly illustrated by the following example, which has been discussed extensively by Ward and Hirschberg (1985) (see Pierrehumbert and Hirschberg 1990:295, (26); Steedman 2007):

(24) H: Harry's such a klutz.
       S: He's a good BADMINTON player !
                       L*+H   LH%
       "You do not suppose it to be common ground that he's a good badminton player"
       (implies *You seem to have forgotten that he's a good badminton player, (from which it follows that he is no klutz).*

In terms of the present theory, this all-theme utterance achieves its illocutionary force of contradiction by: (i) marking the utterance as a theme that someone fails to suppose to be common ground via the L*+H accent (even though the hearer may in fact already know that Harry is a good badminton player); (ii) claiming via an LH% boundary that it is the hearer who fails in this way; and (iii) leaving the hearer to infer for themselves on the basis of their world knowledge about badminton players the implicated rheme, that Harry is not in fact a klutz.

The contradiction is particularly effective, because (i) and (ii) between them distance the speaker from the inference, forcing the responsibility for inferring the implicated rheme on the hearer, and achieving the further implication that the earlier remark was ignorant. However, all of these effects are indirect, rather than being part of the literal meaning of the words or the accents and boundaries.[28]

Similar isolated themes have often been confounded, implicitly or explicitly, with rhemes (see Hedberg and Sosa 2006:ex20,21 and n3, and Hedberg 2006:n3 for a careful discussion), differing only from the same words uttered with an H*LL% tune in terms of "lack of commitment" (Pierrehumbert and Hirschberg 1990) or "uncertainty" (Šafářová 2005; Nilsenová 2006). However, it is important to notice that any such noncommitment or uncertainty concerns the entailment of whether Harry is or is not a klutz, rather than whether he is or is not a good badminton-player. This is consistent with the present theory, according to which such effects are indirect effects of the claim that the explicitly stated proposition is thematic—that is, already common ground—rather than rhematic or becoming common ground.[29]

Such isolated themes differ from the themes in examples like (9) and (10) in not

(i) a. Your MOTHER called you.
     b. The NAZIS did this to me.
     c. The DOG made a mess.

[28] The same exchange with an L+H* LH% tune has a very similar effect, but, by claiming that the hearer does suppose the proposition to be common ground, softens the implication of obtuseness to one of mere forgetfulness. On the other hand, the same response ending in an LL% boundary rather than LH%, thereby associating speaker agency with the supposition of ignorance, constitutes an even more forceful rejection:

(i) S: He's a good BADMINTON player !
              L*+H   LL%
     "I do not suppose it to be common ground that he's a good badminton player"
     (implies *You fail to realize that he's a good badminton player, (from which it follows that he is no klutz).*

[29] Such effects are extremely common in dialog corpora. Green and Carberry (1994) cite studies showing that about 13% of answers to Yes/No questions are indirect.

evoking a previously identified set of specific alternatives. In this respect the notion of contrast associated with the theme accent is entirely parallel to that of the rheme accent, in allowing both specified and unspecified alternative sets. In that sense, their existence confirms that there is no distinction between "constrastive" and "non-contrastive" accents—*all* accents are constrastive.

Such implicature-laden isolated themes often give rise to very vivid and memorable utterance. The all-theme contour was crucial in a television advertisement of the '70s for a well-known indigestion remedy. The scene includes a man and his noticeably unsympathetic wife. The man is morosely contemplating a large bowl that may have recently held spaghetti. The following exchange occurs:[30]

> (25) HE: I can't believe I ate the whole thing.
>
>   SHE: YOU   ATE it Ralph .
>   L+H* L+H*   HL%
>   "I suppose it to be common ground that you (as opposed to anyone else) ate it (as opposed to doing anything else)."
>   (implies: *You know perfectly well that you ate it, Ralph.*)

Another memorable all-theme utterance was produced by Col. John Brooks (retd.), known in Britain in 1974 as "The Spanking Colonel", who successfully sued a national newspaper for libel concerning the consensuality or otherwise of an incident involving the *au pair*. When asked by an underprepared television anchor whether he had indeed committed the eponymous act (which he had never disputed), he frowningly replied as follows, an unrepentant little smile playing over his lips:

> (26) Well,   YES .
>   L+H* LL%
>   "I suppose the affirmative to be common ground"
>   (implies: *You ought to know that I did.*)

3. A COMPOSITIONAL SEMANTICS OF INFORMATION STRUCTURE. So much for the natural history. How should a formal semantics be defined to support such intonational meanings?

3.1. BACKGROUND. Three kinds of theory have been proposed to address this question, and are reviewed at length in von Stechow 1991. The first and oldest is based on the idea of "structured meanings" (Cresswell 1973, 1985; von Stechow 1981; Krifka 1991, and, with reservations, Rooth 2010), which factors the focused expression into a pair of logical forms consisting of the focused phrase itself, and a property obtained by explicit λ-abstraction over the focused phrase.

The second approach is that of "alternative semantics" (Jackendoff 1972; Karttunen 1976, 1977; Karttunen and Peters 1979; Wilson and Sperber 1979; Selkirk 1984; Rooth 1985, 1992, 1996; Steedman 1991, 2000a; Büring 1997a, 2003, 2007, 2010; Schwarzschild 1999), which defines what Rooth calls the "focus semantic value" $[\![S]\!]^f$ as an "open proposition", in which the focus phrase is replaced by a (typed) free variable, defining a set of alternatives which instantiate that open proposition. The focus semantic value stands in contrast to the "ordinary semantic value" of the sentence $[\![S]\!]^o$. Since the open formulæ we are concerned with here are no longer confined to propositions, and may or may not include contrasted elements, it seems more helpful to refer to the former value as the "alternative" logical form.

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[30] A sound file for the full dialog is available at:
`http://homepages.inf.ed.ac.uk/steedman/whole_thing.wav`.

A third approach to information structure is associated with the transformational-generative theory of natural language syntax, and seeks to identity a focus position in underlying structure, related to the surface structural position by (overt or covert) transformational "movement" (Chomsky 1971; Jackendoff 1972; Rochemont and Culicover 1990; Erteschik-Shir 1997, 1998; Truckenbrodt 1999, 2007; Szendrői 2001, 2004; Neeleman and Szendrői 2004). Since the semantics of movement is essentially λ-abstraction, the latter approach is closely related to that of structured meanings.

The notion of narrow focus incorporated in these theories roughly corresponds to the present notion of *contrast*. Some of these authors, notably Büring (1997b, 2003), include a further topic/comment distinction, which, as he points out, corresponds to the present theme/rheme distinction. While there is considerable dialog among these positions (and some authors might even disagree with the place they have been assigned in the partition), they are technically distinct proposals, some defined at the level of logical form, or at the level of surface syntax, or both.

Nevertheless, all of them involve a mechanism distinct from syntactic derivation for "projecting" focus from accented words onto extended "wide" focus domains, and all appeal to some notion of *abstraction* over the focused element within the proposition, either in the form of λ-abstraction itself (or equivalent type-shifting) as a primitive operation, or in the definition of an open formula, or in movement operations whose implicit semantics corresponds to λ-binding, all of which are used to identify the background or presupposition by algorithmically searching the proposition for the focus.

The latter point is less clear in the case of the Alternative Semantics-based approaches, which are "in situ" theories of focus, founded on the very natural and appealing idea that it is the occurrence of the accent itself that somehow defines the set $[\![S]\!]^f$ of alternatives. However, the only fully successful attempt to formally define $[\![S]\!]^f$ for alternative semantics, by Rooth (2010), does so (with evident reluctance) in terms of structured meanings, using an abstraction algorithm.

There is something odd about all of these accounts. All of them apply some very heavy machinery to the ordinary semantic value of the utterance, in order to identify properties that *by definition* are so self-evident that in many cases they can be omitted entirely. It seems as though an in situ theory of focus worthy of the name should be able to take advantage of this fact immediately, at the time the accent is encountered.

The present paper offers a "strictly in situ" account, which differs from standard in situ theories in rejecting any idea of focus projection other than surface compositional syntactic derivation. It differs also in deriving alternative sets directly via the same surface derivation, eschewing all extraneous operations of abstraction, or equivalent movement or type-lifting. The scope of such derivational focus projection will be seen in section 4 to be limited by prosodic boundaries delimiting prosodic phrases, which as we saw in cases like (9) may or may not be marked by explicit prosodic boundaries.

3.2. SEMANTICS OF CONTRAST. We can capture such a version of Alternative Semantics by assuming that all logical forms of all linguistic elements come in pairs (Λ^o, Λ^a) consisting of an "ordinary" logical form Λ^o and an "alternative" logical form Λ^a, in which the constants c corresponding to words bearing an accent (if any) have been replaced by unique free variables of the same type τ_c as c. The latter is equivalent to Rooth's focus semantic value $[\![S]\!]^f$.

The free variables are "designated," in the sense that each is unique to the particular word token whose accent gave rise to them. We can then refer to the alternative set of

all contextually supported instantiations of Λ^a as $\{\Lambda^a\}$.[31]

For example, the alternative semantic content of the all-rheme example (1), *That was my wife* might be written as follows:[32]

$$(27) \quad \left\{ \begin{array}{l} \textit{was } sk_{\lambda x.\textit{wife } x \wedge \textit{mine } x} \textit{ that} \\ \textit{was } sk_{\lambda x.v_{\tau_{\textit{wife}}} x \wedge \textit{mine } x} \textit{ that} \end{array} \right\}$$

The logical form follows *TS* in assuming that definites and indefinites translate as *generalized Skolem terms*, rather than as existential generalized quantifiers. Skolem terms are widely used to eliminate existentials in automated theorem proving. *TS* describes at some length how generalized Skolem terms can be used to monotonically compute interpretations for quantified expressions, including "inverse" and/or"narrow scope" readings in which they are functionally dependent upon universal quantifiers in whose scope they fall. The present paper is confined to simpler examples confined to generalized Skolem *constants*, of the form sk_p, in which p is a property corresponding to the restrictor of a traditional generalized quantifier. Skolem terms can be thought of as unique *names* for the corresponding entities in the model.

The general idea behind the semantics of generalized Skolem terms in *TS*, simplified here to cover only simple definite and indefinite generalized Skolem constant terms, and extended to alternative-semantic free variables, is as follows.

A model $\mathfrak{M}$ for the present logical language L includes a *correspondence* $\mathscr{C}$ from the *objects* {anna, manny, … } and *relations* {man, marry, introduce, … } in $\mathfrak{M}$ into a set of *object symbols* {$anna, manny, …$} (not including any generalized Skolem terms or free variables), and a set of *relation symbols* {$man, marry, introduce, …,$} in L. The function $\mathscr{C}^{-1}$ on the range of the correspondence $\mathscr{C}$ is defined as the *inverse* of $\mathscr{C}$. Then:

1. The correspondence $\mathscr{C}$ *satisfies* a formula $Ra_1 … a_n$ in which R is a relation symbol in L and all a_i are object symbols in L in the standard way, if and only if the n-tuple $\langle \mathscr{C}^{-1}(a_1), …, \mathscr{C}^{-1}(a_n) \rangle$ is in the relation $\mathscr{C}^{-1}(R)$ in $\mathfrak{M}$.

2. The correspondence $\mathscr{C}$ satisfies a formula $Ra_1 … a_n$ in which in which R is a relation symbol in L and some a_i are generalized Skolem terms sk_{p_i} if and only if there is an interpretation for each Skolem term sk_{p_i} as an object symbol a'_i in L such that a'_i satifies the restrictor condition p of the skolem term sk_{p_i}, and when the Skolem terms sk_{p_i} are replaced by the object symbols a'_i, $\mathscr{C}$ satisfies $Ra_1 … a_n$.

3. The correspondence $\mathscr{C}$ satisfies a formula $Ra_1 … a_n$ in which in which R and/or some a_i are free variables v_{τ_R} and/or $v_{\tau_{p_i}}$ if and only if there is an interpretation for each free variable as a relation symbol R' or an object symbol a'_i in L such that, when the free variables are replaced by the relation and/or object symbols a'_i, $\mathscr{C}$ satisfies $Ra_1 … a_n$.

A number of complications for the model theory which need not detain us here arise from the interaction of these definitions with negation and the conjunctive logical connectives (see *TS*). Most important, since generalized Skolem terms have to be interpreted as object symbols in L, rather than being directly interpreted by the correspondence $\mathscr{C}$, the rules of the semantics given in *TS*:ch5 for formulæ involving logical conjunction $X \wedge Y$ and the conditional $X \rightarrow Y$ in L ensure that the *same* interpretation is

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[31] This mechanism replaces the terser * operator of Steedman (2000a).

[32] The anaphoric and deictic nature of the pronoun *that* is ignored here, as is any distinction between referential and attributive indefinites.

chosen for generalized Skolem terms in both X and Y. Exactly parallel conditions must also apply for the free variables v_{τ_p} introduced here.

Apart from those details, we can assume for present purposes that the rest of the model behaves much like a standard model for first-order predicate logic. For example, the ordinary logical form Λ^o in (27) holds just in case there is an object symbol, say *anna*, with the property $\lambda x.wife\ x \wedge mine\ x$, and who is the referent of "that". The alternative logical form Λ^a holds if there is an object symbol with a property $\lambda x.v_{\tau_{wife}}\ x \wedge mine\ x$, who is the referent of "that". The type of $v_{\tau_{wife}}$ might be as general as Montague's property type $e \rightarrow t$, or might be more restrictive, such as $lady \rightarrow t$.

The significance of the alternative logical form is that it defines an alternative set $\{\Lambda^a\}$ of propositions including Λ^o, some others of which may also hold in the model. The alternative set $\{\Lambda^a\}$ will come into its own in section 4, when we consider the effect of *only* in utterances like the following, which are standardly held in alternative semantic terms to mean something like "That was my wife, and no instance of Λ^a other than Λ^o holds."

> (28) That was only my WIFE.

First we need briefly to consider negation. In the context of the question "is there anything you don't eat?", it is natural to answer as in (29a):[33]

> (29) a. I don't eat red MEAT .
>   H*   LL%
>
>   b. $\left\{ \begin{array}{l} \neg eat\ sk_{\lambda x.meat\ x \wedge red\ x}\ me \\ \neg eat\ v_{\tau_{\lambda x.meat\ x \wedge red\ x}}\ me \end{array} \right\}$

Here the alternatives seem to be propositions about my not eating alternative comestibles, as in (29b). Note that these alternatives do not all have to be red, nor do they have to not be meat.

Negation is perhaps more commonly encountered in all-theme utterances like the following, which might be an alternative response to the question "Who was that lady I saw you with last night?":

> (30) a. That was NOT my WIFE .
>   L+H*   L+H* LH%
>
>   b. $\left\{ \begin{array}{l} \neg was\ sk_{\lambda x.wife\ x \wedge mine\ x}\ that \\ was\ sk_{\lambda x.v_{\tau_{wife}}\ x \wedge mine\ x}\ that \end{array} \right\}$

Here, unsurprisingly, given the contrastive accent on *not*, the alternatives seem to be (thematic) propositions about who it *was*.

Next, consider the following variant of (10):

> (31) Q: I know Anna dated a man with a red CADILLAC. But who did she
>   MARRY?
>   A: (Anna MARRIED) (a man with a big PINK Cadillac) .
>   L+H* LH%   H*   LL%

The LH% boundary splits the utterance into two intonational phrases and hence two information units, which the accents distinguish as usual as theme and rheme.

The alternative semantic content of the theme in the answer to (31) can be represented as in (32).

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[33] Since we are only dealing with Skolem constants here, we can ignore the question of polarity of Skolem terms, and the fact discussed in *TS*:ch11 that in the general case they have to carry markers of any negation operator whose scope they are in. A number of further simplifications to the semantics are made throughout the paper, including elimination of all details of tense, and mass/count distinctions in NPs.

(32) $\left\{ \begin{array}{l} \lambda x.married\ x\ anna \\ \lambda x.v_{\tau_{married}}\ x\ anna \end{array} \right\}$

The L+H* accent in (31) falls on the word *married* because that is the word whose content distinguishes *this* theme from one or more other potential themes, here *Anna dated*. Accordingly, its interpretation in the alternative logical form in (32) is distinguished by a free variable $v_{\tau_{married}}$ of the same type. Thus, $v_{\tau_{married}}$ is the alternative logical form equivalent of Selkirk's and Rooth's surface-structural narrow-focus marker *married*$_F$. This definition holds for the model established in the above discourse (31), in part because of the availability of an alternative theme to (32), namely $\lambda x.dated\ x\ anna$.

Of course, we saw at (17) that themes including this one may not, and in fact usually do not, bear any accent at all, as in:

(33) A: (Anna married) (a man with a big PINK Cadillac) .
                                    H*   LL%

Such noncontrastive or unmarked themes are ones in which the values of Λ^o and Λ^a are identical, $\lambda x.married\ x\ anna$. Since both hold under exactly the same conditions, we will often abbreviate such noncontrastive pairs on the page as a single logical form.

Similar considerations govern the effect of the rheme-tune in (31) and (33). The H* accent marks the second information unit as a rheme, and it falls on the word *pink* because it is the interpretation of this word that distinguishes *this* rheme from one or more others that the discourse context affords. As in the case of the theme (32), this element of the ordinary logical form is replaced by a free variable in the alternative logical form:

(34) $\left\{ \begin{array}{l} \lambda p.p\ sk_{\lambda x.man\ x \wedge in\ x\ sk_{\lambda y.cadillac\ y \wedge pink\ y \wedge big\ y}} \\ \lambda p.p\ sk_{\lambda x.man\ x \wedge in\ x\ sk_{\lambda y.cadillac\ y \wedge v\tau_{pink}\ y \wedge big\ y}} \end{array} \right\}$

The interpretation (or rather, the claim that it is rhematic) holds in discourse (31) because of the availability in the discourse context of someone with a Cadillac distinguished by color from the man with the big pink Cadillac.

As noted earlier, the fact that the property *big* can further be accommodated as given requires only that there should not be someone in the context who has a *little* pink Cadillac—see *SP*:107.

This account diverges on this point from Büring (2003:536), who claims on the basis of examples like the following that the theme alternative set that he designates as *CT* cannot be defined in terms of abstraction or open propositions over the accented words or corresponding logical elements:

(35) Q: Where will the guests at Ivan and Theona's wedding be seated?
      A: FRIENDS and RELATIONS of the couple will sit at the TABLE .
          L+H*   L+H*   LH%   H*   LL%

Büring rightly notes that the theme alternative set of the answer is *the guests*, rather than *the Xs and Ys of the couple*. However, we are talking about *Ivan and Theona*'s wedding, so *the couple* acts here as an epithet referring to an available discourse entity. In the terms of Prince (1981), *of the couple* is non-evoked, merely anchoring *friends and relations* to *Ivan and Theona* in contrast to *other guests* (cf. discussion of (7), above).

