THE SURFACE-COMPOSITIONAL SEMANTICS OF ENGLISH INTONATION

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This article 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 article 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 that constrains language-specific intonation and its interpretation more narrowly than previous attempts.*

Keywords: intonation structure, information structure, second-occurrence focus, combinatory categorial grammar (CCG), syntax, semantics

1. INTRODUCTION. The main claims of this article concern the semantics of information structure—the part of sentence semantics that has to do with the relation of utterance to discourse context and participant supposition about '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 crosslinguistic 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).

* Preliminary versions of some of these ideas were presented under various titles at the Conference on Focus and Natural Language Processing at Schloß Wolfsbrunnen (Steedman 1994, 2000a), the LSA Summer Institute Workshop on Topic and Focus, Santa Barbara, July 2001 (Steedman 2007), the 2nd International Conference on Linguistic Evidence, Tübingen, February 2006, and the CHC Workshop on the Prosody-Syntax Interface, UCL, October 2006, and in talks at OSU in 2006, and at Penn, NYU, Cornell, UT Austin, and Northwestern in 2007. Thanks to the audiences there, and to Sasha Calhoun, Chris Geib, Rob Clark, Stephen Isard, Aravind Joshi, Kordula de Kuthy, Bob Ladd, Alex Lascarides, Detmar Meurers, Ron Petrick, Steve Pulman, Geoff Pullum, Craige Roberts, Mats Rooth, Matthew Stone, Alice Turk, and Bonnie Webber, and to the referees for *Language*. The work was supported at different stages by ERC Advanced Fellowship 249520 GRAMPLUS, EC FP7 IP grant 270273 Xperience, the Edinburgh-Stanford Link grant Sounds of Discourse from the Scottish Executive, and by a sabbatical leave in 2006–7 at the University of Pennsylvania granted by the University of Edinburgh.

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, but 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, which themselves are defined in terms of as few as two abstract pitch levels, high (H) and low (L), from which actual contours can be derived algorithmically. It remains unclear, however, 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 article follows Pierrehumbert & 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 article argues that the primary function of all prosodic accents is to mark points of contrast with alternatives. It further distinguishes 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, 1990, Rooth 1985, Rochemont 1986, Ladd 1996, 2008:218–21, Beaver et al. 2007, Beaver & 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 level of the intonational phrase, together with all of 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 F0 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 F1 and F2 (Higashikawa & Minifie 1999, Nicholson & 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 F0 pitch variation in some speakers (Liberman & Pierrehumbert 1984, Ladd & Schepman 2003, Calhoun 2006, 2010, Katz & 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 F0 pitch as a principal prosodic marker. (The speaker who prepared the sound files for the examples discussed in this article is one such.) Such pitch accents can also be successfully used in speech synthesis to convey information-structural distinctions (Cassell et al. 1994, Prevost & Steedman 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 interannotator reliability on the L+H*/H* distinction (Syrdal & McGory 2000, Wightman 2002). Part of the problem seems to lie with the instructions in the ToBI annotation manual (Beckman & Hirschberg 1999). One distinguishing characteristic of the L+H* accent is that the rise to the pitch maximum is LATE, beginning no earlier than the 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, figure 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). Multiple annotation merely exposes the problem, however, rather than solving it. Faute de mieux, the instructions to ToBI annotators remain pitch-track based, and the system is very fairly characterized in 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, figure 5) or to correlate the annotators' accent labels with consistent discourse functions (e.g. Hedberg & Sosa 2007) 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 about tone identification (e.g. Welby 2003, Ito & Speer 2008, 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 article 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 & 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 that 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 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, table 2; cf. Büring 2013).[2]

These uncertainties about 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—as exhibited, for example, 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

[1] See http://homepages.inf.ed.ac.uk/steedman/soi.html or http://muse.jhu.edu/journals/language/v090/90.1.steedman01.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.

categories seems to have something to do with our conviction that there is an important semantic distinction behind them.

The present article 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 article 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 nonfinal 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 nonnative speakers) so reduced as to be completely ambiguous, and are here used only to aid comparison with the soundfiles and the reader's intuitions about the intended semantic distinctions.

1.3. OUTLINE. The remainder of the article is divided into four main sections. In §§2 and 3, 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. These sections are deliberately informal, intended to provide intuitive motivation for what follows, and orientation to a very diverse and conflicted descriptive literature.

A formal semantics for these elements is sketched in §4, 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 [1967]), 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 the 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 maintenance 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.)

The core of the article is §5, in which the alternative semantics of information structure is extended and integrated with a base-generative theory of grammar proposed in Steedman 2000b (*The syntactic process*, 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 under surface-compositional logical form of the kind proposed in Steedman 2012 (*Taking scope*, hereafter *TS*) for standard word meaning and quantification. By linking information-structural scope to syntactic derivation, this account solves an open problem for standard alternative-semantics accounts first noticed by Wold (1996). Some further ramifications are reviewed and conclusions drawn in §6.

2. INTONATION AND INFORMATION STRUCTURE 1: ACCENTS. The term 'accent' is here restricted to what Bolinger (1986) and Ladd (1996) call 'primary' accents. Primary ac-

cents are distinguished from other maxima that arise from the alignment of lexical stress with the metrical grid treated in §6.2. 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 consider these dimensions in turn.

2.1. ACCENT 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 at hand, as in the alternative semantics of Karttunen 1976, Karttunen & Peters 1979, Wilson & 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 indicated intonation is appropriate.[3]

(1) That was my WIFE.
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 that 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 that 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]

In terms of Halliday's (1963, 1967a,b) 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.

[3] The notation for tunes is Pierrehumbert's (see Pierrehumbert & Hirschberg 1990 for details, including intuitively accessible idealized graphical representations of all of the prosodic contours discussed here, some of which are not intuitively obvious from the notation (1990:281). See Liberman & 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.

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' is used here to refer to this property of English words bearing accents, denoting Vallduví and Vilkuna's (1998) '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 that 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 the speaker 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. (≥ 1 $\forall/\#\forall \geq 1$)

Rooth also points out (1996b: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 be 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 article argues for a similarly strict in-situ theory of contrast.

PRINCE'S TAXONOMY OF GIVENNESS. The requirements within the noun phrase for accent and nonaccent in terms of alternative sets are somewhat subtle (Prince 1981, Rooth 1992, Schwarzschild 1999, Büring 2003). Example 6a, with its phrase-final pitch accent, can be uttered 'out of the blue'—that is, without any prior context-setting utterance, and without

[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 & 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 & Vilkuna 1998. This usage has caused considerable confusion—for example, Pulman 1997:85—and is avoided here, except when referring to the work of others using the term.

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.

By contrast, 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 of 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 is not 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. (But 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 accommodate 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 nonfinal accent is always evoked in Prince's sense. In examples like 7, 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 in Rooth 1992, extension to specific alternative sets arises from a combination of semantic and pragmatic factors.

2.2. 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 'theme' and 'rheme' components of the utterance are distinguished, these terms being used in the sense of Bolinger (1958, 1961) rather than Halliday (1963, 1967a,b).

