Against Prosodic Composition

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Abstract

In recent analyses in Combinatory Categorial Grammar (CCG), Mark Steedman has suggested that the class of legitimate constituency bracketings is determined by intonational structure and its pragmatic interpretation. According to this theory, the intonational, informational and syntactic structures of English are one, and can be captured in a single unified grammar.

In this paper, we argue that the intonational — or rather prosodic — grammar is highly restrictive. In fact, the only operation which should be allowed in prosody is Application. In suggesting so, we argue against the original proposals of Steedman (1991), where a restricted version of Prosodic Functional Composition was also included. Under the assumption that the derivation should directly define the domains of phonological implementation, we show that correct assignment of tonal domains only can be obtained if Application is the sole operation available in prosody.

Finally, we present a reanalysis of certain structures in which according to Steedman prosodic composition must apply obligatorily, and argue for a more refined representation of the intonational form as well as its interpretation.

1. Intonational categories

This paper addresses a number of problems in the interaction between intonation and syntax in the grammar of English. Whereas in syntax there is hardly any disagreement about the fact that sentences may be segmented into words, the segmentation of intonation is still a matter of dispute. Likewise, it may be considered uncontroversial that the terminal elements of a syntactic string should be interpreted as expressions referring to entities in the real world and relations between such entities. The interpretation aspect of intonation analysis is, however, far less understood, and constitutes a field of vivid ongoing research.

Couched within the framework of *Combinatory Categorial Grammar* (CCG), the analysis which follows, nevertheless builds on certain fundamental assumptions about the meaning of intonation as well as its linguistic form. First of all, both aspects are taken to be of a compositional nature. More specifically, it is assumed that each of the composite semantic objects correspond to a unique linguistic expression and vice versa. A second assumption only adheres to phonological form. As a consequence of their flexibility with respect to the string of segments, intonation contours will be represented autosegmentally along the lines of the theories of Pierrehumbert and associates.

(1) gives an overwiev of the parts of the intonational vocabulary of English we will be dealing with in this paper, and introduces a general terminology for referring to its different types. For matters of phonetic implementation we refer the reader to works like Pierrehumbert (1980), Beckman and Pierrehumbert (1986) and the introduction in Pierrehumbert and Hirschberg (1990).

(1) (i) Pitch Accents: **H***, **L+H***

(ii) Phrasal Tones
- (a) Phrase Accent: **L**
- (b) Boundary Tones: **H%**, **L%**

This vocabulary consists of a number of pitch accents and phrasal tones, which can be combined into well-formed strings, or tunes, according to the regular grammar given in (2)[1].

(2) *Alphabet*: **H***, **L+H***, **L**, **H%**, **L%**;

Syntax: Intonation = Tune^{+};
Tune = IntermediatePhraseTune^{+} BoundaryTone;
IntermediatePhraseTune = PitchAccent^{+} PhraseAccent;
PitchAccent = **H*** | **L+H***;
PhraseAccent = **L**;
BoundaryTone = **H%** | **L%**;

Under the CCG approach to intonation analysis, (combinations of) the tonal words listed in (1) are given the categories shown in (3).

(3)

L+H*	:=	Theme/Bh	**LH%**	:=	Bh
	:=	Bh/Bh	**LL%**	:=	Bl
H*	:=	(Utterance\Theme)/Bl	**L**	:=	bl
	:=	(Utterance/Theme)/bl	**Ø**	:=	X/X
	:=	Bl/Bl			
	:=	bl/bl			

Pitch accents are categorised as functions over boundary tones into the two major informational types theme and rheme. The latter category is itself a function from themes to utterances. The additional categories associated with each of the pitch accents serve to describe their

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[1] This partial grammar of English intonation is designed after Bird (1991). By convention plus superscript, the Kleene-plus, indicates one or more occurrances of a symbol, and vertical bar stands for disjunction. The reader is warned not to confuse the asterisk which marks accentual status in representations like **H*** with the Kleene-star.

function in accent sequences. Phrasal tones are atomic.[2] As can be seen, CCG intonation differs from the Pierrehumbert analysis in its treatment of phrasal tones. It does not distinguish between phrase accents and boundary tones, but treats them as one unit. Finally, segmental material which is unspecified for tonal value, is associated with the so-called null tone (Ø), which is assigned the identity function *X/X*.