The anchoring status of *of the couple* is further evident from the fact that it could be omitted entirely: FRIENDS *and* RELATIONS would refer just as well. (See note 7. If the modifier were "of the bride", that would not be the case. An accent would be required, and the modifier could not be omitted without changing meaning.)

Contrary to Büring's claim, therefore, such examples are entirely consistent with

the theory advanced here and in earlier papers. According to the present theory, the notion of contrast marked by the theme- and rheme–accents is identical. Both require the marked word or the corresponding concept to be not-given, in the sense that some alternative elements of the same type must be contextually available, while everything else must be given, in the sense of accommodatable as a property of the alternative set in question. However, as for Rooth 1992, what is or is not accommodatable in a given context is not defined in the semantics.

Rooth (1992) and Féry and Samek-Lodovici (2006) claim that, while the first occurrence of the word *farmer* in the following example may be accented, as in a, as Schwarzschild (1999) would predict, it may also be unaccented, as in b:[34]

(36) a. An AMERICAN FARMER was talking to a CANADIAN farmer .
             L+H*   L+H*   L+H*   LL%

     b. An AMERICAN farmer was talking to a CANADIAN farmer .
             L+H*   L+H*   LL%

(In either case, of course, the second occurrence of "farmer" is given/evoked, and must be deaccented.)

In the first case, it is clear that the speaker defines the noun *farmer* as new/contrastive, as is appropriate in an out-of-the-blue context in which the word has not been mentioned. In the second case, this amounts in present terms to the claim that the speaker can define the same word as given or non-contrastive, and that in the same out-of-the-blue context, the hearer will accommodate the presupposition that all alternatives in play are farmers.

However, in the latter case, it is not in fact clear that hearers can be so accommodating in the null context (as opposed to contexts where farmers have already been evoked, and these are both second mention foci, in the sense to be discussed below). In the absence of an objective measure that distinguishes primary accents, lexical accents, and deaccent, and in the presence of undoubted contrastive accent on "American" and consequent downstepped accent in (36a), it is hard to be sure, but (36) seems to need some degree of accent on the first occurrence of "farmer", while (36b) with all farmers entirely deaccented seems unacceptable out-of-the-blue. Féry and Samek-Lodovici (2006) themselves point out that when the nominal property in question is modified, as in the following example, then there has to be a phrase-final accent:

(37) An AMERICAN farmer with a big pink CADILLAC was talking to a CANA-DIAN farmer with a big pink Cadillac.

They conclude (2006:137) that the first occurrence of "farmer" in (36) is not in fact semantically given, and account for its diminished prominence in terms of nested focus domains, of which the highest extends over the whole sentence, together with an optimality-theoretic cascade of constraints over foci within that domain, of the kind also proposed by Truckenbrodt (1995, 1999), and Schwarzschild (1999) (cf. German et al. 2006). However, Féry and Samek-Lodovici offer no evidence that the first occurrence of "farmer" is actually destressed in the same sense as the second, as opposed to merely being downstepped relative to AMERICAN, so it is unclear that such apparatus is warranted.

---

[34] The prosodic annotation is mine (Féry and Samek-Lodovici do not specify the type of the accents, but they say it is to be read "as the beginning of a joke"). they seem in fact to make the stronger claim (2006:139) that (36a) is actually ungrammatical "under the focus context at issue." It is not entirely clear what focus context they have in mind, but it seems to be that of what in section 2.4 was called an "all-theme" utterance.

3.3. SEMANTICS OF THEME, RHEME, AGENCY, AND ACHIEVEMENT. The theme or topic has frequently been identified with an implicit or explicit discourse contextual *question* (Sgall et al. 1973; van Kuppevelt 1995; *passim*), sometimes viewed as just one in a partially ordered list (or push-down stack) of such "questions under discussion," (QUD, Ginzburg 1996; Roberts 1996). Büring (2003:535) suggests that the rheme can be defined as the complement of a functional question-like *CT*, which he compares to the present notion of theme.

However, we have seen that there exist all-rheme utterances, such as (19), *Your* MOTHER *called*. Such rhemes do not seem to answer any implicit question, anymore than the sound of the telephone itself does.

We have also seen that there are also all-theme utterances that are propositional rather than functional, such as (24), *He's a good* BADMINTON *player*. Such utterances seem to have their effect by entailing contradiction of a prior proposition, such as *Harry's such a klutz*, rather than by direct questioning. The Colonel's theme-accented (26), *Well,* YES*!* is an *answer*, rather than a question.

Accordingly, rather than appealing to the discourse-structural notion of QUD, the present proposal extends the earlier semantic fragment by representing the common ground as a (sub) model $\mathfrak{C}$, and the property of a proposition holding in $\mathfrak{C}$ as a logical modality [C]. The thematic function of *being already supposed present in common ground* can then be represented as θ, and the rhematic function of *being made present in common ground* as ρ, defined as follows:[35]

(38) $\theta =_{def} \lambda p \lambda x.suppose([C]theme\ p^o \wedge \forall a \in \{p^a\}\ [theme\ a \rightarrow a = p^o])x$

(39) $\rho =_{def} \lambda p \lambda x.[C]update\ \mathfrak{C}\ p^o\ x \vee \exists t[theme\ t \wedge update\ \mathfrak{C}\ (p^o\ t)\ x]$

—where:

1. p is a polymorphic variable ranging over pairs (p^o, p^a) where p^o is a function of any valency (including propositions of zero valency), and p^a is a function of the same valency that includes at least one free variable;

2. $\{p^a\}$ is the alternative set characterized by p^a;[36]

3. *suppose* can be thought of as a modal version of Beaver's (2001) fallible presupposition operator ∂—roughly, verify or *update* with respect to the common ground $\mathfrak{C}$;

4. the predicate *theme* is assumed to be directly interpreted in the common ground model $\mathfrak{C}$ as a (polymorphic) property theme. The theme is introduced into $\mathfrak{C}$ by update.

5. *update* can be thought of as a fallible update predicate which fails if its argument is not a proposition, and which either extends the common ground model $\mathfrak{C}$ by the denotation of a proposition p, or finds a theme t and extends $\mathfrak{C}$ by the denotation of the result of applying p to t, or vice versa. Update should therefore not be thought of as a component of the model theory itself. It is rather a way of changing between models.

(Thus, as in Büring 2003, only the theme (if any) is directly represented in the model. However, the rheme is here a function from models to defeasibly updated models.)

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[35] The latter definition is simplified here by omitting any mention of the alternative semantic value p^a.

[36] As discussed earlier, the way the set $\{p^a\}$ is computed and what it contains is highly context dependent, and is not considered part of the semantics.

The variable x in (38) and (39) ranges over the *agents* of supposition or update, the speaker S and hearer H, while their *achievement* of thematic supposition or rhematic update is represented as $\top$ (success) or $\bot$ (failure).

Thus, the information-structural interpretation of the answer in (31) is the following:[37]

$$(40) \quad (\top\theta \left\{ \begin{array}{l} \lambda x.married\ x\ anna \\ \lambda x.v_{\tau married}\ x\ anna \end{array} \right\} H)(\top\rho \left\{ \begin{array}{l} \lambda p.p\ sk_{\lambda x.man\ x \wedge with\ x\ sk_{\lambda y.cadillac\ y \wedge pink\ y \wedge big\ y}} \\ \lambda p.p\ sk_{\lambda x.man\ x \wedge with\ x\ sk_{\lambda y.cadillac\ y \wedge v_{\tau pink}\ y \wedge big\ y}} \end{array} \right\} S)$$

> "You suppose the question of who Anna married (as opposed to dated) to be common ground, I make it common ground that it was a man with a big pink (as opposed to some other color) Cadillac."

Once the conditions θ and ρ defined in (38) and (39) have been evaluated, the two core λ-terms reduce to a pair containing the standard ordinary and alternative logical forms:

$$(41) \quad \left\{ \begin{array}{l} married\ sk_{\lambda x.man\ x \wedge with\ x\ sk_{\lambda y.cadillac\ y \wedge pink\ y \wedge big\ y}}\ anna \\ v_{\tau married}\ sk_{\lambda x.man\ x \wedge with\ x\ sk_{\lambda y.cadillac\ y \wedge v_{\tau pink}\ y \wedge big\ y}}\ anna \end{array} \right\}$$

However, such standard forms are, strictly speaking, redundant: (40) typifies the only level of representation that is necessary as an interface to interpretation (Zubizarreta 1998:23,n31 makes a related point concerning the information structural nature of LF in her Minimalist Programmatic account of intonation).

3.4. DIRECTION AND INDIRECTION IN INTONATIONAL MEANING. In this formalism, we can write the translations of (14) and (15) as follows:

(42) a. You put my TROUSERS in the MICROWAVE!
<div style="text-align:center">H*   H*   LL%</div>

$$\top(\rho \left\{ \begin{array}{l} put(in\ microwave)trousers\ H \\ put(in\ v_{\tau microwave})\ v_{\tau trousers}\ H \end{array} \right\} S)$$

"I make it common ground that you put my trousers in the microwave." (implicates (e.g.) *I notice you did that*.)

b. You put my TROUSERS in the MICROWAVE?
<div style="text-align:center">L*   L*   LH%</div>

$$\bot(\rho \left\{ \begin{array}{l} put(in\ microwave)\ trousers\ H \\ put(in\ v_{\tau microwave})\ v_{\tau trousers}\ H \end{array} \right\} H)$$

"You do not make it common ground that you put my trousers in the microwave." (implicates (e.g.) *Explain why you did that.*)

---

[37] The reference to a question in glosses for themes should not be confused with the notion of QUD discussed earlier. A theme is a *claim* about discourse context, rather than an element of the context itself. The pronoun in glosses for rhemes such as "it was a man with a big pink cadillac" are intended to reflect the type-raised translation of such NP rhemes. While the distinction between the speaker claiming the hearer to be doing the supposing of the question under discussion via the LH% boundary, and claiming to do it themselves via an LL% boundary might appear from this gloss to be unimportant, the indirect effect of the latter is much more abrupt and uningratiating.

(43) a. You put my TROUSERS in the MICROWAVE?

$$\top(\rho \left\{ \begin{array}{l} put\,(in\ microwave)\ trousers\ H \\ put\,(in\ v_{\tau_{microwave}})\ v_{\tau_{trousers}}\ H \end{array} \right\} H)$$

with H* over *put(in microwave)*, H* over *trousers*, and LH% at the end.

"You make it common ground that you put my trousers in the microwave."

(implicates (e.g.) *Are you telling me you did that?*)

b. You put my TROUSERS in the MICROWAVE!

$$\bot(\rho \left\{ \begin{array}{l} put\,(in\ microwave)\ trousers\ H \\ put\,(in\ v_{\tau_{microwave}})\ v_{\tau_{trousers}}\ H \end{array} \right\} S)$$

with H+L* over *put(in microwave)*, H+L* over *trousers*, and LL% at the end.

"I do not make it common ground that you put my trousers in the microwave.'

(implicates (e.g.) *I can't believe you did that.*)

Examples (42b), (43a), and (43b) can all have the effect of indirectly eliciting a justification from the hearer. So, why so much variation? Clearly, there is a gradation from the neutral (42a) to the rather aggressive and face-threatening (43b), with (42b) and (43a) somewhere in the middle.[38]

What seems to be going on is something like the following. Asserting via an echo-statement that the hearer makes a supposition common ground, as in (43a), does not call for consistency maintenance on their own behalf any more than (42a) (although it does invite them to do some for the speaker). (42b), on the other hand, by claiming the hearer fails to make a supposition common ground, requires the hearer to do consistency maintenance for both participants, say via a further explanation. (43b) is the most aggressive, because it implies that the speaker cannot themselves accept the facts. The implication of the latter is that any attempt at consistency maintenance by the hearer may not be gratefully received.

The important point is that such nuances of politeness, committment, and face-threatening are not the literal meanings of the tunes. The varying politeness in these examples is rather an effect of implicature and/or perlocutionary sideeffects, arising via inference from a literal meaning of the tunes that is solely to do with individual supposition and/or assertion concerning distributed common ground.

3.4.1. INTONATION AND CONVERSATIONAL IMPLICATURE. The examples in (42) and (43) all involve contexts in which the claims made about the world are veridical, and only those concerning realization in common ground may be false. These are the least dramatic and aggressive tunes, and are characteristic of normal low-key dialog. However, it is also possible to make more aggressively flouting claims concerning speaker/hearer supposition, as in the following:[39]

(44) Well, I'll be a MONKEY'S UNCLE !

$$\top(\rho \left\{ \begin{array}{l} of\ monkey\ uncle\ me \\ of\ v_{\tau_{monkey}}\ v_{\tau_{uncle}}\ me \end{array} \right\} S)$$

with H* over *of monkey*, H* over *uncle*, and LL% at the end.

"I make it common ground that I infer I am a monkey's uncle."

(implicates *I'm inconsistent. Now I'll believe anything!*)

---

[38] The British English usage of H* LH% noted earlier is also almost excessively polite.

[39] This and the next example work almost identically if the all-theme contour L+H* L+H* LL%, meaning "I suppose it to be common ground that P" is substituted.

The fact that intonational meanings can be deployed in this indirect fashion should not come as too much of a surprise. Rhetorical devices like tag questions exhibit much the same possibility of dissonance between what the speaker claims about the hearer's knowledge, and what the hearer actually does know, and are accompanied by similar intonation.

According to the present theory, all so-called conversational implicatures can be analyzed solely in terms of success or failure in supposition or update of the common ground by speaker or hearer, without explicit reference in the semantics to notions of cooperation, recognition of intention, flouting of maxims, relevance, or to speech-act types and illocutionary uptake. Many of the examples discussed by Grice (1975) and Searle (1975) seem to be susceptible to similar knowledge-based analysis, making speech-act-theoretic analyses merely epiphenomenal, as proposed by Steedman and Johnson-Laird (1980), Schegloff (1988), Cohen and Levesque (1990), and Geis (1995).

For example, if if someone says the following:

(45) It's COLD in here !
           H*   LL%
$$\top(\rho \left\{ \begin{array}{l} \textit{cold here} \\ v_{\tau_{cold}} \;\textit{here} \end{array} \right\} S)$$

      "I make it common ground that it's cold in here."

—then a hearer who does not actually think it is warm will verify or accommodate the following belief (Steedman and Petrick 2007):

(46) [C]*cold here*

Since being cold is an undesirable state, the hearer will begin to generate plans to negate it, using their knowledge of the situation, the things in it such as windows, their affordances, such as closing, and their effects, such as stopping being cold and starting being warm. In a situation where a window is open, the hearer may then either themselves execute a plan to close it, or suggest such a plan to the original speaker.[40]

In the first case, the original utterance *has the effect of* an indirect request paraphraseable as *Please shut the window*. However, this result has been achieved without requiring explicit recognition on the hearer's part of an act of requesting, without any calculation on their part concerning the speaker's state of mind and intentions, and without identification of flouted conversational maxims, or explicit calculation of degree of relevance. Steedman 2007 considers further examples of indirection, including effects like irony/sarcasm that have been held by Griceans to depend on the hearer's explicit recognition of flouted maxims.

The precise mechanism of such common sense inference is of course the central open problem of artificial intelligence. However, there is a certain amount of experimental evidence for such an egocentric or solipsistic account of conversational inference based on speaker supposition concerning common ground. Bard et al. (2000) and Bard and Aylett (2005) show that intelligibility of spoken referring expressions in Edinburgh Map Task dialogs depends on speaker-availability of referents rather than speaker knowledge of hearer-availability, contrary to Clark and Krych (2004). Keysar et al. (2003) make a related point concerning a manipulation dialog task, using an eye-movement measure.

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[40] A fragment of such a logic is axiomatized in Steedman and Petrick (2007). Such fragments do not of course constitute a claim to have solved the open problem of commonsense reasoning that such inferences also in general depend upon.

3.4.2. INTERIM SUMMARY. The system relating these three dimensions of information structural meaning to the full range of Pierrehumbert's tones can be set out diagrammatically as in tables 1 and 2 (cf. Steedman 2007), in which θ signifies thematic supposition concerning common ground, and ρ signifies rhematic update, while $\top$ and $\bot$ signify success or failure of either supposition or update by the either speaker/hearer agent S and H, independently specified by the boundary.

	$\top$	$\bot$
θ	L+H*	L*+H
ρ	H*, H*+L	L*, H+L*

Table 1: Meaning Elements Contributed by Accents (adapted from Steedman 2007).

S	L, LL%, HL%
H	H, HH%, LH%

Table 2: Meaning Element Contributed by Boundaries (adapted from Steedman 2007).

The claim is that this is all there is to the literal meaning of the tones. All other functions and meaning characteristics that have been associated with English intonational tunes, such as "topic continuation," "other-directedness," "floor-claiming," "turn-yielding," "discourse-structuring," "evaluation with respect to subsequent material," "politeness," "face," "deixis," "commitment," "uncertainty," "affect", "ownership", "indirection," and perhaps even "questioning," arise as indirect effects of the interaction with context of literal meanings made up of the above simple components.

4. THE GRAMMAR OF INTONATION AND INFORMATION STRUCTURE. The earlier papers show that an account of intonational meaning of the above kind is compatible with a Montague-style surface compositional grammar, despite the fact that intonation structure in examples like (10) departs from standard assumptions about surface structure. The present section revises this analysis and extends it to the wider range of phenomena outlined above, including the semantics of focusing particles such as *only* and the phenomenon of "second-occurence focus" (Partee 1991).

4.1. COMBINATORY CATEGORIAL GRAMMAR. Combinatory Categorial Grammar (CCG) is a form of lexicalized grammar in which grammatical *categories* are made up of a syntactic type defining valency and order of combination, and a logical form. For example, the English intransitive verb *walks* has the following category, which identifies it syntactically as a function from (subject) NPs (which the backward slash identifies as on the left, and the feature-value indicated by subscript *SG* identifies as bearing singular agreement) into sentences S:

(47) walks $:= S\backslash NP_{SG} : \lambda x.walk\, x$

Its interpretation is written as a λ-term associated with the syntactic category by the colon operator ":".[41]

---

[41] This use of the λ-calculus is simply as a compositional "glue language" whose terms are isotopic to the derivation and define the way meanings of words and constituents are assembled into terms of first order logic representing sentence meanings. This use is distinct from the use of λ abstraction in the logical language itself

The transitive verb *married* has the syntactic category of a function from (object) nounphrases (which the forward slash identifies as on the right) into predicates or intransitive verbs:

(48) married := $(S\backslash NP)/NP : \lambda x.\lambda y.marry\ xy$

In this case, the syntactic type is simply the SVO directional form of the semantic type. In the logical form, juxtaposition of function and argument symbols as in *marry x* indicates function application. A convention of left associativity holds, according to which *marry xy* is equivalent to $(marry\ x)y$.