THEME VERSUS RHEME. We can begin to analyze the notions of theme and rheme in terms of the more primitive concept of common ground, which originated with Stalnaker (1979). This notion is related to various notions of mutual belief, or 'copresence', proposed by Lewis (1969), Schiffer (1972), Cohen (1978), Clark and Marshall (1981), Cohen and Levesque (1990), Hobbs (1990), Jacobs (1991), Clark (1996), Ginzburg

[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 n. 6), anchoring adjuncts can often simply be omitted entirely.

(1996), Poesio and Traum (1997), Pulman (1999), Thomason (2000, 2001), and Stone (1998, 2004).[8]

The present article 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-upon 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 as 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 that the hearer recognizes as false, giving rise, as we see below, to indirect effects.

In these terms, theme and rheme can be informally defined as in 8.

(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) the common ground.

This opposition is reminiscent of Gussenhoven's (1983a:201) opposition between SELECTION and ADDITION of items to the background, and of 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. In present terms, they associate H* with both 'new' information, or contrast, and rhematic function, or update (1990:289–90). They associate L+H* 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, as well as two of the prosodic contours that distinguish theme and rheme, is illustrated by the following minimal pair of dialogues, in which in each case the preceding discourse including the WH-question in

[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 below, but the general idea is similar.

Q establishes 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 & 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 marrying* upwardly entails that we are talking about *Anna* as opposed to *Emma*, the hearer can accommodate to 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 (2012b) makes clear) is a distinct notion of intersentential discourse structure, rather than of intrasen-

[11] Earlier papers on intonation in CCG frameworks mark the internal boundary in examples like 9A as an L intermediate boundary. Such a boundary would not normally be detectable in the pitch track, however, and the present article 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 return to the question of speaker-defined information structure in connection with criticisms by Joshi (1990) and Pulman (1997) of earlier versions of the present proposal in §6.2.

tential information structure. The QUD in Roberts's discourse-pragmatic sense may limit, but does not fully determine, the speaker's semantic information structure.[14]

It is 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' functions, 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 that 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]

2.3. 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. An ambiguity of the English language is exploited 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 minimal pair of utterances in 14.

(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 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

[14] For example, out-of-the-blue warnings like *Your TROUSERS are on fire!* are licensed whatever question is under discussion, including none at all.

[15] A referee 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 §5.3, among some other assumptions. We return briefly to this account in §6.1 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.

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]

3. INTONATION AND INFORMATION STRUCTURE 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, boundary tones are assumed 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.

3.1. 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, the speaker claims 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 also 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 (1983a:201) and Gunlogson (2001, 2002) talk in this connection of the speaker or hearer being 'committed to' a proposition (see discussion by Šafářová (2005), who regards the relevant dimension as 'uncertainty'). The present article argues that all of these notions are entailments of 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%

[17] The effect of the L* accents is reminiscent of Freud's (1925) observations about 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'.

[18] Pierrehumbert and Hirschberg consider boundaries such as LH% to be 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' (1990:305–6).

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

For Standard American English (SAE) speakers, 15a is appropriate only as an echo question (Ladd 2008:113–14). 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 about final-rise declaratives in SAE.)[20]

With the quite rare intonation contour 15b, by contrast (which would often be realized with the H+L* variant of the L* accent), speakers claim 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.

3.2. UNMARKED THEMES VERSUS 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 an accent. For example, the following responses to the questions in 9 and 10 above are possible.

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

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

b. Q: What about Anna?
A: $(\text{Anna})_{\theta}$ $(\text{will marry MANNY})_{\rho}$.
H* LL%

c. Q: What's new?
A: $(\text{Anna will marry MANNY})_{\rho}$.
H* LL%

[20] British English speakers use the H* LH% contour more widely, to mark out-of-the-blue yes-no questions, including those that 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 toward 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.

In English, rheme accents including those in all-rheme utterances can in some cases occur nonfinally, just in case the postaccent material is established or can be accommodated as background given the subject (Bolinger 1972a). For example, the all-rheme example in 19 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%

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

It is presumably the difficulty of accommodating any parallel presupposition that causes most hearers to reject a similar intonation contour for examples like 20, discussed in rather different terms in Ladd 2008:245.[23]

(20) #JESUS wept.

Schmerling (1976:41–42) 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 1970s, 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 thus it 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 (1977:10–11; see also 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 already being 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 a characteristic activity of ex-presidents from whom one has not 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 nonfinal accented utterances can have additional unaccented final adjuncts, as in 22.

(22) JOHNSON died yesterday.

However, the possibility of such subject-accented all-rheme utterances in English is in other respects very restricted, as Bolinger pointed out. It does not appear to extend to fully transitive examples like 23, 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]

[22] See n. 21.

[23] Ladd suggests that one factor contributing to the difference between 21b and 20 is the involvement of an unaccusative verb in the former. Examples like 19, however, 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 about 21a.

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

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

(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, a point to which we return in §5.2.[27]

3.3. 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 example in 24, which has been discussed extensively by Ward and Hirschberg (1985) (see also Pierrehumbert & Hirschberg 1990:295, ex. 26, and 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 hearers 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. All of these effects are indirect, however, 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 & Sosa 2007, exx. 20, 21 and n. 3, and Hedberg 2006, n. 3, for a careful discussion), differing only from the same words uttered with an H*LL% tune in terms of 'lack of commitment' (Pierrehumbert & Hirschberg 1990) or 'uncertainty'

[27] Apparent exceptions like the following transitives appear to depend on the involvement of Prince's deictic ANCHORING function—see §2.1.

(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. By contrast, 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).*)

(Šafářová 2005, Nilsenová 2006). It is important to notice, however, 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 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 'contrastive' and 'noncontrastive' accents—ALL accents are contrastive.

Such implicature-laden isolated themes often give rise to very vivid and memorable utterances. The all-theme contour was crucial in a television advertisement of the 1970s 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 a person misleadingly identified in the press as 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.*)

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

4.1. 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.

[29] Such effects are extremely common in dialogue corpora. Green and Carberry (1994) cite studies showing that about 13% of answers to yes-no questions are indirect.

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

The second approach is that of alternative semantics (Jackendoff 1972, Karttunen 1976, 1977, Karttunen & Peters 1979, Wilson & Sperber 1979, Selkirk 1984, Rooth 1985, 1992, 1996b, 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 that instantiate that open proposition. The focus semantic value stands in contrast to the 'ordinary semantic value' of the sentence $[\![S]\!]^o$. Since the open formulae 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.

A third approach to information structure is associated with the transformational-generative theory of natural language syntax and seeks to identify a focus position in underlying structure, related to the surface-structural position by (overt or covert) transformational 'movement' (Chomsky 1971, Jackendoff 1972, Rochemont & Culicover 1990, Erteschik-Shir 1997, 1998, Truckenbrodt 1999, 2007, Szendrői 2001, 2004, Neeleman & 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 dialogue 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, some at the level of surface syntax, and some at 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 article 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 is seen in §5 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.