2. Derivation of structure

The prosodic combinatory rules include forward and backward functional application, and a very restricted version of functional composition, shown as (4).

(4) *Forward Prosodic Functional Composition*

$$X/Y \quad Y/Z \quad \Rightarrow \quad X/Z$$

where $Y \in \{\text{Bh, Bl}\}$

Steedman argues that the restriction is required, because the whole point of the prosodic categories is to *prevent* composition across the theme-rheme boundary. Note, however, that this way the above definition becomes quite ad hoc. In fact, the only occasion when composition is required is when *X/Y* is a pitch accent (either followed by another pitch accent, or by an *X/X* category).

Interaction between intonation and syntax is ensured by the Prosodic Constituent Condition stated in (5).

(5) *The Prosodic Constituent Condition (PCC)*
Combination of two syntactic categories via a syntactic combinatory rule is only allowed if their prosodic categories can also combine (and vice versa).

The effects of PCC can be seen in the derivations (6) and (7). In derivations like these, we always show the results of both syntactic and prosodic combination. The rules applied are indicated by pairs of indexes, of which the first corresponds to the syntactic, and the second to the prosodic rule. The directionality of the operation is indicated by > or <, whereas the letter *T* stands for type-raising and *B* for composition. Where no index letter is supplied, the combination is simply a matter of application.

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[2] Prevost and Steedman (1993) introduces an alternative notation where categories receive the general format *X:Y*. Here, the colon is used to separate a structural category *X* from its interpretation *Y*. This makes it possible to collect all three phrasal tones under the same structural category, such that the members of this category are distinguished only by their different interpretations. Although this revision undoubtedly contributes to making the different levels of representation in CCG more explicit, it is of no importance to the discussion that follows. We therefore remain faithful to the representational format, and in part also to the categorial distinctions introduced in Steedman (1991).

(6) Well, what about FRED? What did HE eat?

```
     (FRED                  ate)          (the          BEANS)
      L+H*                  LH%                         H* LL%
    ------------      ----------------  ------------  -------------------
    NP: fred'         (S\NP)/NP: eat'   NP/N: the'    N: beans'
    Theme/Bh               Bh              X/X        Utterance\Theme
---------------------->T
S/(S\NP): λP [P fred']
    Theme/Bh
------------------------------------------->B,> ------------------------------------>,>
      S/NP: λx [(eat' x) fred']                        NP: the' beans'
               Theme                                   Utterance\Theme
        ----------------------------------------------------------------------->,<
                          S: eat' (the' beans') fred'
                                 Utterance
```

(7) Well, what about the BEANS? Who eat THEM?

```
     (FRED)                 (ate            the           BEANS)
      H* L                                                L+H* LH%
    --------------     ---------------   ------------  ----------------
    NP: fred'          (S\NP)/NP: eat'   NP/N: the'    N: beans'
    Utterance/Theme         X/X             X/X        Theme
----------------------->T                ------------------------->,>
S/(S\NP): λP [P fred']                        NP: the' beans'
    Utterance/Theme                                Theme
                    --------------------------------------------->,>
                              S\NP: eat' (the' beans')
                                        Theme
------------------------------------------------------------------->,>
                 S: eat' (the' beans') fred'
                          Utterance
```

In the given contexts, the intonation contour assigned to the string *Fred ate the beans* differs depending on the theme-rheme division of the sentence. This division is indicated by brackets in both examples. The question in (6) establishes the fact that Fred ate something as the theme of discourse, whereas in (7) it is the fact that somebody ate the beans that serves this function. This is reflected intonationally by the use of the tune *L+H* LH%*.[3] Rhemes, on the other hand, typically carry the tune *H* LL%*.

The derivation in (7) also shows why prosodic composition cannot apply freely. The initial word *Fred* is associated with a rhematic tune with the function *(Utterance/Theme)*. It is, however, also adjacent to a word carrying the null tone or identity function *X/X*. If these two

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[3] Especially when in pre-rhemal position, themes are uttered with this tune only in very careful speech. The more "casual" way of uttering such themes involves a relatively flat intonation countour, treated by Steedman (1991) as a sequence of null tones which receives their theme status by virtue of a special rule. We refer the reader to the literature for further details.

functions were allowed to compose, the theme-rheme division of the sentence would not be appropriate for the specified context anymore. Thus, prosodic composition has to be restricted to apply only *within* the theme or rheme constituents, in other words within an intonational phrase. This is exactly what the restriction stated in the rule of (4) does, as it only allows composition between two pitch accents or between a pitch accent and a null tone. This way *Fred* and *ate* can no longer combine prosodically and the Prosodic Constituent Condition prevents composition of their syntactic categories, too.