In other cases categories may "wrap" arguments into the logical form, as in the analysis of Bach (1979, 1980), Dowty (1982), and Jacobson (1992). For example, the following is the category of the English ditransitive verb *introduced*, which reverses the dominance/command relation of indirect and direct object *x* and *y* between syntactic derivation and the logical functor *introduced*:

(49) introduced := $((S\backslash NP)/PP)/NP : \lambda x.\lambda y.\lambda z.introduced\ yxz$

One reason for such wrapping is to capture at the level of logical form the binding theory and its dependence on the c- or f-command hierarchy in which subject outscopes direct object, which outscopes indirect (dative PP) object, which outscopes more oblique arguments—see Steedman 1996 for discussion.[42]

All such categories are syntactically and semantically *functions*, and can apply to arguments by the following rules:

(50) *Forward and backward functional application*

    a. $X/_\star Y : f \quad Y : a \quad \Rightarrow \quad X : f\ a$ (>)

    b. $Y : a \quad X\backslash_\star Y : f \quad \Rightarrow \quad X : f\ a$ (<)

(The $\star$ slash-type in these rules identifies them as applying to any category, according to the notation of Baldridge and Kruijff (2003) and *TS*, whose details we will mostly pass over here.)

All syntactic operations of CCG are distinguished by being strictly *type-dependent*, rather than structure-dependent. For present purposes, besides *functional application* (above), they can be regarded as limited to operations of *type-raising* (corresponding to the combinator **T**) and *composition* (corresponding to the combinator **B**).

Type-raising turns argument categories (such as *NP*) into functions over the functions that take them as arguments (such as verbs), onto the results of such functions. Thus NPs like *Anna* can take on such categories as the following:

(51)   a. $S/(S\backslash NP_{SG}) : \lambda p.p\ anna$

     b. $S\backslash(S/NP) : \lambda p.p\ anna$

     c. $(S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p.p\ anna$

     d. etc.

(It will sometimes be useful to schematize such families of categories as $NP^{\uparrow}$.)

Type raising has to be strictly limited to argument categories. One way to do so is to specify it in the lexicon, in the categories for proper names, determiners, and the like,

---

to define structured meanings, and does not compromise the claim to be strictly in situ. Nor is it in itself a source of computational complexity, a point that seems to have escaped some critics of the present approach, including Liang et al. (2011).

[42] The present analysis differs from that of Bach and colleagues in making WRAP a *lexical* operation, rather than a syntactic combinatory rule. One advantage of this analysis, which is discussed further in Steedman 1996, is that phenomena depending on WRAP, such as reflexive-binding, raising, and control, are immediately predicted to be *bounded* phenomena.

and type raise only over the original set of lexical functors.[43]

The type-raised or cased proper noun categories schematized as $NP^\uparrow$, such as nominative $S/(S\backslash NP)$, are of syntactic types that correspond to Montagovian generalized quantifiers. Definite and indefinite determiners accordingly bear categories of the form $NP^\uparrow/N$. However, this paper follows *TS* in assuming that no nounphrases other than true universals bear the semantics of generalized quantifiers. Rather, they are generalized Skolem terms of the kind encountered in part II. Thus, the categories of determiners, adjectives and nouns, can be written for present purposes as follows:[44]

(52) a. $\text{a} := NP^\uparrow_{SG}/_\diamond N_{SG} : \lambda n \lambda p.p(sk_n)$
   b. $\text{big} := N/_\diamond N : \lambda p \lambda x.p\ x \wedge big\ x$
   c. $\text{pink} := N/_\diamond N : \lambda p \lambda x.p\ x \wedge pink\ x$
   d. $\text{Cadillac} := N_{SG} : cadillac$

Thus, "a big pink Cadillac" gives rise to the following nominative category, among other cased forms:

(53) $S/(S\backslash NP_{SG}) : \lambda p.p(sk_{\lambda y.p\ y \wedge cadillac\ y \wedge pink\ y \wedge big\ y})$

The inclusion of composition rules like the following as well as simple functional application and lexicalized type-raising engenders a potentially very freely "reordering and rebracketing" calculus, engendering a generalized notion of surface or derivational constituency.

(54) *Forward composition* (>**B**)
   $X/_\diamond Y : f \quad Y/_\diamond Z : g \quad \Rightarrow_\mathbf{B} \quad X/_\diamond Z : \lambda x.f(gx)$

(The $\diamond$ modality on the slashes in this rule again follows the notation of Baldridge and Kruijff, and disallows its application to certain categories, including those bearing $\star$ modality like (59) below.)

For example, the simple transitive sentence of English has *two* equally valid surface constituent derivations, each yielding the same logical form:

(55)
$$
\begin{array}{ccc}
\text{Anna} & \text{married} & \text{Manny} \\
\hline
S/(S\backslash NP_{SG}) \ ^{>\mathbf{T}} & (S\backslash NP)/NP & S\backslash(S/NP) \ ^{<\mathbf{T}} \\
: \lambda f.f\ anna & : \lambda x.\lambda y.marry\ xy & : \lambda p.p\ manny
\end{array}
$$
$$
\underline{S/NP : \lambda x.marry\ x\ anna}^{>\mathbf{B}}
$$
$$
\underline{S : marry\ manny\ anna}_{<}
$$

(56)
$$
\begin{array}{ccc}
\text{Anna} & \text{married} & \text{Manny} \\
\hline
S/(S\backslash NP_{SG}) \ ^{>\mathbf{T}} & (S\backslash NP)/NP & (S\backslash NP)\backslash((S\backslash NP)/NP) \ ^{<\mathbf{T}} \\
: \lambda f.f\ anna & : \lambda x.\lambda y.marry\ xy & : \lambda p.p\ manny
\end{array}
$$
$$
\underline{S\backslash NP : \lambda y.marry\ manny\ y}_{<}
$$
$$
\underline{S : marry\ manny\ anna}^{>}
$$

In the first of these, *Anna* and *married* compose as indicated by the annotation >**B** to form a non-standard constituent of type S/NP. In the second, there is a more traditional derivation involving a verbphrase of type $S\backslash NP$. Both yield identical logical forms, and both are fully legal surface or derivational constituent structures. More complex

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[43] This restriction means that type-raising in English has exactly the same effect as explicit morphological case-marking in a language like Latin or Japanese—see *SP* for discussion. Of course, one might express such a system via lexical rules, rather than by exhaustive listing in the lexicon.

[44] In the more extensive account in *TS*, Skolem terms are under-specified in the lexicon, and become captured by operators such as universal quantifiers, as the derivation proceeds. For the simple cases to hand, this complication is suppressed. The $\diamond$ modality on the slashes in these categories is needed in English to prevent VP-style reordering of the NP, as allowed in German.)

sentences may have many semantically equivalent derivations.[45]

This theory has been applied to the linguistic analysis of coordination, relativization/topicalization, and intonational structure in English and many other languages. For example, since substrings like *Anna married* (and also *Anna says she married*) are fully interpreted derivational *constituents* of type S/NP, CCG supports a movement-free analysis of long-range dependencies such as those in topicalized sentences:

(57)

Manny,	Anna	says	she	married
$S_t/(S/NP)$	$S/(S\backslash NP)$	$(S\backslash NP)/_\diamond S$	$S/(S\backslash NP)$	$(S\backslash NP)/NP$

$$\frac{\quad S/_\diamond S \quad}{} {}^{>\mathbf{B}}$$
$$\frac{\quad S/NP \quad}{} {}^{>\mathbf{B}}$$
$$\frac{\quad S/NP \quad}{} {}^{>\mathbf{B}}$$
$$\frac{\qquad\qquad St \qquad\qquad}{} {}^{>}$$

The analysis of relativization is similar, with the object relative pronoun taking the place of topicalized *Manny*, and bearing the following category, in which the noun postmodifier category $N\backslash N$ replaces S_t as result—see *SP* for details:

(58) $(N\backslash_\diamond N)/(S/NP)$

Similarly, if conjunctions like *and* bear the category (59), in which $\star$ modalities mean that it can *only* combine via the application rules (50), CCG supports a movement- and deletion- free account of right node raising, as in (60):[46]

(59) and $:= (X\backslash_\star X)/_\star X$

(60)

[Louise dated]	and	[Anna(says she) married]	Manny
S/NP ${}^{>\mathbf{B}}$	$(X\backslash_\star X)/_\star X$	S/NP ${}^{>\mathbf{B}}$	$S\backslash(S/NP)$ ${}^{<\mathbf{T}}$

$$\frac{\qquad (S/NP)\backslash_\star(S/NP) \qquad}{} {}^{>}$$
$$\frac{\qquad\qquad S/NP \qquad\qquad}{} {}^{<}$$
$$\frac{\qquad\qquad\qquad S \qquad\qquad\qquad}{} {}^{<}$$

—and of cluster coordination (with the two steps marked $>$, $<$ of coordination reduced to one marked $<>$, to save space):

(61)

I	introduced	Tom	to Sue	and	Anna	to Manny
$S/(S\backslash NP)$	$((S\backslash NP)/PP)/NP$	$((S\backslash NP)/PP)\backslash(((S\backslash NP)/PP)/NP)$	$(S\backslash NP)\backslash((S\backslash NP)/PP)$	$(X\backslash_\star X)/_\star X$	$(S\backslash NP)\backslash(((S\backslash NP)/PP)/NP)$	

$$\frac{\quad (S\backslash NP)\backslash(((S\backslash NP)/PP)/NP) \quad}{} {}^{<\mathbf{B}}$$
$$\frac{\quad (S\backslash NP)\backslash(((S\backslash NP)/PP)/NP) \quad}{} {}^{<>}$$
$$\frac{\quad S\backslash NP \quad}{} {}^{<}$$
$$\frac{\quad S \quad}{} {}^{>}$$

In the terms of the minimalist program (MP) of Chomsky (1995), CCG provides a formal mechanism that eliminates all operations equivalent to overt or covert "movement", "deletion", and/or "copying", in favor of a single syntactic/semantic operation of type-dependent combinatory "merger" over adjacent constituents.

4.2. GRAMMAR, PROSODY, AND INFORMATION STRUCTURE. The availability of fully interpreted nonstandard derivational constituents corresponding to substrings like *Anna (says she) married* was originally motivated by their use in explaining the relativization and coordination constructions exemplified above. CCG was proposed as a way to capture those constructions with a semantically surface-compositional grammar obeying a very strict form of the constituent condition on rules (Chomsky 1955/1975;

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[45] The apparently adverse consequences in terms of expanded search-space for the parser can be avoided by a number of algorithmic solutions proposed by König (1994), Eisner (1996), and in *SP*, which are applied in practical parsers such as Hockenmaier and Steedman 2002 and Clark and Curran 2004.

[46] *SP* and *TS* present a more extensive account of coordination in CCG.

see *SP*:ch1 for discussion). However, as Steedman (1985) and Oehrle (1988) pointed out, a theory that allows alternative derivations like (55) and (56) is also immediately able to capture the fact that prosody makes exactly the same constituencies into intonational phrases, as in (9) and (10).

The way that CCG derivation is made sensitive to prosodic accents and boundaries is as follows. First, as in Steedman (2000a), the presence of an accent on a word is made to mark its whole lexical syntactic category for the success or failure of thematic supposition or rhematic update concerning common ground, via compound feature-values such as $\top, \theta$ and $\bot, \rho$ on its arguments (if any) and its result. This marking is projected onto derived categories until it is closed by combination with a boundary, in a way to be described.[47]

Second, departing from all earlier versions of the theory, whenever we are concerned with issues of accent/contrast, we will regard all CCG categories from the lexicon on up as having *two* parallel logical forms, which respectively contribute compositionally to the ordinary and alternative logical forms, Λ^o and Λ^a, defined earlier.

In the case of unaccented words that are entirely contextually given, Λ^o and Λ^a are identical, but in the accented or otherwise contrastive case, the alternative value is one in which the corresponding semantic element has been replaced by a variable of the same type. We can write these two semantic values in braces, and regard the earlier simple logical forms as abbreviating ordered pairs $\{\Lambda^o, \Lambda^a\}$.

For example, the proper name *Anna* bearing an L+H* accent has the following nominative category, among other raised types:[48,49]

(62)   ANNA $:= S_{\top,\theta}/(S_{\top,\theta}\backslash NP_{\top,\theta}) : \left\{ \begin{array}{l} \lambda p.p\ anna \\ \lambda p.p\ v_{\tau_{anna}} \end{array} \right\}$
       L+H*

The same word bearing an L*+H accent has the following category, in which $\top/\bot$ polarity is reversed and everything else is the same:

(63)   ANNA $:= S_{\bot,\theta}/(S_{\bot,\theta}\backslash NP_{\bot,\theta}) : \left\{ \begin{array}{l} \lambda p.p\ anna \\ \lambda p.p\ v_{\tau_{anna}} \end{array} \right\}$
       L*+H

The feature bundle $\top/\bot, \theta$ ensures that a verb so marked can only combine with arguments that are compatible with theme marking and that polarity of achievement—excluding those bearing the rheme-marking feature value bundle $\top/\bot, \rho$—and marks its result in the same way.[50]

Similarly, the rheme-accented versions of *Anna* are as follows:

(64)   ANNA $:= S_{\top,\rho}/(S_{\top,\rho}\backslash NP_{\top,\rho}) : \left\{ \begin{array}{l} \lambda p.p\ anna \\ \lambda p.p\ v_{\tau_{anna}} \end{array} \right\}$
       H*

---

[47] The combination of an accent with a word is thus essentially morpholexical, as in Drubig (2003):1,6.

[48] Number agreement is suppressed in the interests of reducing formal clutter. It is important to realize that polarity and thematicity have to be passed as syntactic features rather than in the logical form because an intonational phrase may bear more than one accent, which must be compatible types.

[49] By a similar argument, the topicalized object category in example (57) is in most British dialects restricted to *theme-accented* constituents:

(i) MANNY $:= St_{\top,\theta}/(S_{\top,\theta}/NP_{\top,\theta})$
     L+H*

[50] Thus, we assume that examples like (9) and the following involve two rhematic information structural units of opposite polarity, despite the lack of a medial boundary tone. We return to this point in connection with rule (71).

(i) The BLACKBOARD's painted ORANGE !
        L*   H*   LL%

(65) ANNA $:= S_{\bot,\rho}/(S_{\bot,\rho}\backslash NP_{\bot,\rho}) : \left\{ \begin{array}{l} \lambda p.p\ anna \\ \lambda p.p\ v_{\tau_{anna}} \end{array} \right\}$
    L*

In all four cases (62-65), the element in the alternative logical value corresponding to the accented word is replaced by a variable, $v_{\tau_{anna}}$, of the same type as *anna*. It will on occasion be useful to schematize the syntactic type of such categories over all raised NP types, as in $NP_{\top,\rho}^{\uparrow}$.[51]

If *Anna* is completely given—that is, there is no previous accented mention, so that no non-trivial alternatives are evoked or otherwise in play—then a subject bearing no accent has the following category, in which the ordinary and focus semantic values are the same:

(66) Anna $:= S_{\pi,\eta}/(S_{\pi,\eta}\backslash NP_{\pi,\eta}) : \left\{ \begin{array}{l} \lambda p.p\ anna \\ \lambda p.p\ anna \end{array} \right\}$

π and η are variables over the values $\top/\bot$ and θ/ρ which ensure that all elements have the same values as any category it reduces with. They are usually suppressed by convention. To avoid cluttering the derivations, we will also abbreviate the two identical logical forms of unaccented categories as a single formula without braces. Thus, the above category will often be abbreviated as follows:

(67) Anna $:= S/(S\backslash NP) : \lambda p.p\ anna$

It nevertheless still has two logical forms, and in particular the two λ-bound variables p remain distinct.

However, if there has been a previous accented mention, then an unaccented word may have become thematic, in which case the unaccented word will have the same contrastive category as the thematically accented version, with the same non-trivial alternative logical form. For example:

(68) Anna $:= S_{\top,\theta}/(S_{\top,\theta}\backslash NP_{\top,\theta}) : \left\{ \begin{array}{l} \lambda p.p\ anna \\ \lambda p.p\ v_{\tau_{anna}} \end{array} \right\}$

The latter category (68) is required to account for the phenomenon of second occurrence focus, and will come into its own in the discussion of that phenomenon in section 4.3.2. However, its use is more widespread, and we will first see it used section 4.2.2 to capture the the impossibility in general of uttering unaccented complements in English out-of-the-blue all-rheme utterance, requiring that they bear *only* (accusative, etc.) second occurrence focus categories analogous to (68), and never be entirely given, in contrast to nominatives like (67). First we consider some simpler cases.

4.2.1. ENGLISH THEME-RHEME ARTICULATION. The categories of accented and unaccented words are such as to allow them to combine with unaccented words, or words bearing the same accent. Thus, accent is projected over phrases with one or more compatible accents.

As noted earlier, boundaries, unlike accents, are not properties of words or phrases, but independent string elements in their own right which merely coarticulate with adjacent words. They bear a category which, by mechanisms parallel to those discussed in more detail in *SP*, "freezes" θ and ρ-marked constituents as complete thematic or rhe-

---

[51] All combinatory rules, such as Forward Application, (50a), also have ordinary and alternative logical components, written in full as here:

  (i) *Forward functional application*

$$X/_{\star}Y : \left\{ \begin{array}{l} f^o \\ f^a \end{array} \right\} \quad Y : \left\{ \begin{array}{l} a^o \\ a^a \end{array} \right\} \quad \Rightarrow \quad X : \left\{ \begin{array}{l} f^o\ a^o \\ f^a\ a^a \end{array} \right\} \tag{$>$}$$

However, we will regard the standard notation used in earlier versions as an abbreviation for the full rules.

matic information-/intonation–structural units marked ϕ, making them unable to combine further with anything except similarly complete ϕ-marked prosodic units. For example, the hearer-agency–signaling LH% boundary bears the following category (as with the category (67) for unaccented *Anna*, the identical ordinary and alternative logical forms are represented as one):

(69) LH% := $S\ldots_\phi \backslash_\star S\ldots_{\pi,\eta} : \lambda f.\pi(\eta\ f\ \mathrm{H})$

$S\ldots$ is a variable ranging over S and syntactic function categories into S, f is the interpretation of $S\ldots$, π is a variable ranging over $\top$ and $\bot$, η ranges over syntactic and semantic thematicity and rhematicity features θ and ρ, defined in terms of the alternative semantics discussed in section 3 and Steedman 2000a, 2007, and ϕ marks the result as a complete phonological phrase, which can only combine with another such, while $\star$ modality limits this combination to application.[52]

As in Steedman 2000a, apart from the new semantics, the derivation of (a slightly simplified version of) (10) then appears as in (70).

(70)

> "You suppose the question of who Anna (as opposed to anyone else) married to be common ground, I make it common ground that it was Manny (as opposed to anyone else)"

In the last step of derivation (70), the markers of speaker/hearer supposition, common ground realization or its negation, and theme/rheme status are evaluated by the hearer with respect to the context, to check that the associated presuppositions hold or can be consistently accommodated. In the latter case this includes support for or accommodation of the relevant alternative sets, and will include updates including any new theme. This process will typically give rise to indirect effects of politeness, uncertainty, sarcasm, and the like. If any of these presuppositions fails, then processing will block and incomprehension will result.