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

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 within whose scope they fall. The present article is restricted 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:

(i) The correspondence $\mathscr{C}$ SATISFIES a formula $Ra_1 \ldots a_n$ 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 $\langle \mathscr{C}^{-1}(a_1), \ldots, \mathscr{C}^{-1}(a_n) \rangle$ is in the relation $\mathscr{C}^{-1}(R)$ in $\mathfrak{M}$.

(ii) The correspondence $\mathscr{C}$ satisfies a formula $Ra_1 \ldots a_n$ 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' satisfies 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 $Ra_i \ldots a_n$.

(iii) The correspondence $\mathscr{C}$ satisfies a formula $Ra_1 \ldots a_n$ 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

[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.

that, when the free variables are replaced by the relation and/or object symbols a'_i, $\mathscr{C}$ satisfies $Ra_1 \ldots a_n$.

A number of complications for the model theory that 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*:Ch. 5 for formulae involving logical conjunction $X \wedge Y$ and the conditional $X \rightarrow Y$ in L ensure that the SAME interpretation is chosen for generalized Skolem terms in both X and Y. Exactly parallel conditions must also apply for the free variables $v\tau_p$ 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 it 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 $\{\Lambda^a\}$ comes into its own in §5, when we consider the effect of *only* in utterances like that in 28, 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 29.[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 be meat.

Negation is perhaps more commonly encountered in all-theme utterances like 30a, 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. $\left\{\begin{array}{l}\neg was\ sk_{\lambda x.wife\ x\ \wedge\ mine\ x}\ that \\ \neg was\ sk_{\lambda x.v\tau_{wife}\ x\ \wedge\ mine\ x}\ that\end{array}\right\}$

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.

[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*:Ch. 11 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 article, including elimination of all details of tense and mass/count distinctions in NPs.

(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.

(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.

(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, I 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 35 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*. We are talking about *Ivan and Theona*'s wedding, however, so *the couple* acts here as an epithet referring to an available discourse entity. In the terms

of Prince 1981, *of the couple* is nonevoked, merely anchoring *friends and relations* to *Ivan and Theona* in contrast to *other guests* (see also 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 n. 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. As in Rooth 1992, however, 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 example 36 may be accented, as in 36a, as Schwarzschild (1999) would predict, it may also be unaccented, as in 36b.[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 noncontrastive, and that in the same out-of-the-blue context, the hearer will accommodate the presupposition that all alternatives in play are farmers.

In the latter case, however, 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-occurrence 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*, and 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 37, then there has to be a phrase-final accent.

(37) An AMERICAN farmer with a big pink CADILLAC was talking to a CANADIAN 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

[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 that 36a is actually ungrammatical 'under the focus context at issue' (2006:139). It is not entirely clear what focus context they have in mind, but it seems to be that of what in §3.3 was called an 'all-theme' utterance.

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.

4.3. 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' (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.

We have seen, however, that there exist all-rheme utterances, such as 19, *Your MOTHER called*. Such rhemes do not seem to answer an implicit question any more 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) $\theta =_{def} \lambda p \lambda x.suppose([\mathrm{C}]theme\ p^o \wedge \forall a \in \{p^a\}\ [theme\ a \rightarrow a = p^o])x$

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

In these definitions, the following hold true.

(i) 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.

(ii) $\{p^a\}$ is the alternative set characterized by p^a.[36]

(iii) *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 $\mathfrak{C}$.

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

(v) UPDATE can be thought of as a fallible update predicate that fails if its argument is not a proposition, and that 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.

[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.

(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.)

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 ⊤ (success) or ⊥ (failure).

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

(40) $(\top\theta \begin{Bmatrix} \lambda x.married\ x\ anna \\ \lambda x.v\tau_{married}\ x\ anna \end{Bmatrix} H)\ (\top\rho \begin{Bmatrix} \lambda p.p\ sk_{\lambda x.man\ x\ \wedge\ with\ x\ sk_{\lambda y.cadillac\ y\ \wedge\ pink\ y\ \wedge\ big\ y}} \\ \lambda p.p\ sk_{\lambda x.man\ x\ \wedge\ with\ x\ sk_{\lambda y.cadillac\ y\ \wedge\ v\tau_{pink}\ y\ \wedge\ big\ y}} \end{Bmatrix} S)$

'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) $\begin{Bmatrix} married\ sk_{\lambda x.man\ x\ \wedge\ with\ x\ sk_{\lambda y.cadillac\ y\ \wedge\ pink\ y\ \wedge\ big\ y}}\ anna \\ v\tau_{married}\ sk_{\lambda x.man\ x\ \wedge\ with\ x\ sk_{\lambda y.cadillac\ y\ \wedge\ v\tau_{pink}\ y\ \wedge\ big\ y}}\ anna \end{Bmatrix}$

However, such standard forms are, strictly speaking, redundant: 40 typifies the only level of representation that is necessary as an interface to interpretation (Zubizarreta makes a related point about the information-structural nature of logical form in her minimalist-programmatic account of intonation (1998:23, n. 31)).

4.4. DIRECTION AND INDIRECTION IN INTONATIONAL MEANING. In this formalism, the translations of 14 and 15 can be written as follows.

(42) a. You put my TROUSERS in the MICROWAVE!

H* H* LL%

$\top(\rho \begin{Bmatrix} put(in\ microwave)\ trousers\ H \\ put(in\ v\tau_{microwave})\ v\tau_{trousers}\ H \end{Bmatrix} S)$

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

b. You put my TROUSERS in the MICROWAVE?

L* L* LH%

$\bot(\rho \begin{Bmatrix} put(in\ microwave)\ trousers\ H \\ put(in\ v\tau_{microwave})\ v\tau_{trousers}\ H \end{Bmatrix} H)$

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

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

H* H* LH%

$\top(\rho \begin{Bmatrix} put(in\ microwave)\ trousers\ H \\ put(in\ v\tau_{microwave})\ v\tau_{trousers}\ H \end{Bmatrix} H)$

'You make it common ground that you put my trousers in the microwave.' (implies (e.g.): *Are you telling me 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 speakers 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.

b. You put my TROUSERS in the MICROWAVE!

H+L* H+L* LL%

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

'I do not make it common ground that you put my trousers in the microwave.' (implies (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 the hearer's own behalf any more than 42a (although it does invite the hearer to do some maintenance for the speaker). Example 42b, by contrast, by claiming that the hearer fails to make a supposition common ground, requires the hearer to do consistency maintenance for both participants, say via a further explanation. Example 43b is the most aggressive, because it implies that the speakers 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, commitment, 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 side effects, arising via inference from a literal meaning of the tunes that has solely to do with individual supposition and/or assertion concerning distributed common ground.

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 they are characteristic of normal low-key dialogue. It is also possible, however, to make more aggressively flouting claims about speaker/hearer supposition, as in 44.[39]

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

H* H* LL%

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

'I make it common ground that I infer I am a monkey's uncle.' (implies: *I'm inconsistent. Now I'll believe anything!*)

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 they 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

[38] The British English usage of H* LH% noted earlier (n. 20) 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.

cooperation, recognition of intention, flouting of maxims, relevance, or to speech-act types and illocutionary uptake. Many of the examples discussed by Grice (1975 [1967]) 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, consider if someone says the following.