3.□Composition of null tones

As we have mentioned before, the set of possible grammatical operations in the prosodic domain is restricted to *Forward* and *Backward Functional Application* and *Forward Functional Composition* . Having established this background, we now turn to the main issue addressed in this paper, and take a closer look at the role of composition in the fragment of English intonation so far treated in CCG. Given the fact that prosodic composition is subject to some rather heavy constraints which make its scope extremely narrow, we hypothesise that it should be excluded from the grammar altogether. Such an adjustment of Steedman's original proposal would reduce the complexity of the grammar formalism to a minimum, and would make the issue of prosodic derivation simply a matter of functional application.

Below, we give a critical account of Steedman's motivation for the prosodic composition rule, and show how certain sets of problematic data cannot be given an adequate analysis unless prosodic composition is excluded from the grammar. This move subsequently forces us to re-state the informational category assigned to certain kinds of accents. As such accents do not participate actively in the construction of theme-rheme structure, we propose they should be analysed as empty of any informational content at this particular level (cf. section 4).

(8) Q: Well, what about FRED? What did HE eat?
A: (FRED must have been eating) (the BEANS)
L+H* LH% H*□LL%

Consider the dialogue (8). In the given context, it seems natural to divide the answer into a theme followed by a rheme as indicated by the brackets. A natural candidate melody for the sentence fragment *Fred must have been eating* should in other words be the theme marking melody *L+H*□LH%*. In Steedman's representational system, this melody consists of two elements, a 'rising' *L+H** pitch accent and a boundary *LH%*. The syntactic unit corresponding to the whole melody, on the other hand, consists of no less than five words. In this particular case the first syntactic word, *Fred*, is the metrically most prominent word of the sentence. Hence it will be associated with the pitch accent. The boundary tone falls by definition on the last word within the melodic domain, and is therefore associated with *eating*.

This leaves a stretch of three syntactic words totally unspecified for pitch value. They carry the null tone which belongs to the prosodic category *X/X*, a general identity function. In CCG, null tones within the intonational nucleus are ambiguous as to which identity they are parasitic to. Recall that it is assumed that the *L+H** accent belongs to the category *Theme/Bh*, the *LH%*

border to the category *Bh*, and that composition is restricted to pairs of constituents where the first carries the categorial identity of accents. This makes repeated composition possible, from the accent onwards, right through the whole stretch of null tone material. The resulting structure is as shown in (9).

```
(9)     FRED        must         have        been        eating□…
        L+H*                                             LH%
      --------   ----------   ---------   ----------   ---------
        NP       (S\NP)/VP    VP/VPen    VPen/VPing   VPing/NP
      Theme/Bh      X/X         X/X         X/X          Bh
      ------->T
      S/(S\NP)
      Theme/Bh
      ---------------------->B,>B
              S/VP
            Theme/Bh
            ------------------------->B,>B
                     S/VPen
                    Theme/Bh
                    -------------------------->B,>B
                              S/VPing
                             Theme/Bh
                             ------------------------------>B,>
                                         S/NP
                                         Theme

(10)    FRED        must         have        been        eating      …
        L+H*                                             LH%
      --------   ----------   ---------   ----------   ---------
        NP       (S\NP)/VP    VP/VPen    VPen/VPing   VPing/NP
      Theme/Bh      X/X         X/X         X/X          Bh
      ------->T                           ------------------------>B,>
      S/(S\NP)                                    VPen/NP
      Theme/Bh                                      Bh
                              ----------------------------->B,>
                                         VP/NP
                                          Bh
                 -------------------------------------->B,>
                              (S\NP)/NP
                                 Bh
      -------------------------------------------->B,>
                     S/NP
                     Theme
```

(9) is, however, not the only possible structure which can be assigned to this sentence. In fact, its mirror image (10) is an equally plausible structure. In (10) the sequence of null tone identity functions transports the category of the final border step by step to the left by forward application.