If it succeeds, then the full logical form can reduce to give the canonical proposition as the result of the derivation.[53]

While the present theory follows standard alternative semantics in assuming that alternative sets are justified by antecedents in a dynamically changing discourse representation, it is important to realize that the representation of congruence between question and answer is different. Rather than identifying the theme via an *F*-marked traditional constituent resulting from a process of focus-projection, it is identified by a θ-marked prosodic-phrasal constituent, as in Selkirk's 1984 account and its "edge-based" descendants. The present theory differs from Selkirk's only in completely identifying intonation structure with CCG surface-syntactic structure (see Selkirk 1984:291). It fol-

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[52] In Steedman 2000a, the boundary is further decomposed as in Pierrehumbert and Hirschberg 1990 into a phrasal tone and a boundary tone. We suppress this complication here.

[53] As noted in connection with example (40), this last step is not strictly necessary.

lows that the projection of theme/rheme marking onto the intonational phrases marking question-answer congruence can be accomplished by syntactic derivation alone, with boundaries like (69) limiting the scope of the present strictly derivational equivalent of "focus projection." This is a point of difference from standard syntax-based accounts of prosodic structure (Kaisse 1985; Truckenbrodt 1995, 1999, 2007).

The alternative answer (17) to the same question *Who did* ANNA *marry?*, in which the theme is a second mention focus unmarked theme stemming from the category (68) and lacks a boundary tone, is very similar, if we assume the following unary rule:[54]

(71) *Prosodic phrase promotion rule* (%)
$$S\ldots_{\pi,\eta} : f \quad \Rightarrow_\% \quad S\ldots_\phi : \pi(\eta f \mathrm{S})$$

This rule operates nondeterministically with the same effect as an L or LL% boundary, allowing (16), (17), and (18a,b). The derivation of the latter (with a simplifying change in tense) goes as follows:

(72)

Anna	married	MANNY H*	LL%
$S_{\top,\theta}/(S_{\top,\theta}\backslash NP_{\top,\theta})^{>\mathbf{T}}$	$(S\backslash NP)/NP :$	$S_{\top,\rho}\backslash(S_{\top,\rho}/NP_{\top,\rho})^{<\mathbf{T}}$	$S\ldots_\phi \backslash_\star S\ldots_{\pi,\eta} :$
$: \left\{ \begin{array}{l} \lambda f.f\ anna \\ \lambda f.f\ v_{\tau_{anna}} \end{array} \right\}$	$\lambda x.\lambda y.married\ xy$	$: \left\{ \begin{array}{l} \lambda p.p\ manny \\ \lambda p.p\ v_{\tau_{manny}} \end{array} \right\}$	$: \lambda g.\pi(\eta\ g\ \mathrm{S})$

$$S_{\top,\theta}/NP_{\top,\theta} : \left\{ \begin{array}{l} \lambda x.married\ x\ anna \\ \lambda x.married\ x\ v_{\tau_{anna}} \end{array} \right\}^{>\mathbf{B}}$$

$$S_\phi/NP_\phi : \top(\theta \left\{ \begin{array}{l} \lambda x.married\ x\ anna \\ \lambda x.married\ x\ v_{\tau_{anna}} \end{array} \right\} \mathrm{S}) \qquad S_\phi\backslash(S_\phi/NP_\phi) : \top(\rho \left\{ \begin{array}{l} \lambda p.p\ manny \\ \lambda p.p\ v_{\tau_{manny}} \end{array} \right\} \mathrm{S})$$

$$S_\phi : \top(\rho \left\{ \begin{array}{l} \lambda p.p\ manny \\ \lambda p.p\ v_{\tau_{manny}} \end{array} \right\} \mathrm{S})(\top(\theta \left\{ \begin{array}{l} \lambda x.married\ x\ anna \\ \lambda x.married\ x\ v_{\tau_{anna}} \end{array} \right\} \mathrm{S}))$$

$$S : \left\{ \begin{array}{l} married\ manny\ anna \\ married\ v_{\tau_{manny}}\ v_{\tau_{anna}} \end{array} \right\}$$

"I suppose the question of who Anna (as opposed to anyone else) married to be common ground, I make it common ground that it was Manny (as opposed to anyone else)"

The above example is semantically and information-structurally identical to (70), apart from the attribution of theme-supposition to the speaker rather than the hearer.

The assumption is that all words are generalized for accent and non-accent in the same way as (62–68), including (52b-d).[55]

(73) a. $a := NP^{\uparrow}_{\pi,\eta}/N_{\pi,\eta} : \lambda n \lambda p.p(sk_n)$

    b. $\begin{array}{l} \text{BIG} \\ \text{H*} \end{array} := N_{\top,\rho}/N_{\top,\rho} : \left\{ \begin{array}{l} \lambda n \lambda x.n\ x \wedge big\ x \\ \lambda n \lambda x.n\ x \wedge v_{\tau big}\ x \end{array} \right\}$

    c. $\begin{array}{l} \text{PINK} \\ \text{H*} \end{array} := N_{\top,\rho}/N_{\top,\rho} : \left\{ \begin{array}{l} \lambda n \lambda x.n\ x \wedge pink\ x \\ \lambda n \lambda x.n\ x \wedge v_{\tau pink}\ x \end{array} \right\}$

    d. $\begin{array}{l} \text{CADILLAC} \\ \text{H*} \end{array} := N_{\top,\rho} : \left\{ \begin{array}{l} cadillac \\ v_{\tau cadillac} \end{array} \right\}$

Thus, one possible derivation of the nominal *a big* PINK *Cadillac* from example (40) goes as follows:

---

[54] In earlier papers, acoustically reduced intermediate phrase L boundaries were assumed to end unmarked themes, among other places. This clumsy technical device was widely derided (Croft 1995; Ladd 1996). The present paper bows to such criticism, eschewing all such inaudible boundaries as an unnecessary encumbrance, in favor of the (equivalent) rule (71).

The nondeterminism of both mechanisms is partly compensated by the fact that their application is forced by any occurence of adjacent accents with different types, such as the H* and L+H* in example (9).

We cannot make the rule (71) intrinsically θ-marking, because it also applies to accented constituents, including ρ-marked ones, as in (80).

[55] From now on, we suppress $\diamond$ modality on nominal categories to reduce clutter. As usual, it may be convenient to schematize such generalization in a lexical rule.

(74)

	a	man	with	a	big	PINK H*	Cadillac

$$\frac{}{NP^{\uparrow}/N} \quad \frac{}{N} \quad \frac{}{(N\backslash N)/NP} \quad \frac{}{NP^{\uparrow}/N} \quad \frac{}{N/N} \quad \frac{}{N_{\top,\rho}/N_{\top,\rho}} \quad \frac{}{N}$$

$$: \lambda n \lambda p.p(sk_n) \quad : man \quad : \lambda x \lambda n \lambda y.n\, y \wedge with\, xy \quad : \lambda n \lambda p.p(sk_n) \quad : \lambda n \lambda x.n\, x \wedge big\, x \quad : \left\{ \begin{array}{l} \lambda n \lambda x.n\, x \wedge pink\, x \\ \lambda n \lambda x.n\, x \wedge v\tau_{pink} \end{array} \right\} \quad : cadillac$$

$$N_{\top,\rho} : \left\{ \begin{array}{l} \lambda x.cadillac\, x \wedge pink\, x \\ \lambda x.cadillac\, x \wedge v\tau_{pink}\, x \end{array} \right\} >$$

$$N_{\top,\rho} : \left\{ \begin{array}{l} \lambda x.cadillac\, x \wedge pink\, x \wedge big\, x \\ \lambda x.cadillac\, x \wedge v\tau_{pink}\, x \wedge big\, x \end{array} \right\} >$$

$$NP^{\uparrow}_{\top,\rho} : \left\{ \begin{array}{l} \lambda p.p(sk_{\lambda x.cadillac\, x \wedge pink\, x \wedge big\, x}) \\ \lambda p.p(sk_{\lambda x.cadillac\, x \wedge v\tau_{pink}\, x \wedge big\, x}) \end{array} \right\} >$$

$$N_{\top,\rho}\backslash N_{\top,\rho} : \left\{ \begin{array}{l} \lambda n \lambda y.n\, y \wedge with\, (sk_{\lambda x.cadillac\, x \wedge pink\, x \wedge big\, x})^y \\ \lambda n \lambda y.n\, y \wedge in(sk_{\lambda x.cadillac\, x \wedge v\tau_{pink}\, x \wedge big\, x})^y \end{array} \right\} <$$

$$N_{\top,\rho} : \left\{ \begin{array}{l} \lambda y.man\, y \wedge with\, (sk_{\lambda x.cadillac\, x \wedge pink\, x \wedge big\, x})^y \\ \lambda y.man\, y \wedge in(sk_{\lambda x.cadillac\, x \wedge v\tau_{pink}\, x \wedge big\, x})^y \end{array} \right\} <$$

$$NP^{\uparrow}_{\top,\rho} : \left\{ \begin{array}{l} \lambda p.p(sk_{\lambda y.man\, y \wedge with\, (sk_{\lambda x.cadillac\, x \wedge pink\, x \wedge big\, x})^y})^y \\ \lambda p.p(sk_{\lambda y.man\, y \wedge in(sk_{\lambda x.cadillac\, x \wedge v\tau_{pink}\, x \wedge big\, x})^y})^y \end{array} \right\} >$$

As usual, the effect of focus projection—that is, projection of rheme-marking—onto the entire NP is accomplished by syntactic derivation.[56]

If the result is then fed into derivations (70) and (72) in place of MANNY, we obtain appropriate logical forms for (31A) and (33A).

4.2.2. ENGLISH ALL-RHEME UTTERANCE. Since we have assumed unaccented subjects in out-of-the-blue utterances not to be specified on the theme/rheme dimension, the prosodic contour in (72) also allows an alternative analysis as an all-rheme utterance, as follows:

(75)

Anna	married	MANNY H*	. LL%

$$\frac{}{S/(S\backslash NP)}>\mathbf{T} \quad \frac{}{(S\backslash NP)/NP} \quad \frac{}{S_{\top,\rho}\backslash(S_{\top,\rho}/NP_{\top,\rho})}<\mathbf{T} \quad \frac{}{S\dots_{\phi}\backslash_{\star}S\dots_{\pi,\eta}}$$

$$: \lambda f.f\, anna \quad : \lambda x.\lambda y.married\, xy \quad : \left\{ \begin{array}{l} \lambda p.p\, manny \\ \lambda p.p\, v\tau_{manny} \end{array} \right\} \quad : \lambda g.\pi(\eta\, g\, S)$$

$$\frac{}{S/NP : \lambda x.married\, x\, anna}>\mathbf{B}$$

$$S_{\top,\rho} : \left\{ \begin{array}{l} married\, manny\, anna \\ married\, v\tau_{manny}\, anna \end{array} \right\} <$$

$$S_{\phi} : \top(\rho \left\{ \begin{array}{l} married\, manny\, anna \\ married\, v\tau_{manny}\, anna \end{array} \right\} S) <$$

$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$

$$S : \left\{ \begin{array}{l} married\, manny\, anna \\ married\, v\tau_{manny}\, anna \end{array} \right\}$$

"I make it common ground that Anna married Manny (as opposed to anyone else)"

Since English unaccented verbs in out-of-the-blue utterance are also unspecified on the theme/rheme dimension, there is also an all-rheme analysis for intransitive sentences like the following (as well as a rheme-theme analysis involving the prosodic phrase promotion rule (71) that is left as an exercise):

---

[56] Although "Cadillac" has a previous contrastive mention, only the non-contrastive completely given category for the noun is compatible with rheme marking, and this seems to yield the attested reading.

(76)

$$
\begin{array}{c}
\text{Your} \qquad \underset{\text{H}*}{\text{MOTHER}} \qquad\qquad \text{called} \qquad\qquad \underset{\text{LL\%}}{\cdot} \\[2pt]
\cfrac{S_{\top,\rho}/(S_{\top,\rho}\backslash NP_{\top,\rho})}{:\left\{\begin{array}{l}\lambda f.f\ (your\ mother)\\ \lambda f.f\ (your\ v_{\tau_{mother}})\end{array}\right\}}{}^{>\mathbf{T}} \quad \cfrac{S\backslash NP}{:\lambda x.called\ x} \quad \cfrac{S\ldots_\phi\backslash_\star S\ldots_{\pi,\eta}}{:\lambda g.\pi(\eta\ g\ S)}
\end{array}
$$

$$
\cfrac{\qquad\qquad\qquad\qquad}{S_{\top,\rho}:\left\{\begin{array}{l} called\ (your\ mother)\\ called\ (your\ v_{\tau_{mother}})\end{array}\right\}}{}^{>}
$$

$$
\cfrac{\qquad\qquad\qquad\qquad}{S_\phi:\top(\rho\left\{\begin{array}{l} called\ (your\ mother)\\ called\ (your\ v_{\tau_{mother}})\end{array}\right\}S)}{}^{<}
$$

$$
\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots
$$

$$
S:\left\{\begin{array}{l} called\ (your\ mother)\\ called\ (your\ v_{\tau_{mother}})\end{array}\right\}
$$

"I make it common ground that your mother called"

However, we are free to make a different assumption for objects and other complements. The impossibility of out-of-the-blue utterance and any all-rheme reading for (16), unlike (17), is captured by arranging that the raised categories for unaccented objects are lexically thematic and contrastive, analogously to (68), and that they systematically lack any completely given category analogous to (67):

(77) $\text{Manny} := (S_{\top,\theta}\backslash NP_{\top,\theta})\backslash((S_{\top,\theta}\backslash NP_{\top,\theta})/NP_{\top,\theta}):\left\{\begin{array}{l}\lambda p.p\ manny\\ \lambda p.p\ v_{\tau_{manny}}\end{array}\right\}$

$\qquad\qquad := S_{\top,\theta}\backslash(S_{\top,\theta}/NP_{\top,\theta}):\left\{\begin{array}{l}\lambda p.p\ manny\\ \lambda p.p\ v_{\tau_{manny}}\end{array}\right\}$

These categories impose the requirement that the preceding discourse include a previous contrastive mention.

The former category in (77) allows the following rheme-theme analysis for (16), appropriate as an answer to the question *Who married Manny:*[57]

(78)

$$
\begin{array}{c}
\underset{\text{H}*}{\text{ANNA}} \qquad\qquad \text{married} \qquad\qquad \text{Manny} \qquad\qquad \underset{\text{LL\%}}{\cdot}
\end{array}
$$

$$
\cfrac{S_{\top,\rho}/(S_{\top,\rho}\backslash NP_{\top,\rho})}{:\left\{\begin{array}{l}\lambda f.f\ anna\\ \lambda f.f\ v_{\tau_{anna}}\end{array}\right\}}{}^{>\mathbf{T}} \quad \cfrac{(S\backslash NP)/NP}{:\lambda x.\lambda y.married\ xy} \quad \cfrac{(S_{\top,\theta}\backslash NP_{\top,\theta})\backslash((S_{\top,\theta}\backslash NP_{\top,\theta})/NP_{\top,\theta})}{:\left\{\begin{array}{l}\lambda p.p\ manny\\ \lambda p.p\ v_{\tau_{manny}}\end{array}\right\}}{}^{<\mathbf{T}} \quad \cfrac{S\ldots_\phi\backslash_\star S\ldots_{\pi,\eta}}{:\lambda g.\pi(\eta\ g\ S)}
$$

$$
\cfrac{S_\phi/(S_\phi\backslash NP_\phi):\top(\rho\left\{\begin{array}{l}\lambda f.f\ anna\\ \lambda f.f\ v_{\tau_{anna}}\end{array}\right)S\right\}}{}^{\%} \qquad \cfrac{S_{\top,\theta}\backslash NP_{\top,\theta}:\left\{\begin{array}{l}\lambda x.married\ manny\ x\\ \lambda x.married\ v_{\tau_{manny}}\ x\end{array}\right\}}{}^{<}
$$

$$
\cfrac{S_\phi\backslash NP_\phi:\top(\theta\left\{\begin{array}{l}\lambda x.married\ manny\ x\\ \lambda x.married\ v_{\tau_{manny}}\ x\end{array}\right\}S)}{}^{<}
$$

$$
\cfrac{S_\phi:\top(\rho\left\{\begin{array}{l}\lambda f.f\ anna\\ \lambda f.f\ v_{\tau_{anna}}\end{array}\right\}S)(\top(\theta\left\{\begin{array}{l}\lambda x.married\ manny\ x\\ \lambda x.married\ v_{\tau_{manny}}\ x\end{array}\right\}S))}{}^{>}
$$

$$
\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots
$$

$$
S:\left\{\begin{array}{l}married\ manny\ anna\\ married\ v_{\tau_{manny}}\ v_{\tau_{anna}}\end{array}\right\}
$$

"I make Anna (as opposed to anyone else) common ground, I suppose the question of who married Manny (as opposed to anyone else) to be common ground"

Nevertheless, it also prevents a all-rheme analysis analogous to (75), hence the anomaly of the out-of-the-blue utterance (23) with the same contour:[58]

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[57] This is another place where earlier CCG analyses assumed a phonetically absorbed L boundary. Again, rule (71) does the same work.

[58] The potential overgeneration in the related footnote 26 is also excluded. This analysis eliminates the overgeneration in Steedman 2000a noted by Meurers and de Kuthy (2005).
By contrast, an all-theme version of (79), parallel to (24), is correctly allowed, although such utterances are by definition not out-of-the-blue:

   (i) Q: No-one in their right mind would marry Manny!

      A: (ANNA married Manny)$_\theta$.

         L+H*   LH%

(79)

$$\frac{\overset{\text{ANNA}}{\overset{H*}{\rule{0pt}{0pt}}}}{S_{\top,\rho}/(S_{\top,\rho}\backslash NP_{\top,\rho})}{>}\mathbf{T} \quad \frac{\overset{\text{married}}{\rule{0pt}{0pt}}}{(S\backslash NP)/NP \quad (S_{\top,\theta}\backslash NP_{\top,\theta})\backslash((S_{\top,\theta}\backslash NP_{\top,\theta})/NP_{\top,\theta})}{<}\mathbf{T} \quad \frac{\overset{\text{Manny}}{\rule{0pt}{0pt}}}{} \quad \frac{\overset{\dot{L}\dot{L}\%}{\rule{0pt}{0pt}}}{S\ldots_\phi\backslash_\star S\ldots_{\pi,\eta}}$$

$$\frac{S_{\top,\theta}\backslash NP_{\top,\theta}}{\rule{0pt}{0pt}}{<}$$

"#I make it common ground that Anna (as opposed to anyone else) married
Manny"

For similar reasons, the following rheme-theme analysis is the only one allowed for the
example: an out-of-the-blue all-rheme interpretation is again correctly ruled out.