(45) It's COLD in here!

$$\top(\rho\{\substack{\text{H*}\\ \textit{cold here}\\ v\tau_{\textit{cold}}\textit{ here}}\}\substack{\text{LL\%}\\ \text{S}})$$

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

A hearer who does not think it is actually warm will then verify or accommodate the following belief (Steedman & Petrick 2007).

(46) [C]*cold here*

Since being cold is an undesirable state, the hearer will begin to generate plans to negate it, using 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 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 paraphrasable 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 the hearer's part about 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 commonsense inference is of course the central open problem of artificial intelligence. There is, however, a certain amount of experimental evidence for such an egocentric or solipsistic account of conversational inference based on speaker supposition concerning the common ground. Bard et al. 2000 and Bard & Aylett 2005 show that intelligibility of spoken referring expressions in Edinburgh map-task dialogues depends on speaker availability of referents rather than speaker knowledge of hearer availability, contrary to Clark & Krych 2004. Keysar et al. 2003 makes a related point about a manipulation dialogue task, using an eye-movement measure.

4.5. 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 (see also Steedman 2007), in which θ signifies thematic supposition concerning common ground and ρ signifies rhematic update, while ⊤ and ⊥ signify success or failure of either supposition or update by either the speaker agent S or hearer agent H, independently specified by the boundary.

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-yield-

[40] A fragment of such a logic is axiomatized in Steedman & 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.

	⊤	⊥
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 elements contributed by boundaries (adapted from Steedman 2007).

ing', '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.

5. 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-occurrence focus' (Partee 1991).

5.1. COMBINATORY CATEGORIAL GRAMMAR. COMBINATORY CATEGORIAL GRAMMAR (CCG) is a form of lexicalized grammar in which grammatical CATEGORIES are made up of a syntactic type, which defines 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]

The transitive verb *married* has the syntactic category of a function from (object) noun phrases (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 analyses of Bach (1979, 1980), Dowty (1982), and Jacobson (1992). For example, 49 gives the category of the English ditransitive verb *introduced*, which reverses the domi-

[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 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 and colleagues (2011).

nance/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 rules in 50.

(50) Forward and backward functional application

a. $X/_{\bigstar}Y : f \quad Y : a \quad \Rightarrow \quad X : f\,a$ (>)

b. $Y : a \quad X\backslash_{\bigstar}Y : f \quad \Rightarrow \quad X : f\,a$ (<)

(The ★ 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 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 those in 51.

(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, 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 article follows *TS* in assuming that no noun phrases other than true universals bear the semantics of generalized quantifiers. Rather, they are generalized Skolem terms of the kind encountered in §4.2. Thus, the categories of determiners, adjectives, and nouns can be written for present purposes as in 52.[44]

[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.

[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 underspecified in the lexicon and become captured by operators, such as universal quantifiers, as the derivation proceeds. For the simple cases at hand, this complication is suppressed. The ◇ modality on the slashes in these categories is needed in English to prevent VP-style reordering of the NP, as allowed in German.

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

Thus, *a big pink Cadillac* gives rise to the nominative category in 53, 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 54 as well as simple functional application and lexicalized type-raising produces a potentially very freely 'reordering and rebracketing' calculus, engendering a generalized notion of surface or derivational constituency.

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

(The $\diamond$ modality on the slashes in this rule again follows the notation of Baldridge and Kruijff (2003), and disallows its application to certain categories, including those bearing ★ 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)
$$\dfrac{\dfrac{\text{Anna}}{\underset{:\lambda f.f\ anna}{S/(S\backslash NP_{SG})}}{>}\mathbf{T} \quad \dfrac{\text{married}}{\underset{:\lambda x.\lambda y.marry\ xy}{(S\backslash NP)/NP}} \quad \dfrac{\text{Manny}}{\underset{:\lambda p.p\ manny}{S\backslash(S/NP)}}{<}\mathbf{T}}{\dfrac{S/NP : \lambda x.marry\ x\ anna}{S : marry\ manny\ anna}{<}}{>}\mathbf{B}$$

(56)
$$\dfrac{\dfrac{\text{Anna}}{\underset{:\lambda f.f\ anna}{S/(S\backslash NP_{SG})}}{>}\mathbf{T} \quad \dfrac{\dfrac{\text{married}}{\underset{:\lambda x.\lambda y.marry\ xy}{(S\backslash NP)/NP}} \quad \dfrac{\text{Manny}}{\underset{:\lambda p.p\ manny}{(S\backslash NP)\backslash((S\backslash NP)/NP)}}{<}\mathbf{T}}{S\backslash NP : \lambda y.marry\ manny\ y}{<}}{S : marry\ manny\ anna}{>}$$

In the first of these, *Anna* and *married* compose as indicated by the annotation >**B** to form a nonstandard constituent of type *S*/*NP*. In the second, there is a more traditional derivation involving a verb phrase of type *S**NP*. Both yield identical logical forms, and both are fully legal surface or derivational constituent structures. More complex 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)
$$\dfrac{\dfrac{\text{Manny,}}{St/(S/NP)} \quad \dfrac{\dfrac{\text{Anna}}{S/(S\backslash NP)} \quad \dfrac{\text{says}}{(S\backslash NP)/_{\diamond}S}}{S/_{\diamond}S}{>}\mathbf{B} \quad \dfrac{\dfrac{\text{she}}{S/(S\backslash NP)} \quad \dfrac{\text{married}}{(S\backslash NP)/NP}}{S/NP}{>}\mathbf{B}}{S/NP}{>}\mathbf{B}}{St}{>}$$

[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 & Steedman 2002 and Clark & Curran 2004.

The analysis of relativization is similar, with the object relative pronoun taking the place of topicalized *Manny*, and bearing the category in 58, in which the noun post-modifier category $N\backslash N$ replaces *St* as result; see *SP* for details.

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

Similarly, if conjunctions like *and* bear the category in 59, in which ★ 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)
$$\dfrac{\dfrac{\text{[Louise dated]}}{S/NP}\,{>}\mathbf{B} \quad \dfrac{\dfrac{\text{and}}{(X\backslash_{\star}X)/_{\star}X} \quad \dfrac{\text{[Anna(says she) married]}}{S/NP}\,{>}\mathbf{B}}{(S/NP)\backslash_{\star}(S/NP)}\,{>} \quad \dfrac{\text{Manny}}{S\backslash(S/NP)}\,{<}\mathbf{T}}{S/NP}\,{<}}{S}\,{<}$$

It also supports an account of cluster coordination (with the two steps marked >, < of coordination reduced to one marked <>, to save space).

(61)
$$\dfrac{\dfrac{\text{I}}{S/(S\backslash NP)} \quad \dfrac{\dfrac{\text{introduced}}{((S\backslash NP)/PP)/NP} \quad \dfrac{\dfrac{\text{Tom}}{((S\backslash NP)/PP)\backslash(((S\backslash NP)/PP)/NP)} \quad \dfrac{\text{to Sue}}{(S\backslash NP)\backslash((S\backslash NP)/PP)}\,{<}\mathbf{B}}{(S\backslash NP)\backslash(((S\backslash NP)/PP)/NP)} \quad \dfrac{\dfrac{\text{and}}{(X\backslash_{\star}X)/_{\star}X} \quad \dfrac{\text{Anna}}{S\backslash(S/NP)} \quad \dfrac{\text{to Manny}}{((S\backslash NP)/PP)/NP}\,{<}\mathbf{B}}{(S\backslash NP)\backslash(((S\backslash NP)/PP)/NP)}\,{<>}}{S\backslash NP}\,{<}}{S}\,{>}$$

In the terms of the minimalist program 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.