At this point we would like to focus on the relation between structures like (9), (10) and the phonological representations interpreting their constituents. In ‘standard’ generative grammar, work on the syntax-phonology interface (cf. Selkirk (1984), Nespor and Vogel (1986), Kaisse (1985)) has led to a number of competing theories on the extent and exact nature of syntactic influence on postlexical phonology. All theorists seem to share the belief that syntactic structure defines the domains of the segmental rules of the postlexical component. The opinions, however, differ on the question whether such rules must refer directly to syntactic constituency or whether they refer to the constituents of a prosodic structure established by rules mapping syntax onto phonology.

At the core of these theories lies the assumption that syntax is 'phonology-free', whereas the reverse is not supposed to hold. This approach has proven to be an extremely fruitful basis for describing certain well-known phenomena of external sandhi that apply across boundaries within syntactic phrases. It has been faced with serious problems, however, when it comes to defining how higher order prosodic constituents like the intonational phrase are related to the constituents of syntactic structure.

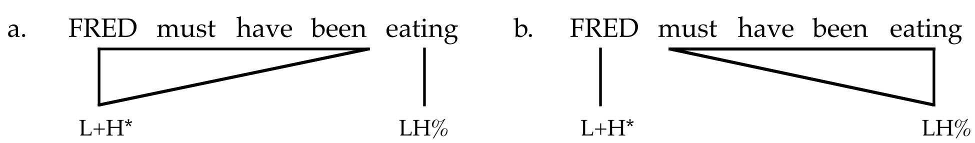
Nespor and Vogel (1986), for example, state that higher prosodic units should interpret increasingly general syntactic information, such that intonational phrases roughly correspond to S-bar constituents and their sisters. But they contradict their own basic claim by allowing their construction algorithm for intonational phrases to take the specific category of phrasal projections into account.

In CCG the perspective is radically different. Here syntax and phonology interact in a two-way fashion, and constrain each other mutually as stated by the Prosodic Constituency Condition (5). This condition is an explicit formulation of a more general claim in CCG (11), that the structures of the intonational, informational and syntactic aspects of utterances are identical.

(11) CLAIM:
The structures demanded by the theory of intonation and its relation to contextual information are the same as the syntactic structures permitted by the combinatory grammar. (Steedman (1991:33))

We may therefore assume that the structure resulting from a categorial derivation also should function as a Prosodic Structure in the sense of Nespor and Vogel. This entails that the derived structure must define the domains of phonology directly. Returning to the derivations (9) and (10), the structure must therefore be able to predict how the phonological segments of the melody are associated with the corresponding text. It should explain why certain tonal words may be projected onto larger phonological domains while such projection of others is blocked. The structures represented in (12a, b) are intended to demonstrate how (9) predicts rightward expansion of the *L+H** accent domain over the entire unspecified material as in (12a), whereas (10) predicts that the border tone must dominate the material to its left, as in (12b).

(12)



(13) shows how the intonation tune in question should be aligned phonologically with its text according to the theories of Pierrehumbert.

(13)

FRED must have been eating
L+H* L H%

The stylised contour above the text in (13) illustrates how the accent peak is immediately followed by an abrupt fall down to a low level which remains relatively stable until the very end of the phrase where a final rise can be observed. In Pierrehumbert's model this low middle part of the contour is controlled by one single segment, a *L* phrase accent, which is associated with the syllable immediately following the accent, and controls the pitch all the way to the final syllable which carries the boundary tone *H%*.

The representation of intonation in CCG, however, does not correspond directly to the Pierrehumbert model. Phrase accents are not uniformly represented as separate segments with an individual categorial status, but they are often collapsed into one unit together with a following border tone. This makes rightward construction of a *L* phrase accent domain as in (13) impossible. Since in our representation, this low segment constitutes a part of the tonal word associated with the final syntactic word of the sentence, one must assume that it should expand its domain to the left as in (12b). It should now be immediately clear that the structure which serves as an adequate basis for phonological interpretation of (8A) is (10). This is the only structure which defines the domain of the 'phrase accent' correctly. (9) on the other hand would predict that the domain of *L+H** would extend all the way to the right boundary. We therefore maintain that a structure like (9) is not supported by prosodic evidence, and therefore should be excluded from the set of possible derivations of CCG. This can only be obtained if prosodic composition is removed from the grammar.