(80) Q: I know Anna got a job, but what became of Manny?

A:

$$\frac{\overset{\text{Anna}}{\rule{0pt}{0pt}}}{S(S\backslash NP)}{>}\mathbf{T} \quad \frac{\overset{\text{MARRIED}}{\overset{H*}{\rule{0pt}{0pt}}}}{(S_{\top,\rho}\backslash NP_{\top,\rho})/NP_{\top,\rho}} \quad \frac{\overset{\text{Manny}}{\rule{0pt}{0pt}}}{S_{\top,\theta}\backslash(S_{\top,\theta}/NP_{\top,\theta})}{<}\mathbf{T} \quad \frac{\overset{\dot{L}\dot{L}\%}{\rule{0pt}{0pt}}}{S\ldots_\phi\backslash_\star S\ldots_{\pi,\eta}}$$

$: \lambda f.f\ anna$ $: \left\{\begin{array}{l}\lambda x.\lambda y.married\ xy\\ \lambda x\lambda y.v_{\tau_{married}}\ xy\end{array}\right\}$ $: \left\{\begin{array}{l}\lambda p.p\ manny\\ \lambda p.p\ v_{\tau_{manny}}\end{array}\right\}$ $: \lambda g.\pi(\eta\ g\ S)$

$$\frac{}{S_{\top,\rho}/NP_{\top,\rho} : \left\{\begin{array}{l}\lambda x.married\ x\ anna\\ \lambda x.v_{\tau_{married}}\ x\ anna\end{array}\right\}}{>}\mathbf{B} \qquad \frac{}{S_\phi\backslash(S_\phi/NP_\phi) : \top(\theta\left\{\begin{array}{l}\lambda p.p\ manny\\ \lambda p.p\ v_{\tau_{manny}}\end{array}\right\}S)}{<}$$

$$\frac{}{S_\phi/NP_\phi : \top(\rho\left\{\begin{array}{l}\lambda x.married\ x\ anna\\ \lambda x.v_{\tau_{married}}\ x\ anna\end{array}\right\}S)}{\%}$$

$$\frac{S : \top(\theta\left\{\begin{array}{l}\lambda p.p\ manny\\ \lambda p.p\ v_{\tau_{manny}}\end{array}\right\}S)(\top(\rho\left\{\begin{array}{l}\lambda x.married\ x\ anna\\ \lambda x.v_{\tau_{married}}\ x\ anna\end{array}\right\}S))}{}{<}$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$S : \left\{\begin{array}{l}married\ manny\ anna\\ v_{\tau_{married}}\ v_{\tau_{manny}}\ anna\end{array}\right\}$$

"I suppose the question of what Manny (as opposed to anyone else)
underwent to be common ground, I make it common ground it was Anna
marrying him (as opposed to doing anything else)"

The same observation applies to examples like the following, consistent with Ladd's
1996 analysis of related examples (cf. Steedman 2000a:119, (62)):[59]

(81) Q: Has Anna read *Ulysses*?
    A: (Anna doesn't READ)$_\rho$ (books)$_\theta$.
            H*   LL%

Like (80), (81) cannot be uttered out-of-the-blue. However, transitive examples with
non-final accent like the following can:[60]

(82) a. I have to SEE a guy.
      b. You need to TALK to someone.
      c. You took ADVANTAGE of me.
      d. He was reading SUPERMAN to some kid.

The postverbal deaccented phrases in these examples seem to constitute accomodatable
background default arguments for these particular verbs, in the same sense that *calling*
is accomodatable as a background activity of mothers in (76), or Prince's "anchor-
ing" background NP modifiers, discussed in section 2.1.1. They must accordingly have
entirely given non-subject categories parallel to (67), specialized for those particular
verbal heads.

---

[59] As in the earlier discussion of (13), this example involves the hearer in accepting the speakers shift from
their theme of the book *Ulysses* to an upwardly-entailed more general theme of *books*.

[60] The latter example is of a kind discussed by Neeleman and Szendrői (2004) as "Superman sentences",
which appear to fall under the same generalization.

Thus, within the present framework, all questions concerning the type and placement of accents in English are lexicalized and associated with a compositional semantics.[61]

4.3. SEMANTICS OF NEGATION AND FOCUSING PARTICLES. As noted in section 3, negation is a function from (Λ^o, Λ^a) pairs to (Λ^o, Λ^a) pairs. We can therefore write the semantics for the unaccented *not* in example (29) as in *TS*, ignoring the issues of polarity discussed at length there, writing the ordinary and alternative logical forms as one, as usual:

(83) $\text{not} := (S_{inf} \backslash NP)/(S_{inf} \backslash NP) : \lambda p \lambda y. \neg p\, y$

Since the positive is the only alternative to the negative, accented *not*, as seen in example (30), has the following category:[62]

(84) $\text{NOT} := (S_{\top,\theta,inf} \backslash NP)/(S_{\top,\theta,inf} \backslash NP) : \left\{ \begin{array}{c} \lambda p \lambda y. \neg p\, y \\ \lambda p \lambda y. \ p\, y \end{array} \right\}$

       L+H*

The derivations of the earlier examples (29) and (30) are left as an exercise.[63]

4.3.1. ONLY. We saw earlier that adnominal *only* operated on both the ordinary and alternative logical forms. It is usually unaccented, when it is assigned the following category:

(85) $\text{only} := NP^{\uparrow}/NP^{\uparrow} : \lambda np \lambda p \lambda \ldots . np^o\ p\ \ldots \wedge \forall a \in \{np^a\}\,[a\, p\ \ldots \rightarrow (a = np^o)]$

This category schema takes the pair (Λ^o, Λ^a) corresponding to the meaning of a type-raised nounphrase $NP\uparrow$, decomposes it into its ordinary and alternative components Λ^o and Λ^a, and yields a new category of the same type whose ordinary and alternative parts are the same, and mean that the original ordinary logical form applied to a predicate p (and whatever other arguments … it needs) holds, and no other member of the original alternative set holds.

For example, the following is an appropriate answer to the question *Who did* ANNA *marry?*:

(86)

"I suppose the question of who Anna married to be common ground, I make it common ground it was Manny and none of the alternatives"

(The answer uses the second-mention contrastive thematic category (68) for unaccented *Anna*.)

Taglicht (1984):148-151 points out that determiners like *only*, resemble the negative determiner *no* in being able to take scope over higher verbs in complex sentences. Thus (87a) is ambiguous between readings paraphrasable as (87b,c):

---

[61] This approach stands in contrast in this respect with the algorithmic account of focus and accent placement of Hajičová et al. (1995), developed within the Prague School approach to topic-focus articulation.

[62] Cf. note 17.

[63] The categories for accented and unaccented *doesn't*, *wasn't*, etc., are simply the compositions of the standard auxiliary categories with the above categories, as in *TS*.

(87) a. They asked us to review no/only books.
      b. They asked us to not/only review books.
      c. They didn't ask/only asked us to review books.

Since the syntactic and semantic analysis of such "scope splitting" examples with *only* is exactly parallel to their analysis with *no* in Błaszczak and Gärtner 2005 and *TS*:§11.3,ex3-74, where additional semantic issues arising from polarity and negation are discussed at length, it is passed over here.[64]

The adverbial *only* in the paraphrases (87b,c) has been extensively investigated in alternative semantic frameworks by Rooth (1985, 1992) and Kratzer (1991), among others, and requires the following category, which imports the latter analysis into the present framework, in which the logical form is very similar to that of the adnominal category (85):

(88) only := $((S \backslash NP)/\ldots)/((S \backslash NP)/\ldots) : \lambda p \lambda x \ldots . p^o x \ldots \wedge \forall a \in \{p^a\} [ax \ldots \rightarrow (a = p^o)]$

We also add a parallel adverbial category for *also*:

(89) also := $((S \backslash NP)/\ldots)/((S \backslash NP)/\ldots) : \lambda p \lambda x \ldots . p^o x \ldots \wedge \exists a \in \{p^a\} [ax \ldots \wedge a \neq p^o)]$

/... and ... respectively schematize syntactically and semantically over a small number of further rightward arguments of the VP and their interpretations, making these categories verb- rather than VP–modifiers. Examples involving these operators are deferred to the next subsection.

4.3.2. "Second occurrence focus" and "nested focus." Unaccented *only* phrases are commonly also found in contexts where they are unmarked themes. For example, if we are trying to detect the source of an outbreak of food-poisoning among diners at a restaurant, questions like the following:

(90) a. Which guest ate only TOFU?
      b. Who only ate VEGETABLES?

—are likely to give rise to answers like the following:

(91) a. ANNA ate only tofu.
      b. MANNY only ate vegetables.

It is clear that "ate only tofu" is a theme in (91a), because if "tofu" is to have an accent at all, it has to be an L+H* *theme* accent. We also assumed in connection with (78) that the heads of transitive arguments like "tofu" were contrastive, despite their lack of accent. Example (91a) therefore gives rise to the derivation in figure 1, in which "tofu" behaves just as if it bore an alternatives-evoking theme accent. This analysis is equivalent to attributing a distinct "second occurrence focus" category to the object, including a contrastive alternative logical form on the relevant word, as in *tofu_F* (Rooth 1996).

The literature is divided on the question of whether second occurrence focus is phonologically distinct from the corresponding uncontrasted item, and marked by some form of phonetic prominence such as length or intensity (Rooth 1992; Bartels 1997; Beaver et al. 2007), or whether it is indistinguishable from simple noncontrastivity (Partee 1991, 1999; Krifka 1996/2002). The instrumental data are equivocal on this

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[64] Błaszczak and Gärtner (2005) (who anticipated the account in *TS*) and Gärtner (to appear), assume a additional specifically prosodic Condition on Extended Scope Taking (CEST), limiting the domain of negation to surface strings that are continuous and constitute a single prosodic phrase. In *TS*, as in Wagner 2005:114, the scope of all operators, including negation, is limited solely by the projection of their lexical logical form by syntactic derivation. While we have seen that prosodic structure is also subject to surface derivation, Wagner shows that negative split scope can cross prosodic boundaries and discontinuous constituents, as the present theory predicts.
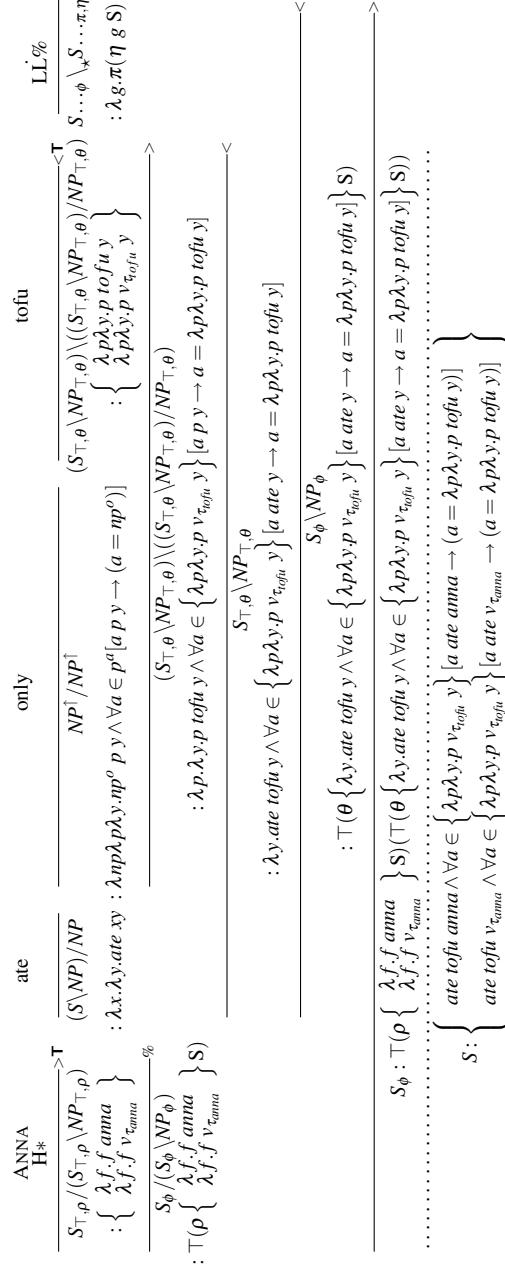
ANNA   ate   only   tofu   LL$\dot{\%}$

H$_*$

$$S_{\top,\rho}/(S_{\top,\rho}\backslash NP_{\top,\rho})$$
$$: \left\{ \begin{array}{l} \lambda f.f\ anna \\ \lambda f.f\ v_{\tau_{anna}} \end{array} \right\}$$

$(S\backslash NP)/NP$
$: \lambda x.\lambda y.ate\ xy$

$NP^{\uparrow}/NP^{\uparrow}$
$: \lambda np\lambda p\lambda y.np^o\ p\ y \wedge \forall a \in p^a[a\ p\ y \rightarrow (a=np^o)]$

$(S_{\top,\theta}\backslash NP_{\top,\theta})\backslash((S_{\top,\theta}\backslash NP_{\top,\theta})/NP_{\top,\theta})$
$: \left\{ \begin{array}{l} \lambda p\lambda y.p\ tofu\ y \\ \lambda p\lambda y.p\ v_{\tau_{tofu}}\ y \end{array} \right\}$

$S\cdots\phi\backslash_\star S\cdots\pi.\eta$
$: \lambda g.\pi(\eta\ g\ S)$

$$\frac{S_\phi/(S_\phi\backslash NP_\phi)}{:\top(\rho\left\{\begin{array}{l}\lambda f.f\ anna\\ \lambda f.f\ v_{\tau_{anna}}\end{array}\right\}S)}$$

$(S_{\top,\theta}\backslash NP_{\top,\theta})\backslash((S_{\top,\theta}\backslash NP_{\top,\theta})/NP_{\top,\theta})$
$: \lambda p.\lambda y.p\ tofu\ y \wedge \forall a \in \left\{ \lambda p\lambda y.p\ v_{\tau_{tofu}}\ y \right\}[a\ p\ y \rightarrow a = \lambda p\lambda y.p\ tofu\ y]$

$$\frac{S_{\top,\theta}\backslash NP_{\top,\theta}}{: \lambda y.ate\ tofu\ y \vee \forall a \in \left\{ \lambda p\lambda y.p\ v_{\tau_{tofu}}\ y \right\}[a\ ate\ y \rightarrow a = \lambda p\lambda y.p\ tofu\ y]}$$

$$\frac{S_\phi\backslash NP_\phi}{: \top(\theta\left\{\lambda y.ate\ tofu\ y\right\}S)(\top(\theta\left\{\lambda y.ate\ tofu\ y \vee \forall a \in \left\{\lambda p\lambda y.p\ v_{\tau_{tofu}}\ y\right\}[a\ ate\ y \rightarrow a = \lambda p\lambda y.p\ tofu\ y]\right\}S))}$$

$$S_\phi : \top(\rho\left\{\begin{array}{l}\lambda f.f\ anna\\ \lambda f.f\ v_{\tau_{anna}}\end{array}\right\}S)(\top(\theta\left\{\begin{array}{l}\lambda y.ate\ tofu\ y\\ \lambda y.ate\ tofu\ y \vee \forall a \in \left\{\lambda p\lambda y.p\ v_{\tau_{tofu}}\ y\right\}[a\ ate\ y \rightarrow a = \lambda p\lambda y.p\ tofu\ y]\end{array}\right\}S))$$

$$S : \left\{ \begin{array}{l} ate\ tofu\ anna \wedge \forall a \in \left\{\lambda p\lambda y.p\ v_{\tau_{tofu}}\ y\right\}[a\ ate\ anna \rightarrow (a = \lambda p\lambda y.p\ tofu\ y)] \\ ate\ tofu\ v_{\tau_{anna}} \vee \forall a \in \left\{\lambda p\lambda y.p\ v_{\tau_{tofu}}\ y\right\}[a\ ate\ v_{\tau_{anna}} \rightarrow (a = \lambda p\lambda y.p\ tofu\ y)] \end{array} \right\}$$

Figure 1:

"I suppose the question of who ate tofu and none of the alternatives to be common ground. I make it common ground that it was Anna"

point (Howell 2008). The present paper remains entirely agnostic on the reality of any phonological difference between objects in examples like figure 1 and other deaccented occurrences.[65]

Support for the present position can be derived from an observation by Wold (1996) concerning the particular version of in situ focus (that is, contrast) proposed by Rooth and Kratzer. Wold points out that it is a consequence of their theory of focus projection that if there are multiple foci and multiple focus sensitive operators like *only*, each focus is captured by the lowest focus sensitive operator whose scope it is in. This consequence makes the wrong prediction for "nested focus" examples like the following elaborated answer to the question "Who did John introduce to Bill?":

> (92) a. Anna only introduced SUE to Bill.
>   b. Anna also only introduced Sue to TOM

The available reading supported by the context is (93a), in which the parentheses indicate the scope of the operators "also" and "only" meaning that Anna introduced Sue and no one else to Tom and to someone else, who the context establishes to be Bill.

> (93) a.   Anna also ((only introduced Sue) to TOM)
>   b. #Anna also ((only introduced Sue to TOM))

However, if both the second mention focus and the novel focus in the second sentence are captured by *only*, that sentence will only yield the contextually infelicitous reading (93b) meaning that Anna introduced Sue and no one else to Tom and to no one else.

This problem is serious enough to have made Rooth (2010) somewhat grudgingly adopt a structured meanings analysis of such examples, as advocated by von Stechow. However, while a structured meanings approach using free abstraction will correctly deliver both readings (93), it will also, unless constrained, yield a third reading, in which the operators and foci cross dependencies, meaning that Anna introduced Sue, among other people, to Tom and to no one else. Such a reading does not in fact appear to be available.

The present strictly in situ theory ties the projection of rheme focus (that is, accent) to the syntactic derivation, so it only allows the two readings indicated in (93a,b). The consistent reading (b) is correctly derived as in figure 2, notwithstanding speculation to the contrary by Pulman (1997a:87—cf. section 5.2.2 below).

As in the case of the unaccented theme *only ate tofu* in figure 1, the unaccented theme *only introduced Sue* in figure 2 has a non-trivial alternative logical form Λ^a, stemming from the unaccented object category (77). The derivation therefore delivers the second ocurrence focus reading semantically, as in Rooth's and Schwartzchild's accounts, rather than anaphorically, as in Krifka's.

The present account, which ties the scope of the focusing operators strictly to syntactic derivation, may thus be seen as representing an advance on the earlier alternative semantics-based accounts of Rooth and Büring using autonomous focus projection, without invoking the less constrained machinery of structured meanings or anaphoric access to second occurrence focus.[66]

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[65] To take this position is not to deny that second occurrence focus may differ phonetically from simple given uses, as Rooth and others claim they do. It is simply to assert that any such differences may not be categorial.

[66] The semantic treatment of second occurrence focus is not forced by the present theory. The same derivation would deliver the correct result for an anaphoric theory of the kind tentatively advocated by Krifka (1996/2002), on the assumption that the relevant alternative set is accessed anaphorically at the point in the derivation where the truth of the claim that *only ate tofu* is thematic is assessed against the hearer's representation of context/common ground.