5.2. 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 1975 [1955]; see *SP*:Ch. 1 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 regard all CCG categories from the lexicon on up as

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

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

having TWO parallel logical forms, which respectively contribute compositionally to the ordinary and alternative logical forms, Λ^o and Λ^a, defined in §4.2 above.

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. These two semantic values can be written in braces, and the earlier simple logical forms can be regarded as abbreviating ordered pairs $\{\Lambda^o, \Lambda^a\}$.

For example, the proper name *Anna* bearing an L+H* accent has the nominative category given in 62,[48] among other raised types.[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 category in 63, 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 bundle $\top/\bot,\rho$—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*

(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 $NP^{\uparrow}_{\top,\rho}$.[51]

[48] 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*

[49] 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 multiple accents, which must be compatible types.

[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%

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

However, the standard notation used in earlier versions is regarded as an abbreviation for the full rules.

If *Anna* is completely given—that is, there is no previous accented mention, so that no nontrivial alternatives are evoked or otherwise in play—then a subject bearing no accent has the category in 66, in which the ordinary and focus semantic values are the same.

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

π and η are variables over the values $\top/\bot$ and θ/ρ, which ensure that any elements have the same values as any categories they reduce with. They are usually suppressed by convention. To avoid cluttering the derivations, I also abbreviate the two identical logical forms of unaccented categories as a single formula without braces. Thus, the above category is often abbreviated as in 67.

(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.

If there has been a previous accented mention, however, 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 nontrivial alternative logical form. For example, see the category in 68.

(68) Anna := $S_{\top,\theta}/(S_{\top,\theta}\backslash NP_{\top,\theta})$: $\begin{Bmatrix}\lambda p.p\ anna\\ \lambda p.p\ \nu_{\tau_{anna}}\end{Bmatrix}$

The latter category (68) is required to account for the phenomenon of second-occurrence focus and comes into its own in the discussion of that phenomenon in §5.3. Its use is more widespread, however, and we first see it used in §5.2 to capture the impossibility in general of uttering unaccented complements in English out-of-the-blue all-rheme utterances, 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.

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 are independent string elements in their own right that merely coarticulate with adjacent words. They bear a category that, by mechanisms parallel to those discussed in more detail in *SP*, 'freezes' θ- and ρ-marked constituents as complete thematic or rhematic 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 category in 69 (as with the category 67 for unaccented *Anna*, the identical ordinary and alternative logical forms are represented as one).

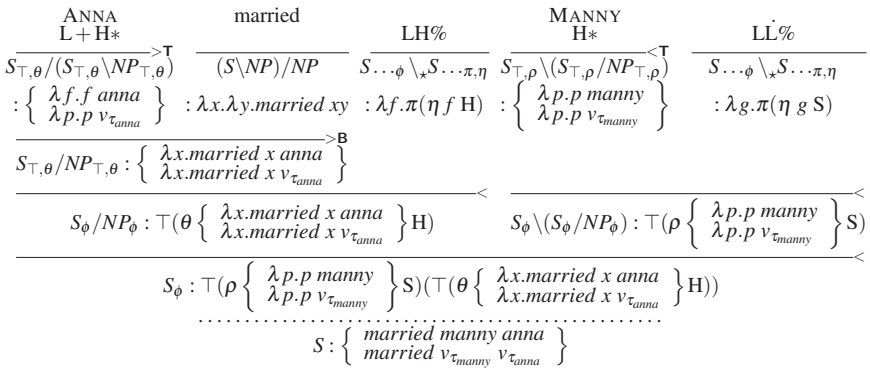
(69) LH% := $S\ldots_{\phi}\backslash_{\bigstar}S\ldots\pi,\eta$: $\lambda f.\pi(\eta\, f\, \mathrm{H})$

S… is a variable ranging over *S* and syntactic function categories into S, *f* is the interpretation of *S*…, 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 §4 and Steedman 2000a, 2007, and ϕ marks the result as a complete phonological phrase, which can combine only with another such, while ★ modality limits this combination to application.[52]

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

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 follows 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 other syntax-based accounts of prosodic structure (Kaisse 1985, Truckenbrodt 1995, 1999, 2007).

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

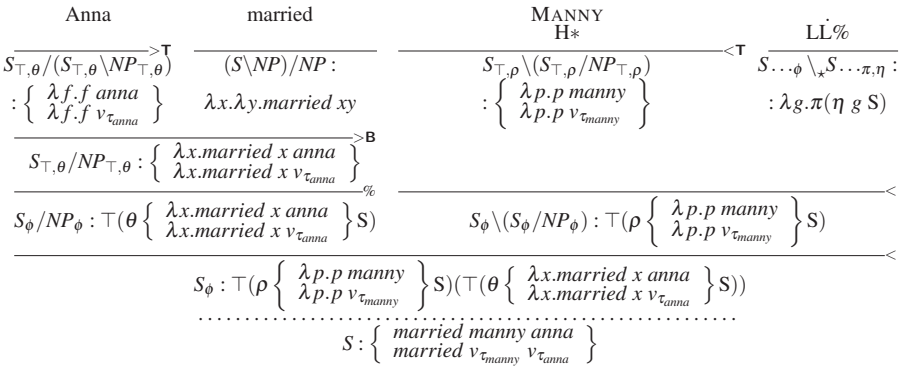
[53] As noted in connection with example 40, this last step is not strictly necessary.

[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 article 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 occurrence of adjacent accents with different types, such as the H* and L+H* in example 9. Rule 71 cannot be made to be intrinsically θ-marking, because it also applies to accented constituents, including ρ-marked ones, as in 80.

(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 in 72.

(72)



'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 nonaccent in the same way as 62–68, including 52b–d.[55]

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

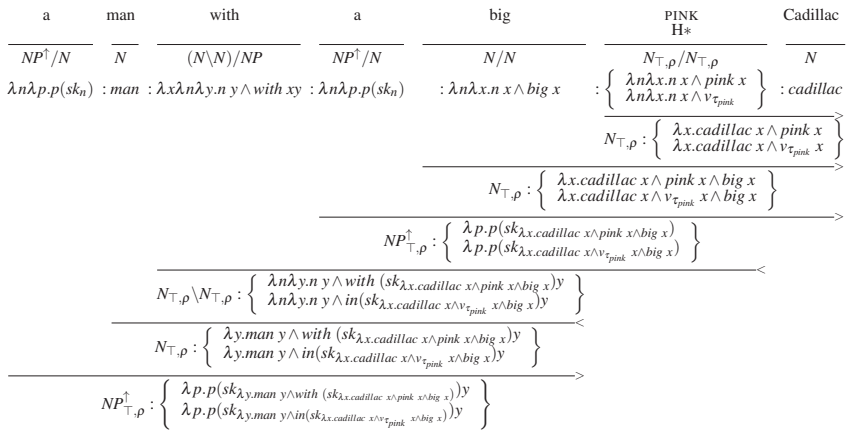
b. BIG := $N_{\top,\rho}/N_{\top,\rho} : \{\lambda n\lambda x.n\ x \wedge big\ x,\ \lambda n\lambda x.n\ x \wedge v\tau_{big}\ x\}$
H*

c. PINK := $N_{\top,\rho}/N_{\top,\rho} : \{\lambda n\lambda x.n\ x \wedge pink\ x,\ \lambda n\lambda x.n\ x \wedge v\tau_{pink}\ x\}$
H*

d. CADILLAC := $N_{\top,\rho}\{cadillac,\ v\tau_{cadillac}\}$
H*

Thus, one possible derivation of the nominal *a big* PINK *Cadillac* from example 31 (and 40) goes as follows.