4. Composition of Multiple Accents

We now turn to examples of multiple accentuation in co-ordinate structures. For sentences like these, Steedman has proposed that prosodic composition has to apply obligatorily. By showing that composition is superfluous even in structures like these, we claim to give the ultimate piece of evidence for its inadequacy in intonational grammar.

(14) Q: What did you give to whom?
A: (I gave) (GEORGE a BOOK and MARtha a REcord)
Theme *Rheme*

```
(15)     GEORGE              a BOOK      and        MARtha              a REcord
           H*                  H*                     H*                 H* LL%
  ------------------------  -----------  ------------  -----------------------  ------------------
  (S/NP)\((S/NP)/NP)      S\(S/NP)      (X\X)/X   (S/NP)\((S/NP)/NP)      S\(S/NP)
  (Utterance\Theme)/Bl      Bl/Bl          X/X             Bl/Bl                   Bl
  --------------------------------------<B,>B       ---------------------------------------------<B,>
        S\((S/NP)/NP)                                          S\((S/NP)/NP)
     (Utterance\Theme)/Bl                                            Bl
                                   ----------------------------------------------------->,>
                                      (S\((S/NP)/NP))\(S\((S/NP)/NP))
                                                    Bl
       ------------------------------------------------------------------------------------<,>
                                S\((S/NP)/NP)
                               Utterance\Theme
```

So far we have only encountered tunes with a single pitch accent. In the 'left node raising' construction (14) and (15)[4], however, we find additional accents within the domain of one and the same tonal border. Successful parsing of such accent sequences requires assignment of the category *Bl/Bl*, an identity function over a final border, to all but the first accents in the sequence. When such multiple accents are distributed over the elements of co-ordinate structures, this produces a puzzling asymmetry in the derivation of the internal structure of the co-ordinates. While the combination of the units contained in the second conjunct will proceed by means of application both syntactically and prosodically, the members of the first conjunct cannot be combined prosodically without resorting to composition. This is due to the fact that here the border tone is simply missing, such that the prosodic function *Bl/Bl* cannot find its argument within the co-ordinated constituent.

To maintain the claim that prosodic composition is not part of the grammar we therefore need to find an alternative analysis for such constructions. The solution we propose, builds on the observation from Steedman (1991) that multiple accentuation bears no direct relation to theme-rheme structure. The function of an additional accent is *not* to signal a new informational constituent of the theme-rheme type, but to highlight parts of the theme or rheme as 'new' information.

We will therefore assume that additional accents should not be assigned to categories characterised as functions over informational entities at this particular level. On the contrary, we will maintain that this aspect of accent use is better described in terms of functions over the distinction given-new. As long as these informational concepts have not been incorporated explicitly in our grammar, we believe additional accentuation should be treated as empty of any informational

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[4] Steedman proposes that conjunctions are assigned the atomic category *conj*, and that co-ordination is achieved by means of a ternary syntactic combinator $X\ conj\ X \Rightarrow X$. Prosodically, the conjunction must, however, be associated with a null tone of the category *X/X*, which calls for binary combination like Application $X/Y\ Y \Rightarrow X$. One of our reviewers has pointed out to us that such parallel use of binary and ternary combinators will produce counterevidence to the claim stated in (11) that syntactic, intonational and informational structure are one. We therefore assume the more traditional view that conjunctions belong to the syntactic category *(X\X)/X*.

content. This naturally leads to a provisional analysis of such accentuation as application of an identity function of the most general kind, the non-directional function *X|X*. We therefore propose that this category be assigned to all but the first member of an accent sequence as in (16).

```
(16)          GEORGE          a BOOK  and    MARtha   a REcord
                H*              H*             H*      H* LL%
       ---------------------  --------  --------  -------  ----------
       (Utterance\Theme)/Bl     X|X       X/X      X|X        Bl
       ---------------------------------<B,        ---------------------<B,>
            (Utterance\Theme)/Bl                           Bl
                                          ---------------------------->,>
                                                      Bl
            ---------------------------------------------------<,>
                             Utterance\Theme
```

Under the current proposal, the structure assigned to a conjunct like *George a book* remains essentially the same, but the way in which it is derived will be considerably simplified. As shown in (16), the prosodic combination of the two objects of both conjuncts now reduces to a matter of simple functional application.