Figure 2:

5. GENERALIZATIONS AND CONCLUSIONS.

5.1. CROSS-LINGUISTIC DIFFERENCES IN ACCENT PLACEMENT. To the extent that it is correct, it is to be expected that the semantics outlined above will prove to be universal, and that a similarly lexicalized approach will apply cross-linguistically.

However, different languages and dialects are free to distribute the semantic work differently across their morpho-syntactic and prosodic systems. This section glances briefly at some specific differences in German and Italian, in which more of the work of denoting thematic and rhematic elements is done by syntax and linear order than in English.[67]

5.1.1. ITALIAN. The Romance languages discussed by Ladd (1996) and Zubizarreta (1998) exhibit stronger constraints on non-final accents than English. *All* utterances lacking final rheme accents, including all-rheme utterances, are disallowed, even as answers to *wh*-questions, and are *only* allowed as a result of second-occurrence focus deaccenting of the verb, as in (94c):

(94) a. Q: Che c'è di nuovo?
              "What's new?"
          A: #(Tua MAMMA ha telefonato)$_\rho$.   "Your MOTHER phoned."
                   H*   LL%
      b. Q: Chi ha telefonato?
              "Who phoned?"
          A: #(Tua MAMMA)$_\rho$ (ha telefonato)$_\theta$.   "Your MOTHER phoned."
                   H*   LL%
      c. Q: Ha telefonato Gianni?
              Did Gianni phone?
          A: No, (tua MAMMA ha telefonato)$_\rho$.   "No, your MOTHER phoned."
                   H*   LL%

For all-rheme utterances and answers to *wh*-questions, the subject must instead be postponed:

(95) a. Q: Che c'è di nuovo?
          A: (Ha telefonato tua MAMMA)$_\rho$.
                               H*   LL%
      b. Q: Chi ha telefonato?
          A: (Ha telefonato)$_\theta$ (tua MAMMA)$_\rho$.
                               H*   LL%
      c. Q: Ha telefonato Gianni?
          A: No, (Ha telefonato tua MAMMA)$_\rho$.
                               H*   LL%

Rather similar restrictions of weight etc. on unaccented objects in such inversions to those discussed for English appear to apply.

These facts can be captured in the following assumptions:

1. Accented NPs in Italian have exclusively leftward-applying (nominative and accusative) rheme-marked categories, type-raised over rightward-combining (intransitive and transitive) verb-categories, e.g.: [68]

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[67] Hoffman (1995a,b), Özge (2003), and Komagata (1999) show that a related analysis can be applied to information structure in Turkish and Japanese, and that in both languages word order is partly determined by information structure.

[68] This amounts to assuming a base-generated rightmost "dedicated focus position" or functional projection for Italian and related languages (Antinucci and Cinque 1977; Cinque 1993; Zubizarreta 1998), without the attendant assumptions of movement and transderivational constraints—see Samek-Lodovici 2005 for

$$\begin{array}{lll} \text{GIANNI} & := & S_\rho\backslash(S_\rho/NP_\rho) \\ \text{H*} & & (S_\rho\backslash NP_\rho)\backslash((S_\rho\backslash NP_\rho)/NP_\rho) \\ & & \&c \end{array}$$

2. Unaccented NPs in Italian have exclusively rightward-applying (nominative) unmarked categories, type-raised over leftward combining (intransitive) verbs, e.g.:

   Gianni $\quad := \quad S/(S\backslash NP)$

3. Unaccented intransitive verbs are exclusively unmarked VS or inverting, e.g.:

   telefonato $\quad := \quad S_{ppt}/NP$

4. Accented intransitive verbs are exclusively rheme-marked SV, e.g.: [69]

   $$\begin{array}{lll} \text{TELEFONATO} & := & S_{ppt,\rho}\backslash NP_\rho \\ \text{H*} & & \end{array}$$

5. Transitive verbs are exclusively SVO, and may be accented/marked or not, e.g.:

   $$\begin{array}{lll} \text{telefonato/TELEFONATO} & := & (S_{ppt}\backslash NP)/NP \\ \text{H*} & & \end{array}$$

We also assume a lexical rule of pro-drop that converts Italian tensed SV(X) verbs into V(X) verbs whose semantics includes an anaphoric subject, making the following equivalent to to English right-dislocated *She 'phoned, your mother*:

(96) Ha TELEFONATO, tua Mamma.

In many languages, including English, French, and Italian, right-dislocated arguments and adjuncts have the character of afterthoughts, identifying referents that should have been background, and receiving low pitch. We assume that the relation between dislocated arguments and the proposition is discourse-anaphoric, rather than purely syntactic.

We further assume that the possibility of non-final accent in corrections like (94c) (which some informants find somewhat odd) arises from the possibility of pro-drop and *left*-dislocation of the subject *tua* MAMMA. In many languages, including English, left dislocation is associated with topic-marking, and this may apply to Italian examples like (94c) (in which case, such dislocated subjects are in present terms (contrastive) *themes*).

5.1.2. GERMAN. German has a rather similar mapping of tones to information-structural meanings to English (see Büring 1997b; Jaeger and Wagner 2003; Wagner 2003, 2006; Braun 2006). However, syntax does more of the work of delimiting thematic and rhematic elements. In particular, first position seems to be strongly associated with theme, even to the extent of separating accented material from other apparently thematic elements, as in (98), below:[70,71]

discussion.

[69] Again, this amounts to assuming a rightmost "dedicated focus position".

[70] Féry (1993) writes such German rheme or *F* accents as H*+L, but I incline to the view of Wunderlich (1991), Braun (2006), and Wagner (2008) that these are H+L*.

[71] As Büring 1997a:83-87 points out, German does not allow any reversal of theme-rheme order analogous to English examples like (9), a fact among many others (including the fact that in German as in English, operators like *auch/also* seem to associate with rhemes and *not* with themes) which he uses to argue *avant la lettre* against the claim of Wagner (2008) that answers like these are "nested focus" structures like (92) discussed in section 4.3.2.

(97) Q: Ich weiss, wer den Danny geheiratet hat. Aber wer hat den MANNY geheiratet?

"I know who married DANNY. But who married *Manny*?"

    A: (Den MANNY)$_\theta$ (hat ANNA geheiratet)$_\rho$.

       L*+H   H+L*   LL%

"ANNA married MANNY."

(98) Q: Ich weiss, wen Anna gesehen hat. Aber wen hat Anna GEHEIRATET?

"I know who Anna SAW. But who did Anna MARRY?"

    A: (GEHEIRATET)$_\theta$ (hat Anna den MANNY)$_\rho$.

         L*+H   H+L*   LL%

"Anna MARRIED MANNY."

Despite this point of similarity, there are considerable differences. Büring (2003) claims that all-theme utterances parallel to (24) do not exist in German. (see Constant 2006:secn.4.3 for some discussion). The details of how intonation and information structure can be more fully integrated into a CCG account of the grammar of Germanic and Romance languages remains a topic for future research.

5.2. INTONATION, COORDINATION, AND EXTRACTION. The present theory extends the claims in Steedman 1991, 2000a that intonation structure, as defined by intonational boundaries, is homomorphic to surface syntactic derivational structure, in the sense that every intonational phrase is also a semantically interpreted syntactic derivational constituent. This is accomplished by making morpholexical categories for accented words, such as (62) and (63), project θ/ρ-marking onto the result of their syntactic combination. Boundary tone categories, such as (69), then apply to θ/ρ-marked syntactic constituents to ϕ-mark them as phonological phrases, bounding θ/ρ-projection, and limiting the result to combination with other ϕ-marked prosodic phrases.

The elimination of an independent level of intonation structure is desirable, because it also eliminates the need for any mechanism of focus projection distinct from syntactic derivation. It follows, as we have seen, that the semantics of information structure can be computed as part of standard compositional interpretation of CCG, of the kind described in *TS*.

This observation carries a number of further implications for the theory of intonation structure and its relation to syntax and semantics.

5.2.1. THE GENERALIZATION. It will be recalled that the present theory makes coordinate structures (including those exemplified in right node-raising (60)) and the domain of topicalization/relativization (exemplified in (57)) identical to surface derivational constituency.

It follows that this theory also predicts the strongest possible relation between intonation structure, information structure, coordination, and extraction, as follows (cf. Steedman 1991):

(99) All and only those substrings that can either undergo coordination or be extracted over can be intonational phrases and information structural units, and vice versa.

Such a condition is enforced as a direct consequence of strict adherence in the present account to the constituent condition on rules (Chomsky 1955/1975:210-211—see *SP*:12-14 for discussion) over all three domains.

5.2.2. ON SOME SUPPOSED COUNTEREXAMPLES TO THE GENERALIZATION.

Joshi 1990:517, and following him Pulman 1997a:85, have suggested that exchanges like the following (from Pulman, structure and prosody added) present counterexamples to this generalization:

(100) Q: What about MARY? What does SHE admire?
      A: (Mary)((admires MUSICALS), (but DETESTS OPERA)).
                    H*   L   H*   H*   LL%

Both authors seem to assume that, because speaker A establishes *Mary admires* as a possible theme, and the conjunction uttered in response by speaker B requires *admires musicals* to be a constituent, this is a case where information structure diverges from intonation/syntactic derivation.

However, we know from example (13) that contexts like the above allow the speaker B to overrule A, and define *Mary* as theme, so examples like (100) do not constitute evidence for any such divergence.

Pulman 1997a:86 further suggests that the intonation structure (101a) cannot be the same as the surface syntactic derivational structure, because the theme *They only asked whether I* KNEW supposedly violates an island constraint.

(101) a. (They only asked whether I KNEW)$_\theta$ (the woman who chairs the ZONING board)$_\rho$
                       L+H* LH%   H*   LL%
     b. Who did they ask whether you knew?
     c. #What did they ask whether you knew the woman who chaired?
     d. #(They asked whether I knew the woman who CHAIRED)$_\theta$ (the ZONING board)$_\rho$
                               L+H* LH%   H*   LL%

However, the acceptability of (101b) as a context for (101a) shows that no island is involved. When there actually is a *wh*-island, as in (101c), and hence a constraint on CCG constituency, then the corresponding intonational bracketing (101d) is indeed equally bad.

Nor in the context of questions like (101b) are the alternatives invoked necessarily confined to women who chair things, as Pulman claims. Such examples therefore confirm rather than controvert the present generalization.

Nor is it the case, as is also claimed by Pulman, that CCG has difficulty with his (51):

(102) John only introduced)$_\theta$(MARY to SUE)$_\rho$

Inspection of the nonstandard constituent *Tom to Sue* in derivation (61) (cf. Steedman 1990a) should make it obvious how such multi-accented information-structural elements are handled without invoking any "more complex 'wrapping' operations" of the kind that Pulman hypothesises. Such examples therefore confirm rather than controvert the present generalization.

5.2.3. ON RELATING TO THE GRID. Another source of potential objections to the present claim of homomorphism between intonation structure and derivational syntactic structure comes from the quarter in which one might have expected it to be most welcome, namely autosegmental-metrical (AM) phonology itself. Such objections reflect a widespread misunderstanding of the relation between metrical and phrasal phenomena in language, which should be thought of as strictly parallel to that pertaining to music, in which there is a well-understood separation between the metrical framework established by the time-signature, bar-lines, ties etc., and rhythmic and melodic phrasing, which is interpreted in relation to, and temporally constrained by, regular meter (Cooper and Meyer 1963:4-7).

We have been able until this point to ignore metrical aspects of prosody, and to dis-

cuss the mapping between logical form (including information structure) and lexical-ized syntax (including intonation structure), in an entirely analytic direction, taking strings of accented and unaccented words as given.

When viewed as a generative theory of the prosody system as a whole, the present theory therefore bears some resemblance to the "accent-first" accounts of Schmerling (1976), Prince (1983), Gussenhoven (1983b), and Selkirk (1984:251) in assuming that accents and boundaries of the kind proposed by Pierrehumbert are assigned indepen-dently from meter, as a reflex of information structure and contrast expressed at the level of logical form, and hence of morphosyntax in the extended sense of that term implied by CCG.[72]

However, the present paper rejects the strict layer hypothesis of Selkirk and Nes-por and Vogel (1986). Because boundary tone categories like (69) mark phonological phrases as combining with other phonological phrases to yield phonological phrases, it is a consequence of the present theory that the intonational phrase is intrinsically recur-sive, as proposed by Ladd, rather than nonrecursive as proposed by Selkirk (1984) and Nespor and Vogel (1986:16) under the Strict Layer Hypothesis (but cf. Nespor 1990).

Thus, as well as the recursive ϕ marking of the utterance level phrase already seen in derivations like (70), there are two distinct recursive analyses of coordinate phrases like *the waiter and the porter and the upstairs maid*:[73]

(103) a. ([(the waiter)$_\phi$ (and the porter)$_\phi$]$_\phi$ (and the upstairs maid)$_\phi$)$_\phi$

b. ((the waiter)$_\phi$ [(and the porter)$_\phi$ (and the upstairs maid)$_\phi$]$_\phi$)$_\phi$

The metrical foot, and under at least some definitions (e.g. Nespor and Vogel 1986:109-110—cf. Dalrymple and Mycock 2011), the "prosodic word" should not be regarded as a level of intonation structure at all. They should rather be viewed as a phenomenon of a quite separate low-level process aligning the phonological form with a metrical framework or "grid"., which has the content-free character of meter in music. Such processes determine phrasings like the following for structures like (103) (Crosby et al. 1941):

(104) ‖$\frac{2}{4}$ (rest) The | WAITer'n the | PORTer'n the | UPstairs | MAID   ‖

Such alignment is here assumed to arise from processes operating purely at the level of the string, to align primary accents with primary metrical stress, align lexical stress and quantity with lesser beats, and in the case of at least some dialects of English, resolve clashing adjacent stresses via a "Rhythm Rule" that in the above case turns "upSTAIRS MAID" into "UPstairs MAID."[74]

Purely metrical units such as the "foot" do not necessarily align with phrasal syn-tactic and prosodic boundaries, although they undoubtedly do determine such offline processes as diachronic lexicalization, as discussed for Germanic within a strict layer framework by Lahiri and Plank 2010. The accenting of "UPstairs MAID" in (104) may

[72] Accent-first theories stand in contrast to the "stress-first" theories of Chomsky (1971); Jackendoff (1972); Liberman (1975); Bing (1979); Ladd (1980); Halle and Vergnaud (1987); Cinque (1993), and Calhoun (2010). See Selkirk 1995 and Ladd 2008:263-280 for discussion.

[73] Ladd (1988, 2008), Féry and Truckenbrodt (2005), and Wagner (2010) discuss phonetic differences at phrase boundaries reflecting depth of embedding for similar coordinate structures. However the current approach does not assume any such strong relation between strength of prosodic boundaries and depth of em-bedding. Boundaries of any strength, including the utterly unmarked boundaries introduced by the prosodic phrase promotion rule (71), will allow either of the structures in (103), so under present assumptions any such correlations are epiphenomenal rather than categorial.

[74] Such string-level metrical rules should probably be thought of computationally as a cascade of finite state transducers, optimized by dynamic programming, of the kind successfully used for prosodic speech synthesis by Ostendorf and Veilleux (1994), rather than elements of grammar proper.

well be lexicalized in the relevant dialects, in which case the role of the English Rhythm rule is also offline.

5.3. CONCLUSION. The system proposed here reduces the literal meaning of the tones to just four semantically grounded binary oppositions, namely: realization in (distributed) common ground; speaker/hearer agency in that realization; contrast/background; and theme/rheme information-structural status, the latter defined in terms of acts of supposition and update of common-ground. The semantics for the tones is cast in a strictly in situ version of alternative semantics in which "focus projection" is entirely accomplished by syntactic derivation, overcoming some empirical shortcomings of earlier versions of the latter approach noted by Wold (1996).

Crucially, these markers concern suppositions that the speaker *claims* by their utterance that they and/or the hearer hold, as distinct from the actual beliefs of either party. It is therefore consistent for the speaker to claim and/or implicate that either they or the hearer does or does not suppose a proposition to already be common ground, or make it common ground, whether or not they actually believe it and whether or not it actually is, or actually does become, common ground. (This is a move that is forced in the present theory by examples like (24) and (44).)

The theory places a correspondingly greater emphasis on the role of speaker-presupposition (and its dual, hearer-accommodation), and on the part played by inference and implicature. To that extent, the present theory follows Halliday, Rooth, Brown 1983:67, Gussenhoven 1983a, Brazil 1997, and Schwarzschild 1999:151 in claiming that it is the speaker who, within the constraints imposed by the context and the participants' actual beliefs and intentions, determines what is theme and rheme, and what contrasts they embody, rather than the context alone.

Within the present framework, implicatures arise from dissonance between the actual state of belief of the hearer, and the (often blatantly false) claims that the speaker makes, in English via intonation, concerning speaker/hearer supposition, contrast, and the changing state of common ground. Traditional functions of the English tones to signal other-directedness, floor-yielding, turn-taking, continuation, politeness, deixis, face, affect, lack of commitment, uncertainty, etc., arise from these literal meanings as indirect effects mediated by inference, which like other more traditional examples of Gricean conversational implicatures, are emergent side-effects of the hearer's fundamental need to maintain consistency at all costs.

The notorious unreliability of ToBI annotators in drawing certain of the AM distinctions assumed here, including the crucial H*/L+H* distinction, discussed in Steedman (2007), makes it hard to test this hypothesis empirically in English using existing corpora. For exactly the same reason, attempts to train intonational recognizers using supervised machine learning over ToBI-labeled data have generally not worked well (Taylor 2000).[75]

It is therefore an important prediction of the theory that, in other languages, the same semantics may at least in part be found to be associated with morphosyntactic rather than intonational markers, such as aspectual inflections and "discourse particles" (Deniston 1934; Schubiger 1965, 1980; Chao 1968; Schauber 1978; Luke 1990; Ho 1993; Maynard 1999; Hole 2004). Tone languages, such as varieties of Chinese, and

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[75] In fact, this is one of the few areas of computational linguistics where *un*supervised machine learning methods using raw data work better than supervised training on human labels: Pate and Goldwater (2011) show that a syntactic chunk recognizer trained on part of the NXT-Format Switchboard corpus (Calhoun et al. 2010) using acoustic features of the speech wave as a whole does better than a similar recognizer trained using ToBI labels.

languages with lexical accent such as Japanese seem to be particularly promising cases (see Büring 2010).

It may or may not be encouraging to remark that the descriptive literature on the semantics of discourse particles in these languages appears to offer a similar diversity of pretheoretical assumptions and ad hoc discourse functional labels to that hitherto found in the literature on intonation in English.

<h2 style="text-align:center">REFERENCES</h2>

ANTINUCCI, FRANCESCO and CINQUE, GUGLIELMO. 1977. Sull'ordine delle parole in italiano: l'emarginazione. Studi di Grammatica Italiana 6 121–146.