(74)



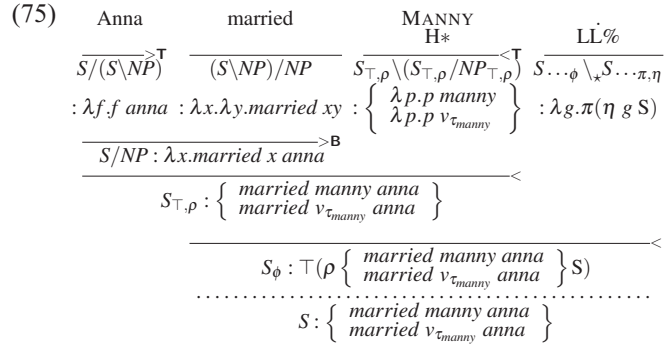
[55] From now on, ◇ modality is suppressed on nominal categories to reduce clutter. As usual, it may be convenient to schematize such generalization in a lexical rule.

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.

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 in 75.

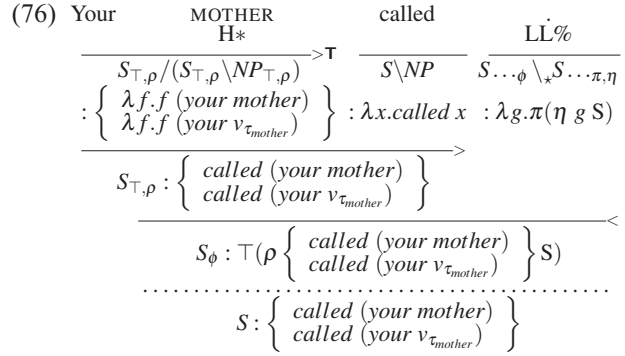
(75)



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

Since English unaccented verbs in out-of-the-blue utterances 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).

(76)



'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) Manny $:= S_{\mathsf{T},\theta}\backslash NP_{\mathsf{T},\theta})\backslash((S_{\mathsf{T},\theta}\backslash NP_{\mathsf{T},\theta})/NP_{\mathsf{T},\theta}) : \begin{Bmatrix}\lambda p.p\ manny\\ \lambda p.p\ v\tau_{manny}\end{Bmatrix}$

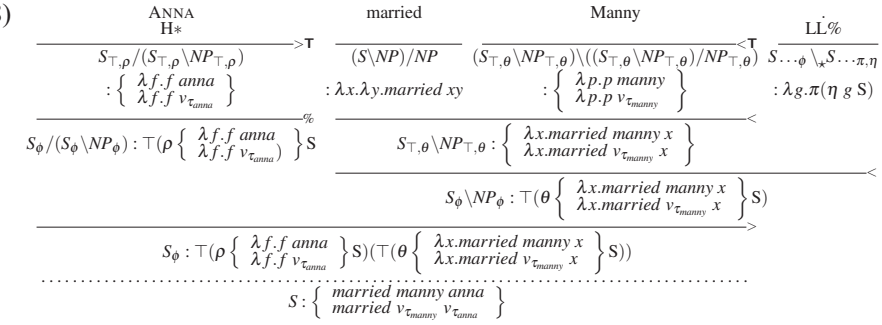
$:= S_{\mathsf{T},\theta}\backslash(S_{\mathsf{T},\theta}/NP_{\mathsf{T},\theta}) : \begin{Bmatrix}\lambda p.p\ manny\\ \lambda p.p\ v\tau_{manny}\end{Bmatrix}$

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

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 a sentence similar to 16, appropriate as an answer to the question *Who married Manny?*.[57]

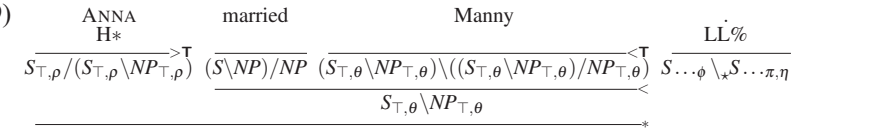
(78)



'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 an all-rheme analysis analogous to 75, hence the anomaly of the out-of-the-blue utterance (23) with the same contour.[58]

(79)

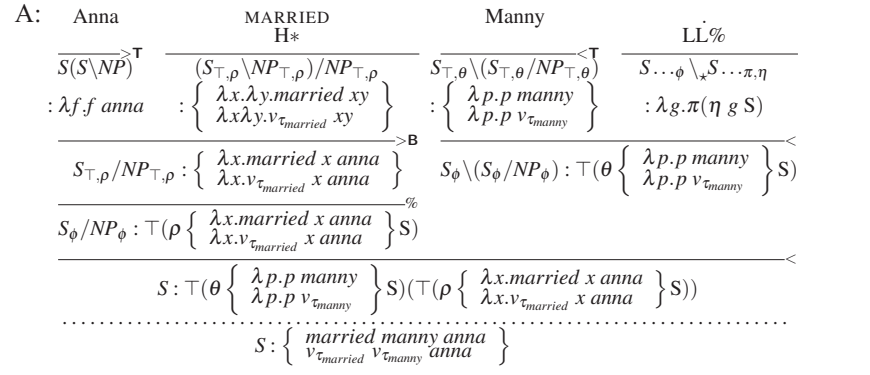


'#I make it common ground that Anna (as opposed to anyone else) married Manny.'

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:



[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 n. 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%

'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 81, consistent with Ladd's (1996) analysis of related examples (cf. *SP*:119, ex. 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 nonfinal accent like those in 82 can be.[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 accommodatable, background default arguments for these particular verbs, in the same sense that *calling* is accommodatable as a background activity of mothers in 76, or Prince's (1981) 'anchoring' background NP modifiers, discussed in §2.1. They must accordingly have entirely given nonsubject categories parallel to 67, specialized for those particular verbal heads.

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]

5.3. SEMANTICS OF NEGATION AND FOCUSING PARTICLES. As noted in §4, negation is a function from (Λ^o, Λ^a) pairs to (Λ^o, Λ^a) pairs. The semantics for the unaccented *not* (*don't*) in example 29 can therefore be written as in *TS*, ignoring the issues of polarity discussed at length there and writing the ordinary and alternative logical forms as one, as usual.