Introducing a non-directional identity function in the grammar may seem a radical step to undertake. In fact, assigning such a function to an intonational element amounts to saying that this element is totally irrelevant to structure. Due to combinatorial flexibility, elements belonging to the *X|X* category will accept any combination suggested by their corresponding syntactic categories. They suppress, so to speak, the requirements of PCC. As long as a thorough investigation incorporating in CCG such discourse concepts as given and new information, is lacking, this is, however, exactly what we would want.

It does not seem possible, though, to do away with directionality in identity functions altogether, and rephrase even the category of null tones as *X|X*. Such a move would reintroduce structural ambiguity in sentences like (9A), and weaken our theory substantially, since this kind of ambiguity was part of our original argument against prosodic composition.

5. A problem and a solution

Mark Steedman (pers. comm.) has pointed out to us that there exist additional cases where prosodic composition may prove necessary in order to avoid derivation of syntactic nonconstituents. Intonationally, the cases in question are instances of the same pattern as example (8A), with a pitch accent followed by one or more null tones and a boundary. In a composition-free framework, the constituent membership of null tone words will be totally governed by the directionality of their prosodic category. In our analysis, null tones have been given the category *X/X*, which means that they only combine to their right, deriving increasingly larger right-branching constituents with the same prosodic category as the next pitch accent or boundary. (17) demonstrates this on a slightly more complex sentence than the ones discussed so far.[5]

```
(17)      (My      Other    sister     says       she       admires)    (CORduroy)
                   L+H*                                       LH%        H*□LL%
        --------- --------- -------- ---------- ---------- ------------ -------------
          NP/N      N/N        N      (S\NP)/S   S/(S\NP)   (S\NP)/NP        NP
          X/X      Th/Bh      X/X       X/X        X/X          Bh          Rheme
                                                 ---------------------->B,>
                                                           S/NP
                                                            Bh
                                         --------------------------->B,>
                                                   (S\NP)/NP
                                                      Bh
                             ------------>T  ------------------------------<A
                              NP\(NP/N)            (S/NP)\NP
                                 X/X                  Bh
        ------------------>B,> ----------------------------------------<B,>
             NP/N                       (S/NP)\(NP/N)
             Th/Bh                            Bh
             -------------------------------------------------<,>
                                S/NP
                               Theme
```

The structure derived in (17) must, however, be rejected for purely syntactic reasons. Although the sequence *sister says she admires* coincides with an intonational domain of the utterance, it does not form a syntactic constituent of the sentence. Unless derivations like (17) are prohibited, there would be nothing in our grammar that could prevent such nonconstituents from entering into syntactic operations. The sentences in (18) show by way of example that the sequence in question neither qualifies as a shared constituent in a co-ordination (18a) nor as the antecedent of a pro-constituent (18b).

(18) a. *My little sister says she admires corduroy, and my big velvet
     b. *My little sister says she admires corduroy, and so does my big

For reasons of syntax, the noun *sister* should therefore not be allowed to combine directly with the sequence *says she admires*. It must first combine with either *own* or *my own*. But for such combination to be obtained, prosodic composition has to be included (19).

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[5] This derivation introduces in CCG an additional syntactic rule of *Left Association* in order to make direct combination of the verb group and its subject possible. We index this combinator as $<A$, and define its syntax and semantics with Moortgat (1988) as follows: $(X\backslash Y)/Z{:}F \Rightarrow (X/Z)\backslash Y{:}\lambda x\lambda y.F(x,y)$

```
(19)    (My     Other    sister    says      she       admires)    (CORduroy)
                L+H*                                   LH%          H*□LL%
       -------  -------  ------  --------  --------  ----------  ------------
        NP/N     N/N       N     (S\NP)/S  S/(S\NP)  (S\NP)/NP       NP
        X/X     Th/Bh     X/X      X/X       X/X         Bh          Rheme
                ---------------->,>B              ----------------------->B,>
                       N                                  S/NP
                     Th/Bh                                 Bh
        ------------------------>,>        ---------------------------->B,>
                NP                                (S\NP)/NP
               Th/Bh                                  Bh
           --------------->T
             S/(S\NP)
              Th/Bh
             ------------------------------------------------>B,>
                              S/NP
                              Theme
```

This structure, however, faces the same problems with respect to tonal implementation as the previously discussed derivation in (9). Once more, prosodic composition makes it possible to derive ill-formed tonal domains. The *LH%* boundary can at most be associated with the string *says she admires*, leaving *sister* as part of the same domain as the pitch accent. We conclude that the analysis fails to explain why there is in fact a pitch fall already on *sister*, and we therefore reject its validity as an argument for prosodic composition.