BACH, EMMON. 1979. Control in Montague Grammar. Linguistic Inquiry 10 513–531.

——. 1980. In defense of passive. Linguistics and Philosophy 3 297–341.

BALDRIDGE, JASON and KRUIJFF, GEERT-JAN. 2003. Multi-Modal Combinatory Categorial Grammar. Proceedings of 11th Annual Meeting of the European Association for Computational Linguistics, 211–218. Budapest.

BARD, ELLEN GURMAN, ANDERSON, ANNE, SOTILLO, CATHERINE, AYLETT, MATTHEW, DOHERTY-SNEDDON, GWYNETH, and NEWLANDS, ALISON. 2000. Controlling the intelligibility of referring expressions in dialogue. Journal of Memory and Language 42 1–22.

BARD, ELLEN GURMAN and AYLETT, MATTHEW. 2005. Referential form, duration, and modelling the listener in spoken dialogue. John Trueswell and Michael Tanenhaus (eds.), Approaches to Studying World-situated Language Use: Bridging the Language-as-Product and Language as Action Traditions, 173–191. Cambridge, MA: MIT Press.

BARTELS, CHRISTINE. 1997. Towards a Compositional Interpretation of English Statement and Question Intonation. Ph.D. thesis, University of Massachusetts, Amherst.

BEAVER, DAVID. 2001. Presupposition and Assertion in Dynamic Semantics. Stanford, CA: CSLI Publications.

BEAVER, DAVID and CLARK, BRADY. 2008. Sense and Sensitivity: How Focus Determines Meaning. Chichester: Wiley-Blackwell.

BEAVER, DAVID, CLARK, BRADY, FLEMMING, EDWARD, JAEGER, FLORIAN, and WOLTERS, MARIA. 2007. When semantics meets phonetics: Acoustical studies of second occurrence focus. Language 83 245–276.

BECKMAN, MARY and HIRSCHBERG, JULIA. 1999. The ToBI annotation conventions. Ms. Ohio State University.

BECKMAN, MARY, HIRSCHBERG, JULIA, and SHATTUCK-HUFFNAGEL, STEPHANIE. 2005. The original ToBI system and the evolution of the ToBI framework. Sun-Ah Jun (ed.), Prosodic Typology: the Phonology of Intonation and Phrasing, vol. I, 9–54. Oxford: Oxford University Press.

BING, JANET. 1979. Aspects of English Prosody. Ph.D. thesis, University of Massachusetts at Amherst. Published by Garland, New York, 1985.

BŁASZCZAK, JOANNA and GÄRTNER, HANS-MARTIN. 2005. Intonational phrasing, discontinuity, and the scope of negation. Syntax 8 1–22.

BOLINGER, DWIGHT. 1958. A theory of pitch accent in English. Word 14 109–149. Reprinted as Bolinger 1965, 17–56.

——. 1961. Contrastive accent and contrastive stress. Language 37 83–96. Reprinted as Bolinger 1965, 101–117.

——. 1965. Forms of English. Cambridge, MA: Harvard University Press.

——. 1972a. Accent is predictable (if you're a mind-reader). Language 48 633–644.

BOLINGER, DWIGHT (ed.). 1972b. Intonation: Selected Readings. Harmondsworth: Penguin Books.

BOLINGER, DWIGHT. 1977. Review of Schmerling (1976). Computational Linguistics: The Finite String 4 2–24. Microfiche 68.

——. 1986. Intonation and Its Parts. Stanford, CA: Stanford University Press.

——. 1989. Intonation and Its Uses. Stanford, CA: Stanford University Press.

BRAUN, B. 2006. Phonetics and phonology of thematic contrast in German. Language and Speech 49 451–493.

BRAZIL, DAVID. 1975. Discourse Intonation. Discourse Analysis Monograph 1. University of Birmingham.

——. 1978. Discourse Intonation II. Discourse Analysis Monograph 2. University of Birmingham.

——. 1997. The Communicative Value of Intonation in English. Cambridge University Press, 2nd edn.

BREEN, MARA, FEDORENKO, EVELINA, WAGNER, MICHAEL, and GIBSON, EDWARD. 2010. Acoustic correlates of information structure. Language and Cognitive Processes 25 1044–1098.

BROWN, GILLIAN. 1983. Prosodic structure and the given/new distinction. Anne Cutler, D. Robert Ladd, and Gillian Brown (eds.), Prosody: Models and Measurements, 67–77. Berlin: Springer-Verlag.

BRUGOS, ALEINA, VEILLEUX, NANETTE, BREEN, MARA, and SHATTUCK-HUFNAGEL, STEPHANIE. 2008. The alternatives (alt) tier for ToBI: Advantages of capturing prosodic ambiguity. Proceedings of Speech Prosody, 273–276. Campinas, Brazil.

BÜRING, DANIEL. 1997a. The great scope inversion conspiracy. Linguistics and Philosophy 20 175–194.

——. 1997b. The Meaning of Topic and Focus: The 59th Street Bridge Accent. London: Routledge.

——. 2003. On d-trees, beans, and B-accents. Linguistics & Philosophy 26 511–545.

——. 2007. Semantics, intonation, and information structure. Gillian Ramchand and Charles Reiss (eds.), Oxford Handbook of Linguistic Interfaces, 445–473. Oxford: Oxford University Press.

——. 2010. Towards a typology of focus realization. Malte Zimmermann and Caroline Féry (eds.), Information Structure, 177–205. Oxford: Oxford University Press.

——. to appear. Syntax, information structure and prosody. Marcel den Dikken (ed.), The Cambridge Handbook of Generative Syntax. Cambridge University Press.

CALHOUN, SASHA. 2006. Intonation and Information Structure in English. Ph.D. thesis, University of Edinburgh.

——. 2010. The centrality of metrical structure in signaling information structure: A probabilistic perspective. Language 86 1–42.

CALHOUN, SASHA, CARLETTA, JEAN, BRENIER, JASON, MAYO, NEIL, JURAFSKY, DAN, STEEDMAN, MARK, and BEAVER, DAVID. 2010. The nxt-format switchboard corpus: A rich resource for investigating the syntax, semantics, pragmatics, and prosody of dialog. Language Resources and Evaluation 44 387–419.

CASSELL, JUSTINE, PELACHAUD, CATHERINE, BADLER, NORM, STEEDMAN, MARK, ACHORN, BRETT, BECKET, TRIPP, DOUVILLE, BRETT, PREVOST, SCOTT, and STONE, MATTHEW. 1994. Animated conversation: Rule-based generation of facial expression, gesture and spoken intonation for multiple conversational agents. Proceedings of the ACM SIGGRAPH '94 Conference, Orlando FL, 413–420.

CHAO, YUEN REN. 1968. A Grammar of Spoken Chinese. Berkeley: University of California Press.

CHOMSKY, NOAM. 1955/1975. The Logical Structure of Linguistic Theory. Chicago: University of Chicago Press.

——. 1971. Deep structure, surface structure, and semantic interpretation. Danny Steinberg and Leon Jakobovits (eds.), Semantics, 183–216. Cambridge: Cambridge University Press.

——. 1995. The Minimalist Program. Cambridge, MA: MIT Press.

CINQUE, GUGLIELMO. 1993. A null theory of phrase and compound stress. Linguistic Inquiry 24 239–297.

CLARK, HERBERT. 1996. Using Language. Cambridge: Cambridge University Press.

CLARK, HERBERT and KRYCH, MEREDITH. 2004. Speaking while monitoring addressees for understanding. Journal of Memory and Language 50 62–81.

CLARK, HERBERT and MARSHALL, CATHERINE. 1981. Definite reference and mutual knowledge. Aravind Joshi, Bonnie Webber, and Ivan Sag (eds.), Elements of Discourse Understanding, 10–63. Cambridge: Cambridge University Press.

CLARK, STEPHEN and CURRAN, JAMES R. 2004. Parsing the WSJ using CCG and log-linear models. Proceedings of the 42nd Annual Meeting of the Association for Computational Linguistics, 104–111. Barcelona, Spain: ACL.

COHEN, PHILIP. 1978. On Knowing What to Say: Planning Speech Acts. Ph.D. thesis, University of Toronto.

COHEN, PHILIP and LEVESQUE, HECTOR. 1990. Rational interaction as the basis for communication. Philip Cohen, Jerry Morgan, and Martha Pollack (eds.), Intentions in Communication, 221–255. Cambridge, MA: MIT Press.

CONSTANT, NOAH. 2006. English Rise-Fall-Rise: A Study in the Semantics and Pragmatics of Intonation. Master's thesis, University of California, Santa Cruz. Http://semanticsarchive.net/Archive.

COOPER, GROSVENOR and MEYER, LEONARD B. 1963. The Rhythmic Structure of Music. University of Chicago Press.

CRESSWELL, MAX. 1973. Logics and Languages. London: Methuen.

——. 1985. Structured Meanings. Cambridge, MA: MIT Press.

CROFT, WILLIAM. 1995. Intonational units and grammatical units. Linguistics 33 839–882.

CROSBY, BING, TEAGARDEN, JACK, and MARTIN, MARY. 1941. The waiter and the porter and the upstairs maid. Decca DLA 2411-1.

CUTLER, ANNE. 1977. The context-independence of "intonational meaning". Procedings of the 13th Regional Meeting of the Chicago Linguistic Society, 104–115. Chicago: CLS.

DALRYMPLE, MARY and MYCOCK, LOUISE. 2011. The prosody semantics interface. Miriam Butt and Tracy Holloway-King (eds.), Proceedings of the LFG Conference, 173–193. Hong Kong: Stanford: CSLI Publications.

DENES, PETER. 1959. A preliminary investigation of certain aspects of intonation. Language and Speech 2 106–122.

DENISTON, JOHN DEWAR. 1934. The Greek Particles. Oxford: Clarendon Press.

DOWTY, DAVID. 1982. Grammatical relations and Montague Grammar. Pauline Jacobson and Geoffrey K. Pullum (eds.), The Nature of Syntactic Representation, 79–130. Dordrecht: Reidel.

DRUBIG, H. BERNHARD. 2003. Toward a typology of focus and focus constructions. Linguistics 41 1–50.

EISNER, JASON. 1996. Efficient normal-form parsing for Combinatory Categorial Grammar. Proceedings of the 34th Annual Meeting of the Association for Computational Linguistics, Santa Cruz, CA, 79–86. San Francisco: Morgan Kaufmann.

ERTESCHIK-SHIR, NOMI. 1997. The Dynamics of Focus Structure. Cambridge: Cambridge University Press.

——. 1998. The syntax-focus structure interface. Peter Culicover and Louise McNally (eds.), Syntax and Semantics, Vol. 29: The Limits of Syntax, 212–240. New York: Academic Press.

FÉRY, CAROLINE. 1993. German Intonational Patterns. Tübingen: Niemeyer.

FÉRY, CAROLINE and SAMEK-LODOVICI, VIERI. 2006. Focus projection and prosodic prominence in nested foci. Language 82 131–150.

FÉRY, CAROLINE and TRUCKENBRODT, HUBERT. 2005. Sisterhood and tonal scaling. Studia Linguistica 59 223–243.

FREUD, SIGMUND. 1925. Negation. James Strachey (ed.), The Ego and the Id, and Other Works. Hogarth Press and the Institute of Psychoanalysis. Standard ed., vol. IX, 235–239.

GÄRDENFORS, PETER (ed.). 1992. Belief Revision. No. 29 in Cambridge Tracts in Theoretical Computer Science. Cambridge: Cambridge University Press.

GÄRTNER, HANS-MARTIN. to appear. Function composition and the linear local modeling of extended neg-scope. Artemis Alexiadou, Tibor Kiss, and Gereon Müller (eds.), Local Modelling of Non-Local Dependencies, 337–352. Berlin: de Gruyter.

GEIS, MICHAEL. 1995. Speech Acts and Conversational Interaction. Cambridge: Cambridge University Press.

GERMAN, JAMES, PIERREHUMBERT, JANET, and KAUFFMAN, STEFAN. 2006. Evidence for phonological constraints on nuclear accent placement. Language 82 151–168.

GINZBURG, JONATHAN. 1996. Interrogatives: Questions, facts, and dialogue. Shalom Lappin (ed.), Handbook of Contemporary Semantic Theory, 385–422. Oxford: Blackwell.

GREEN, NANCY and CARBERRY, SANDRA. 1994. A hybrid reasoning model for indirect answers. Proceedings of the 2nd, 58–65. ACL.

——. 1999. Interpreting and generating indirect answers. Computational Linguistics 25 389–435.

GRICE, HERBERT. 1975. Logic and conversation. Peter Cole and Jerry Morgan (eds.), Speech Acts, *Syntax and Semantics*, vol. 3, 41–58. New York: Seminar Press. Written in 1967.

GUNDEL, JEANETTE. 1999. On different kinds of focus. Peter Bosch and Rob van der Sandt (eds.), Focus: Linguistic, Cognitive, and Computational Perspectives, 293–305. Cambridge: Cambridge University Press.

GUNLOGSON, CHRISTINE. 2001. True to Form: Rising and Falling Declaratives in English. Ph.D. thesis, University of California at Santa Cruz. In preparation.

——. 2002. Declarative questions. Brendan Jackson (ed.), Proceedings of *Semantics and Linguistics Theory XII*, 144–163. Ithaca, NY: Cornell University. To appear.

GUSSENHOVEN, CARLOS. 1983a. On the Grammar and Semantics of Sentence Accent. Dordrecht: Foris.

——. 1983b. Testing the reality of focus domains. Language and Speech 26 61–80.

——. 2007. Types of focus in english. Chungmin Lee, Matthew Gordon, and Daniel Büring (eds.), Topic and Focus, 83–100. Berlin: Springer.

HAJIČOVÁ, EVA and SGALL, PETR. 1988. Topic and focus of a sentence and the patterning of a text. János Petöfi (ed.), Text and Discourse Constitution, 70–96. Berlin: de Gruyter.

HAJIČOVÁ, EVA, SKOUMALOVÁ, HANA, and SGALL, PETR. 1995. An automatic procedure for topic-focus identification. Computational Linguistics 21 81–94.

HALLE, MORRIS and VERGNAUD, JEAN-ROGER. 1987. An Essay on Stress. Cambridge, MA: MIT Press.

HALLIDAY, MICHAEL. 1963. The tones of English. Archivum Linguisticum 15 1.

——. 1967a. Intonation and Grammar in British English. The Hague: Mouton.

——. 1967b. Notes on transitivity and theme in English, part ii. Journal of Linguistics 3 199–244.

HAUSSER, ROLAND. 1984. Surface Compositional Grammar. Munich: Wilhelm Fink Verlag.

HEDBERG, NANCY. 2006. Topic-focus controversies. Valeria Molnar and Susanne Winkler (eds.), The Architecture of Focus. Berlin: Mouton de Gruyter.

HEDBERG, NANCY and SOSA, JUAN. 2006. The prosodic structure of topic and focus in spontaneous English dialogue. Chungmin Lee, Matthew Gordon, and Daniel Büring (eds.), Topic and Focus:Cross-linguistic Perspectives on Meaning and Intonation, no. 82 in Studies in Linguistics and Philosophy. Dordrecht: Kluwer. Proceedings of the LSA Workshop on Topic and Focus, Santa Barbara, CA July, 2001.

HIGASHIKAWA, MASAHIKO and MINIFIE, FRED. 1999. Acoustical-perceptual correlates of "whisper pitch" in synthetically generated vowels. Journal of Speech, Language, and Hearing Research 42 583–591.

HO, YONG. 1993. Aspects of Discourse Structure in Mandarin Chinese. Lewiston, NY: Edwin Mellen Press.

HOBBS, JERRY. 1990. The pierrehumbert-hirschberg theory of intonational meaning made simple: Comments on pierrehumbert and hirschberg. Philip Cohen, Jerry Morgan, and Martha Pollack (eds.), Intentions in Communication, 313–323. Cambridge, MA: MIT Press.

HOCKENMAIER, JULIA and STEEDMAN, MARK. 2002. Generative models for statistical parsing with Combinatory Categorial Grammar. Proceedings of the 40th Meeting of the Association for Computational Linguistics, 335–342. Philadelphia.

HOFFMAN, BERYL. 1995a. Computational Analysis of the Syntax and Interpretation of "Free" Word-Order in Turkish. Ph.D. thesis, University of Pennsylvania. Publ. as IRCS Report 95–17. Philadelphia: University of Pennsylvania.

——. 1995b. Integrating free word order, syntax, and information structure. Proceedings of the 7th Conference of the European Chapter of the Association for Computational Linguistics, 245–252. Dublin: ACL.

HOLE, DANIEL. 2004. Focus and Background Marking in Mandarin Chinese: System and Theory behind *cái, jiù, dōu* and *yě*. RoutledgeCurzon.

HOWELL, JONATHAN. 2008. Second occurrence focus and the acoustics of prominence. Proceedings of the 26th West Coast Conference on Formal Linguistics (WCCFL), vol. 26, 252–260.

ITO, KIWAKO and SPEER, SHARI. 2008. Anticipatory effects of intonation: Eye movements during instructed visual search. Journal of Memory and Language 58 541–573.

JACKENDOFF, RAY. 1972. Semantic Interpretation in Generative Grammar. Cambridge, MA: MIT Press.

JACOBS, JOACHIM. 1991. Focus ambiguities. Journal of Semantics 8 1–36.

JACOBSON, PAULINE. 1992. Flexible categorial grammars: Questions and prospects. Robert Levine (ed.), Formal Grammar, 129–167. Oxford: Oxford University Press.

JAEGER, FLORIAN and WAGNER, MICHAEL. 2003. Association with focus and linear order in German. Semantics Archive.

JOSHI, ARAVIND. 1990. Phrase structure and intonation: Comments on the papers by marcus and steedman. Gerry Altmann (ed.), Cognitive Models of Speech Processing, 457–482. Cambridge, MA: MIT Press.

KAISSE, ELLEN. 1985. Connected Speech: The Interaction of Syntax and Phonology. Orlando, FL: Academic Press.

KARTTUNEN, LAURI. 1976. Discourse referents. James McCawley (ed.), Syntax and Semantics, vol. 7, 363–385. Academic Press.

——. 1977. Syntax and semantics of questions. Linguistics and Philosophy 1 3–44.

KARTTUNEN, LAURI and PETERS, STANLEY. 1979. Conventional implicature. Choon-Kyu Oh and David Dinneen (eds.), Syntax and Semantics 11: Presupposition, 1–56. New York: Academic Press.

KATZ, JONAH and SELKIRK, ELISABETH. 2011. Contrastive focus *vs.* discourse-new: Evidence from phonetic prominence in English. Language 87 771–816.

KEYSAR, BOAZ, LIN, SHUHONG, and BARR, DALE. 2003. Limits on theory of mind use in adults. Cognition 89 25–41.