(83) 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) NOT := $(S_{\mathsf{T},\theta,inf}\backslash NP)/(S_{\mathsf{T},\theta,inf}\backslash NP) : \left\{\begin{matrix}\lambda p\lambda y.\neg p\ y\\ \lambda p\lambda y.\ \ p\ y\end{matrix}\right\}$
L+H*

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

ONLY. We saw earlier that adnominal *only* operated on both the ordinary and the alternative logical forms. It is usually unaccented when it is assigned the category in 85.

(85) 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 noun phrase $NP^{\uparrow}$, decomposes it into its ordinary and alternative components Λ^o

[59] As in the earlier discussion of 13, this example involves the hearer in accepting the speaker's shift from the hearer's 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.

[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.

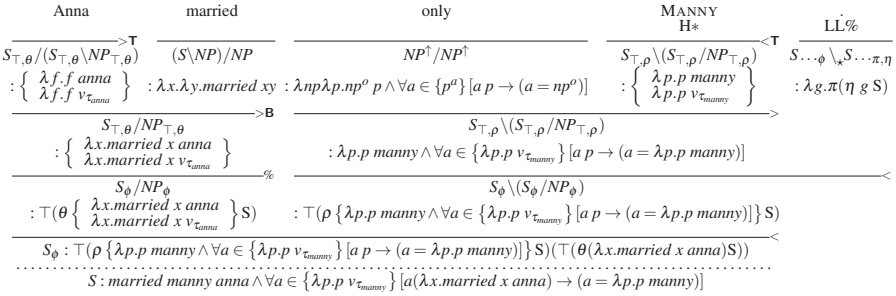
[62] Cf. n. 17.

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

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 (1984:148–51) 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 and 87c.

(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 & Gärtner 2005 and *TS*:§11.3, exx. 73–74, where additional semantic issues arising from polarity and negation are discussed at length, it is passed over here.[64]

The adverbial *only* in paraphrases 87b,c has been extensively investigated in alternative-semantic frameworks by Rooth (1985, 1992) and Kratzer (1991), among others, and requires category 88, 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 := $((S\backslash NP)/\ldots)/((S\backslash NP)/\ldots) : \lambda p\lambda x\ldots p^o x\ldots \wedge \forall a \in \{p^a\}\,[ax\ldots \rightarrow (a = p^o)]$

A parallel adverbial category for *also* can be added.

(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 cate-

[64] Błaszczak and Gärtner (2005) (who anticipated the account in *TS*) and Gärtner (2012) assume an 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.

gories verb modifiers rather than VP modifiers. Examples involving these operators are deferred to the next subsection.

'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 those in 90 are likely to give rise to answers like those in 91.

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

(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 1996a).

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 2002 [1996]). The instrumental data are equivocal on this point (Howell 2008). The present article remains entirely agnostic on the reality of any phonological difference between objects in examples like Fig. 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 Anna 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-occurrence 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.

[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.

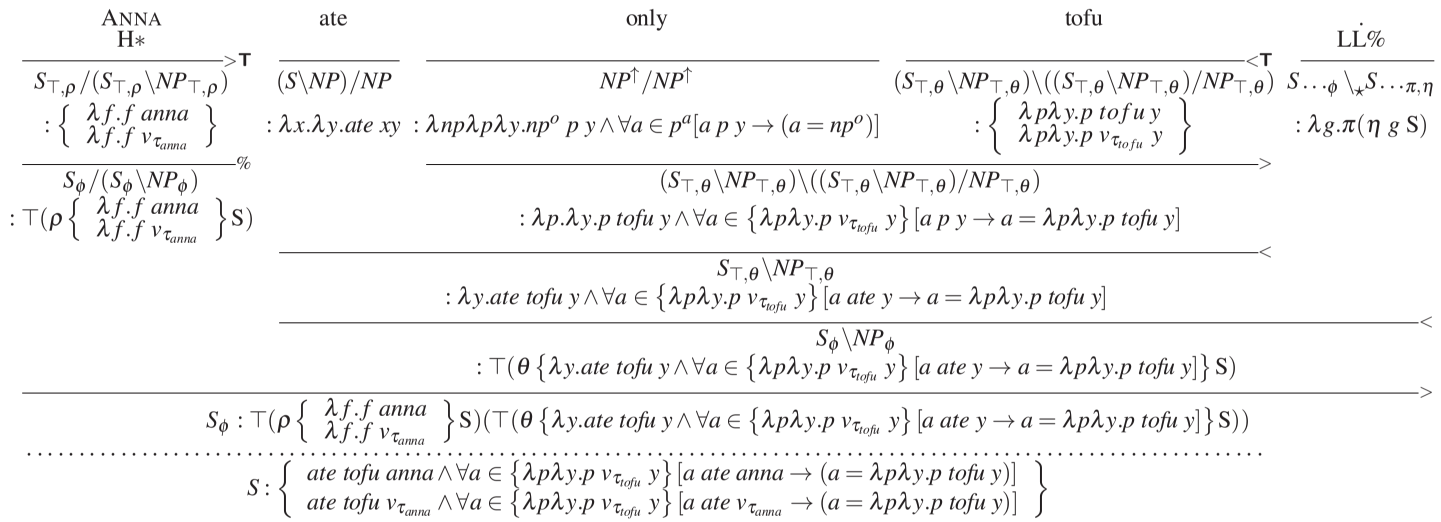


FIGURE 1. Derivation of *ANNA ate only tofu*.

'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.'