The observed conflict between intonation and syntax in cases such as the one discussed above raises the question whether we are to interpret this as evidence against PCC, and thus against the fundamental claims of CCG prosodic theory. As the crucial argument which gives rise to this conflict, is based on observations concerning the phonetic interpretation of tonal representations, it must, however, be external to PCC, which is a principle of the phonology-syntax interface. The unresolved conflict between structures such as (17) and (19) might in other words just as well be a consequence of an inadequate representation of intonation.

It is possible, however, to set up a different grammar of intonation. If we assign separate categories to phrase accents and boundary tones, in total accordance with the theory of Pierrehumbert, then pitch accents, phrase accents and boundary tones can each be functors or arguments, and we arrive at eight possible grammars. Let us consider the one which follows the intuitions behind theories of intonation most closely. This grammar will look like (20), where pitch accents are the only atomic categories and both phrasal tones are functors.

(20)

L+H*	:=	p, p\p, p\t
L	:=	t\p
H%	:=	T\t

The categories of (20) are purely structural, with symbols chosen for their mnemonic value: *p* for pitch accent, *t* for intermediate phrase tune and *T* for the full intonational tune. In this system, only combination of phrase accents and boundary tones would require composition. Such combination has, however, no status in the theory of Pierrehumbert, and it does not reflect a prosodic constituent. Moreover, this grammar produces structures that are uniformly left-branching, that is, it does not require any preplanning in the production of intonation contours (cf. Liberman and Pierrehumbert (1984)).

In a system like this, words that are associated with no tonal segment seem to fall in two categories prosodically. Preaccent words must by neccessity combine to their right, whereas words situated in between the phrase accent and the boundary tone probably are best understood as combining to their left to form part of the same domain as the phrase accent. This directional ambiguity may be resolved by assuming with Gussenhoven (1988) that preaccent words are associated with a special intonational segment, the Onset, which in English always will be realised at mid pitch level. In our system the Onset will be assigned the category *X/X*. Although null tones in the sense of Steedman (1991) may be argued to be no part of the intonation system proper, but rather artifacts of the PCC, we shall continue to make use of this device to explain the prosodic behaviour of words with no tonal specification. Their category will be *X\X*. This can nevertheless be nothing more than a preliminary solution. A more detailed understanding of the prosodic function of such words, cannot be based only on intonation analysis, but must also take into consideration how specific rules of external sandhi apply.

Derivation of the sentence from (17) and (19) will now proceed as shown in (21), where prosodic combination can be achieved by using only application.

```
(21)     (My      Other    sister     says       she       admires)
          Ons      L+H*     L                                 H%
       ---------  -------  -------  ---------  ---------  -----------
         NP/N      N/N      N      (S\NP)/S   S/(S\NP)   (S\NP)/NP
          X/X       p       t\p       X\X        X\X         T\t
       ------------------>B,>
             NP/N
              p
             ------------------------>,<  -------------A
                     NP                    (S/S)\NP
                     t                       X\X
                   ----------------------------------<,<
                                S/S
                                 t
                         -------------------------------------->B,<
                                        S/(S\NP)
                                           t
                                   ------------------------------------->B,<
                                                    S/NP
                                                     T
```

The reader can easily check out that the derivations of the other examples proceed unproblematically in this framework, too. Except for the familiar ‘left-node raising’ constructions, where composition is still required — unless, of course, we use for additional accents the category argued for in this paper, the non-directional *X|X*.

Although the problem illustrated in (17) cannot be solved within the standard intonation analysis of CCG, unless composition is allowed, we conclude that it is possible to design an alternative system of prosodic categories where even this case can be treated using only application. Due to its more refined representation of intonation, this system would also bring CCG intonation analysis more in accordance with the results of generative phonology.

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