KOMAGATA, NOBO. 1999. Information Structure in Texts: A Computational Analysis of Contextual Appropriateness in English and Japanese. Ph.D. thesis, University of Pennsylvania.

KÖNIG, ESTHER. 1994. A hypothetical reasoning algorithm for linguistic analysis. Journal of Logic and Computation 4 1–19.

KRATZER, ANGELIKA. 1991. The representation of focus. Arnim von Stechow and Dieter Wunderlich (eds.), Semantics: An International Handbook of Contemporary Research, 825–834. Berlin: de Gruyter.

KRIFKA, MANFRED. 1991. A compositional semantics for multiple focus constructions. Cornell Working Papers in Linguistics 10 127–158.

——. 1996/2002. Focus and/or context: A second look at second occurrence focus. Hans Kamp and Barbara Partee (eds.), Context-Dependence in the Analysis of Linguistic Meaning: Proceedings of the Prague/Tainach Workshops. Elsevier.

KRUIJFF-KORBAYOVÁ, IVANA and STEEDMAN, MARK. 2003. Discourse and information structure. Journal of Logic, Language, and Information 12 249–259.

LADD, D. ROBERT. 1980. The Structure of Intonational Meaning. Bloomington, IN: Indiana University Press.

——. 1988. Declination "reset" and the hierarchical organization of utterances. Journal of the Acoustical Society of America 84 530–544.

——. 1996. Intonational Phonology. Cambridge: Cambridge University Press. 2nd edition revised 2008.

——. 2008. Intonational Phonology. Cambridge: Cambridge University Press, 2nd edn.

LADD, D. ROBERT and SCHEPMAN, ASTRID. 2003. "Sagging transitions" between high pitch accents in English: Experimental evidence. Journal of Phonetics 31 81–112.

LAHIRI, ADITI and PLANK, FRANS. 2010. Phonological phrasing in Germanic: The judgement of history, confirmed through experiment. Transactions of the Philological Society 108 370–398.

LAMBRECHT, KNUD and MICHAELIS, LAURA. 1998. Sentence accent in information questions: Default and projection. Linguistics and Philosophy 477–544.

LEWIS, DAVID. 1969. Convention: a Philosophical Study. Cambridge, MA: Harvard University Press.

LIANG, PERCY, JORDAN, MICHAEL, and KLEIN, DAN. 2011. Learning dependency-based compositional semantics. Proceedings of the 49th Annual Meeting of the Association for Computational Linguistics: Human Language Technologies, 590–599. Portland, OR: ACL.

LIBERMAN, MARK. 1975. The Intonational System of English. Ph.D. thesis, MIT. Published by Garland Press, New York, 1979.

LIBERMAN, MARK and PIERREHUMBERT, JANET. 1984. Intonational invariance under changes in pitch range and length. Mark Aronoff and Richard Oerhle (eds.), Language Sound Structure, 157–233. Cambridge, MA: MIT Press.

LUKE, KANG KWONG. 1990. Utterance Particles in Cantonese. Amsterdam: John Benjamins.

MANN, WILLIAM and THOMPSON, SANDRA. 1987. Rhetorical structure theory: A framework for the analysis of texts. Tech. Rep. RS-87-185, Information Science Institute, Marina del Rey, CA.

MAYNARD, SENKO. 1999. Discourse analysis and pragmatics. Natsuko Tsujimura (ed.), Handbook of Japanese Linguistics, 425–443. Oxford: Blackwell.

MEURERS, DETMAR and DE KUTHY, KORDULA. 2005. Formal approaches to the interface of syntax and information structure. Lecture Notes, LOT Winter School, Groningen.

MEYER-EPPLER, W. 1957. Realization of prosodic features in whispered speech. Journal of the Acoustical Society of America 29 104–106. Reprinted as Bolinger 1972b:385–390.

NEELEMAN, AD. and SZENDRŐI, KRISZTA. 2004. Superman sentences. Linguistic Inquiry 35 149–159.

NESPOR, MARINA. 1990. On the separation of prosodic and rhythmic phonology. Sharon Inkelas and Draga Zec (eds.), The Phonology-Syntax Connection, 243–258. Chicago: University of Chicago Press.

NESPOR, MARINA and VOGEL, IRENE. 1986. Prosodic Phonology. Dordrecht: Foris.

NICHOLSON, HANNELE and TEIG, ANDREAS. 2003. How to tell beans from farmers: Cues to the perception of pitch accent in whispered norwegian. TromsøWorking Papers in Linguistics 31 315–325.

NILSENOVÁ, MARIE. 2006. Rises and Falls: Studies in the Semantics and Pragmatics of Intonation. Ph.D. thesis, ILLC, Universiteit van Amsterdam.

OEHRLE, RICHARD. 1988. Multidimensional compositional functions as a basis for grammatical analysis. Richard Oehrle, Emmon Bach, and Deirdre Wheeler (eds.), Categorial Grammars and Natural Language Structures, 349–390. Dordrecht: Reidel.

OSTENDORF, MARI and VEILLEUX, NANETTE. 1994. A hierarchical stochastic model for automatic prediction of prosodic boundary location. Computational Linguistics 20 27–54.

ÖZGE, UMUT. 2003. A Tune-Based Account of Turkish Information Structure. Master's thesis, Middle East Technical University, Ankara. `http://www.ii.metu.edu.tr/~umut/`.

PARTEE, BARBARA. 1991. Topic, focus, and quantification. Proceedings of the 1st Conference on Semantics and Linguistic Theory, Ithaca, NY, 159–187.

——. 1999. Focus, quantification, and semantics-pragmatics issues. Peter Bosch and Rob van der Sandt (eds.), Focus: Linguistic, Cognitive, and Computational Perspectives, 213–231. Cambridge: Cambridge University Press.

PATE, JOHN and GOLDWATER, SHARON. 2011. Unsupervised syntactic chunking with acoustic cues: Computational models for prosodic bootstrapping. Proceedings of the 2nd Workshop on Cognitive Modeling and Computational Linguistics, 20–29. Portland, OR: ACL.

PIERREHUMBERT, JANET. 1980. The Phonology and Phonetics of English Intonation. Ph.D. thesis, MIT. Distributed by Indiana University Linguistics Club, Bloomington.

PIERREHUMBERT, JANET and HIRSCHBERG, JULIA. 1990. The meaning of intonational contours in the interpretation of discourse. Philip Cohen, Jerry Morgan, and Martha Pollack (eds.), Intentions in Communication, 271–312. Cambridge, MA: MIT Press.

PITRELLI, JOHN. 2004. ToBI prosodic analysis of a professional speaker of American English. Proceedings of Speech Prosody 2004, 557–560. Nara, Japan.

POESIO, MASSIMO and TRAUM, DAVID R. 1997. Conversational actions and discourse situations. Computational Intelligence 13 309–347.

PREVOST, SCOTT and STEEDMAN, MARK. 1994. Specifying intonation from context for speech synthesis. Speech Communication 15 139–153.

PRINCE, ALAN. 1983. Relating to the grid. Linguistic Inquiry 14 19–100.

PRINCE, ELLEN. 1981. Towards a taxonomy of given-new information. Peter Cole (ed.), Radical Pragmatics, 223–256. New York: Academic Press.

PULMAN, STEPHEN. 1997a. Higher order unification and the interpretation of focus. Linguistics and Philosophy 20 73–115.

PULMAN, STEVE. 1997b. Conversational games, belief revision and bayesian networks. Proceedings of 7th Computational Linguistics in the Netherlands meeting (CLIN-96), 1–25.

——. 1999. Relating dialogue games to information states. Proceedings of European Speech Communication Association workshop on Dialogue and Prosody, De Konigshof, The Netherlands, 17–24.

ROBERTS, CRAIGE. 1996. Information structure in discourse: Towards an integrated formal theory of pragmatics. OSU Working Papers in Linguistics 49 91–136. Published as Roberts 2012b.

——. 2012a. Information structure: Afterword. Semantics and Pragmatics 5 1–19.

——. 2012b. Information structure in discourse: Towards an integrated formal theory of pragmatics. Semantics and Pragmatics 5 1–69.

ROCHEMONT, MICHAEL. 1986. Focus in Generative Grammar. Amsterdam: John Benjamins.

ROCHEMONT, MICHAEL and CULICOVER, PETER. 1990. English Focus Constructions and the Theory of Grammar. Cambridge: Cambridge University Press.

ROOTH, MATS. 1985. Association with Focus. Ph.D. thesis, University of Massachusetts, Amherst.

——. 1992. A theory of focus interpretation. Natural Language Semantics 1 75–116.

——. 1996. On the interface principles for intonational focus. Proceedings of the 6th Conference on Semantics and Linguistic Theory, 202–226. Ithaca, NY: Cornell University.

——. 2005. Topic accents on quantifiers. Greg Carlson and Jeffrey Pelletier (eds.), Reference and Quantification: The Partee Effect, 303–328. Stanford, CA: CSLI Publications.

——. 2010. Second occurrence focus and *relativized stress f*. Malte Zimmerman and Féry (eds.), Information Structure: Theoretical, Typological, and Experimental Perspectives, 14–35. Oxford: Oxford University Press.

ŠAFÁŘOVÁ, MARIE. 2005. The semantics of rising intonation in interrogatives and declaratives. Emar Maier, Corien Bary, and Janneke Huitink (eds.), Proceedings of Sinn und Bedeutung 9, 355–369.

SAMEK-LODOVICI, VIERI. 2005. Prosody-syntax interaction in the expression of focus. Natural Language and Linguistic Theory 23 687–755.

SCHAUBER, ELLEN. 1978. Focus and presupposition: A comparison of English intonation and Navajo particle placement. Donna Jo Napoli (ed.), Elements of Tone, Stress, and Intonation, 144–173. Washington, DC: Georgetown University Press.

SCHEGLOFF, EMANUEL. 1988. Presequences and indirection: Applying speech act theory to ordinary conversation. Journal of Pragmatics 12 55–62.

SCHIFFER, STEPHEN. 1972. Meaning. Oxford: Oxford University Press.

SCHMERLING, SUSAN. 1976. Aspects of English Stress. Austin: University of Texas Press.

SCHUBIGER, MARIA. 1965. English intonation and German modal particles: a comparative study. Phonetica 12 65–84. Reprinted in Bolinger (1972b), 175-93.

——. 1980. English intonation and German modal particles ii: a comparative study. Linda Waugh and C.H. van Schooneveld (eds.), The Melody of Language, 279–298. Baltimore, MD: University Park Press.

SCHWARZSCHILD, ROGER. 1999. Givenness, avoidf, and other constraints on the placement of accent. Natural Language Semantics 7 141–177.

SEARLE, JOHN. 1975. Indirect speech acts. Peter Cole and Jerry Morgan (eds.), Speech Acts, *Syntax and Semantics*, vol. 3, 59–82. New York: Seminar Press.

SELKIRK, ELISABETH. 1984. Phonology and Syntax. Cambridge, MA: MIT Press.

——. 1990. On the nature of prosodic constituency. Papers in Laboratory Phonology 1 179–200.

——. 1995. Sentence prosody: Intonation, stress, and phrasing. John Goldsmith (ed.), The Handbook of Phonological Theory, 550–569. Oxford: Blackwell.

SGALL, PETR, HAJIČOVÁ, EVA, and BENEŠOVÁ, EVA. 1973. Topic, Focus and Generative Semantics. Kronberg: Scriptor Verlag.

SILVERMAN, KIM, BECKMAN, MARY, PITRELLI, JOHN, OSTENDORF, MARIE, WIGHTMAN, COLIN, PRICE, PATTI, PIERREHUMBERT, JANET, and HIRSCHBERG, JULIA. 1992. ToBI: A standard for labeling English prosody. Proceedings of the International Conference on Spoken Language Processing, Banff, Alberta, 867–870. Edmonton: University of Alberta.

S PERBER, D AN and W ILSON, D EIRDRE. 1986. Relevance. Cambridge, MA: Harvard.

S TALNAKER, R OBERT. 1979. Assertion. Peter Cole (ed.), Syntax and Semantics, vol. 9. New York: Academic Press.

S TEEDMAN, M ARK. 1985. Dependency and coordination in the grammar of Dutch and English. Language 61 523–568.

——. 1990a. Gapping as constituent coordination. Linguistics and Philosophy 13 207–263.

——. 1990b. Structure and intonation in spoken language understanding. Proceedings of the 28th Annual Meeting of the Association for Computational Linguistics, 9–16. Pittsburgh: ACL.

——. 1991. Structure and intonation. Language 67 262–296.

——. 1994. Remarks on intonation and 'focus'. Proceedings of the Conference on Focus and Natural Language Processing, vol. 1, 185–204. Schloß Wolfsbrunnen: IBM Deutschland.

——. 1996. Surface Structure and Interpretation. Linguistic Inquiry Monograph 30. Cambridge, MA: MIT Press.

——. 2000a. Information structure and the syntax-phonology interface. Linguistic Inquiry 34 649–689.

——. 2000b. The Syntactic Process. Cambridge, MA: MIT Press.

——. 2007. Information-structural semantics for English intonation. Chungmin Lee, Matthew Gordon, and Daniel Büring (eds.), Topic and Focus:Cross-linguistic Perspectives on Meaning and Intonation, no. 82 in Studies in Linguistics and Philosophy, 245–264. Dordrecht: Kluwer. Proceedings of the LSA Workshop on Topic and Focus, Santa Barbara CA July, 2001.

——. 2012. Taking Scope: The Natural Semantics of Quantifiers. Cambridge, MA: MIT Press.

S TEEDMAN, M ARK and J OHNSON-L AIRD, P HILIP. 1980. Utterances, sentences, and speech-acts: Have computers anything to say? Brian Butterworth (ed.), Language Production 1: Speech and Talk, 111–141. London: Academic Press.

S TEEDMAN, M ARK and P ETRICK, R ON. 2007. Planning dialog actions. Proceedings of the 8th SIGdial Workshop on Discourse and Dialogue, 265–272. Antwerp, Sept., ACL.

S TONE, M ATTHEW. 1998. Modality in Dialogue: Planning Pragmatics and Computation. Ph.D. thesis, University of Pennsylvania.

——. 2004. Intention, interpretation, and the computational structure of language. Cognitive Science 28 781–809.

S YRDAL, A NN and M CGORY, J ULIA. 2000. Inter-transcriber reliability of ToBI prosodic labeling. Sixth International Conference on Spoken Language Processing, 235–238.

S ZENDRŐI, K RISZTA. 2001. Focus and the Syntax-Phonology Interface. Ph.D. thesis, University College London.

——. 2004. Focus and the interaction between syntax and pragmatics. Lingua 114 229–254.

T AGLICHT, J OSEF. 1984. Message and Emphasis. London: Longmans.

T AYLOR, P AUL. 2000. Analysis and synthesis of intonation using the Tilt model. Journal of the Acoustical Society of America 107 1697–1714.

T HOMASON, R ICHMOND. 2000. Modeling the beliefs of other agents: Achieving mutuality. Jack Minker (ed.), Logic-Based Artificial Intelligence, 375–403. Dordrecht: Kluwer.

——. 2001. The beliefs of other agents. Ms. University of Michigan Ann Arbor.

T RUCKENBRODT, H UBERT. 1995. Phonological Phrases: Their Relation to Syntax, Focus, and Prominence. Ph.D. thesis, MIT.

——. 1999. On the relation between syntactic phrases and phonological phrases. Linguistic Inquiry 30 219–255.

——. 2007. Syntax-phonology interface. Paul de Lacy (ed.), Cambridge Handbook of Phonology, 435–456. Cambridge: Cambridge University Press.

V ALLDUVÍ, E NRIC. 1990. The Information Component. Ph.D. thesis, University of Pennsylvania.

V ALLDUVÍ, E NRIC and V ILKUNA, M ARIA. 1998. On rheme and kontrast. Peter Culicover and Louise McNally (eds.), Syntax and Semantics, Vol. 29: The Limits of Syntax, 79–108. San Diego: Academic Press.

VAN K UPPEVELT, J AN. 1995. Discourse structure, topicality and questioning. Journal of Linguistics 31 109–147.

V EILLEUX, N ANETTE, S HATTUCK-H UFNAGEL, S TEPHANIE, and B RUGOS, A LEJNA. 2006. The ToBI tutorial. http://anita.simmons.edu/~tobi/index.html.

VON F INTEL, K AI. 1994. Restrictions on Quantifier Domains. Ph.D. thesis, University of Massachusetts, Amherst.

VON S TECHOW, A RNIM. 1981. Topic, focus and local relevance. Wolfgang Klein and Willem Levelt (eds.), Crossing the Boundaries in Linguistics, 95–130. Dordrecht: Reidel.

——. 1991. Focusing and backgrounding operators. Werner Abraham (ed.), Discourse Particles: Descriptive and Theoretical Investigations on the Logical, Syntactic and Pragmatic Properties of Discourse Particles in German, 37–84. Amsterdam: John Benjamins.

WAGNER, MICHAEL. 2003. Prosody as a diagonalization of syntax: Evidence from complex predicates. Proceedings of the 34th Meeting of the North Eastern Linguistics Society, XXX–XXX. Amherst: GLSA, University of Massachusetts.

——. 2005. Prosody and Recursion. Ph.D. thesis, MIT, Cambridge, MA.

——. 2006. Givenness and locality. Proceedings of the 16th Conference on Semantics and Linguistic Theory, 297–324. Ithaca, NY: CLC Publications.

——. 2008. A compositional analysis of contrastive topics. Proceedings of the 28th Conference of the North Eastern Linguistics Society (NELS). Toronto: GLSA, University of Massachusetts, Amherst.

——. 2010. Prosody and recursion in coordinate structures and beyond. Natural Language & Linguistic Theory 28 183–237.

WARD, GREGORY and HIRSCHBERG, JULIA. 1985. Implicating uncertainty: the pragmatics of fall-rise intonation. Language 61 747–776.

WATSON, DUANE, GUNLOGSON, CHRISTINE, and TANENHAUS, MICHAEL. 2008. Interpreting pitch accents in on-line comprehension: H* vs L+H*. Cognitive Science 32. 1232-1244.

WELBY, PAULINE. 2003. Effects of pitch accent position, type, and status on focus projection. Language and Speech 46 53–81.

WIGHTMAN, COLIN. 2002. ToBI or not ToBI. Proceedings of Speech Prosody, 25–29. Aix-en-Provence: ISCA.

WILSON, DEIRDRE and SPERBER, DAN. 1979. Ordered entailments: An alternative to presuppositional theories. Syntax and Semantics, Vol. 11: Presupposition, 299–323. New York: Academic Press.

WOLD, DAG. 1996. Long distance selective binding: The case of focus. Proceedings of SALT, vol. 6, 311–328.

WUNDERLICH, DIETER. 1991. Intonation and contrast. Journal of Semantics 8 239–251.

ZUBIZARRETA, MARIA LUISA. 1998. Prosody, Focus, and Word Order. Cambridge, MA: MIT Press.