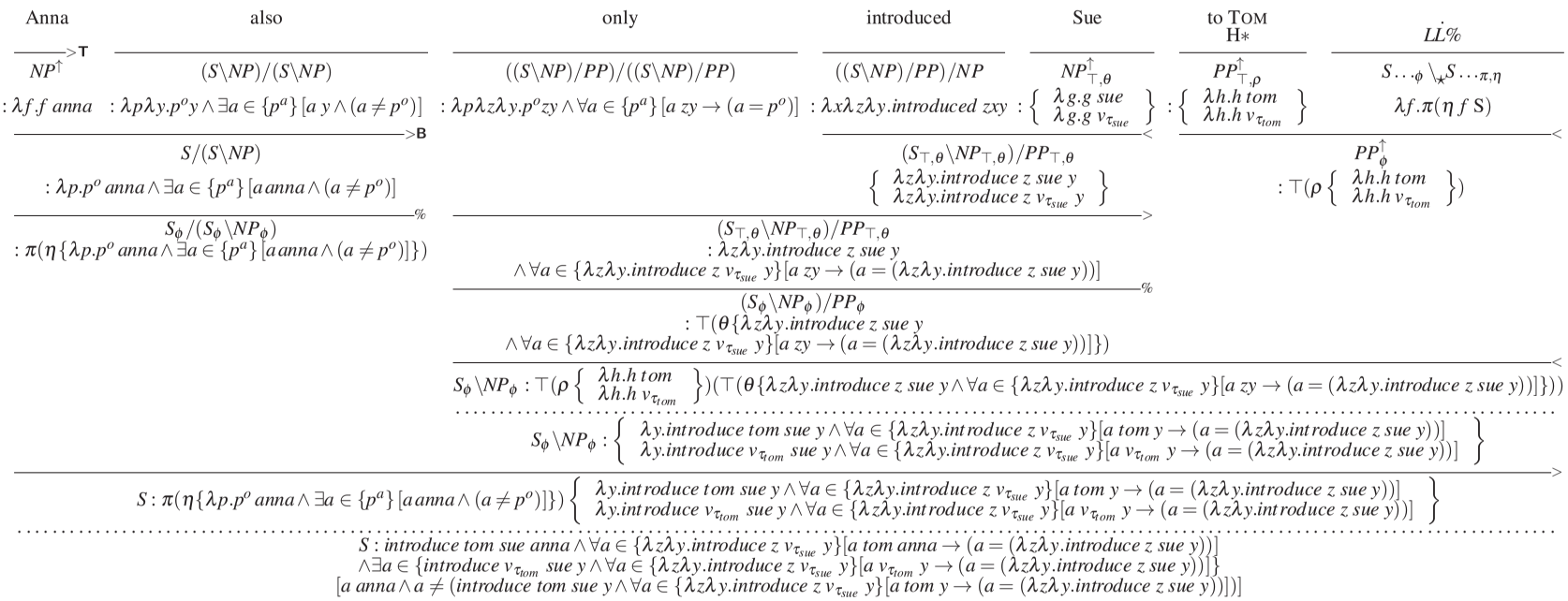


FIGURE 2. Derivation of *Anna also only introduced Sue to TOM.*

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. But while a structured meanings approach using free abstraction will correctly deliver both readings in 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 allows only the two readings indicated in 93a,b. The consistent reading (93b) is correctly derived as in Figure 2, notwithstanding speculation to the contrary by Pulman (1997:87; see also §6.2 below).

As in the case of the unaccented theme *ate only tofu* in Fig. 1, the unaccented theme *only introduced Sue* in Fig. 2 has a nontrivial alternative logical form Λ^a, stemming from the unaccented object category (77). The derivation therefore delivers the second-occurrence focus reading semantically, as in Rooth's and Schwarzschild'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]

6. GENERALIZATIONS AND CONCLUSIONS.

6.1. CROSSLINGUISTIC 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 crosslinguistically.

However, different languages and dialects are free to distribute the semantic work differently across their morphosyntactic 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]

ITALIAN. The Romance languages discussed by Ladd (1996) and Zubizarreta (1998) exhibit stronger constraints on nonfinal 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)$_\rho$.
H* LL%
'Your MOTHER phoned.'

[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 (2002 [1996]), on the assumption that the relevant alternative set is accessed anaphorically at the point in the derivation where the truth of the claim that *ate only tofu* is thematic is assessed against the hearer's representation of context/common ground.

[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.

b. Q: Chi ha telefonato?
'Who phoned?'
A: #(Tua MAMMA)$_\rho$ (ha telefonato)$_\theta$.
H* LL%
'Your MOTHER phoned.'

c. Q: Ha telefonato Gianni?
'Did Gianni phone?'
A: No, (tua MAMMA ha telefonato)$_\rho$.
H* LL%
'No, your MOTHER phoned.'

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%

Restrictions of weight and so forth on unaccented objects in such inversions that are rather similar to those discussed for English appear to apply.

These facts can be captured in the following assumptions.

(i) Accented NPs in Italian have exclusively leftward-applying (nominative and accusative) rheme-marked categories, type-raised over rightward-combining (intransitive and transitive) verb categories, for example:[68]
GIANNI := $S_\rho\backslash(S_\rho/NP_\rho)$
H* $(S_\rho\backslash NP_\rho)\backslash((S_\rho\backslash NP_\rho)/NP_\rho)$
etc.

(ii) Unaccented NPs in Italian have exclusively rightward-applying (nominative) unmarked categories, type-raised over leftward-combining (intransitive) verbs, for example:
Gianni := $S/(S\backslash NP)$

(iii) Unaccented intransitive verbs are exclusively unmarked VS or inverting, for example:
telefonato := S_{ppt}/NP

(iv) Accented intransitive verbs are exclusively rheme-marked SV, for example:[69]
TELEFONATO := $S_{ppt,\rho}\backslash NP_\rho$
H*

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

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

(v) Transitive verbs are exclusively SVO and may be accented/marked or not, for example:

telefonato/TELEFONATO := $(S_{ppt}\backslash NP)/NP$
H*

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 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 nonfinal 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).

GERMAN. German has a mapping of tones to information-structural meanings that is rather similar to English (see Büring 1997b, Jaeger & 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,[70] even to the extent of separating accented material from other apparently thematic elements, as in 98 below.[71]

(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: $(\text{Den MANNY})_\theta$ (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: $(\text{GEHEIRATET})_\theta$ (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:§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.

[70] As Büring (1997b: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) that 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 §5.3.

[71] 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*.

6.2. 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.

THE GENERALIZATION. Recall 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 in 99 (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 1975 [1955]:210–11; see *SP*: 12–14 for discussion) over all three domains.

ON SOME SUPPOSED COUNTEREXAMPLES TO THE GENERALIZATION. Joshi (1990:517) and, following him, Pulman (1997:85) 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 the first speaker establishes *Mary admires* as a possible theme, and the conjunction uttered in response by the second speaker requires *admires musicals* to be a constituent, this is a case where information structure diverges from intonation/syntactic derivation.

We know from example 13, however, that contexts like the above allow the second speaker to overrule the first and define *Mary* as theme, so examples like 100 do not constitute evidence for any such divergence.

Pulman (1997:86) 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 example 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 multiaccented information-structural elements are handled without invoking any 'more complex "wrapping" operations' of the kind that Pulman hypothesizes. Such examples therefore confirm rather than controvert the present generalization.

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 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, and so on, and rhythmic and melodic phrasing, which is interpreted in relation to, and temporally constrained by, regular meter (Cooper & Meyer 1963:4–7).

We have been able until this point to ignore metrical aspects of prosody and to discuss the mapping between logical form (including information structure) and lexicalized 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 independently 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 article rejects the STRICT LAYER HYPOTHESIS of Selkirk and Nespor 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-

[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 2008:263–80 for discussion.

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

The metrical foot and, under at least some definitions (e.g. Nespor & Vogel 1986:109–10; cf. Dalrymple & 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) ||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 syntactic and prosodic boundaries, although they undoubtedly do determine such off-line 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 well be lexicalized in the relevant dialects, in which case the role of the English rhythm rule is also off-line.

6.3. 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

[73] Ladd (1988, 2008), Féry and Truckenbrodt (2005), and Wagner (2010) discuss phonetic differences at phrase boundaries as reflecting depth of embedding for similar coordinate structures. The current approach does not, however, assume any such strong relation between strength of prosodic boundaries and depth of embedding. 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.

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, and so forth, 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, which was 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 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 diversity of pretheoretical assumptions and ad hoc discourse-functional labels similar to that hitherto found in the literature on intonation in English.

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[75] In fact, this is one of the few areas of computational linguistics where UNsupervised 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.

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