# Intonational Phrasing and Discourse Segmentation

Theories that relate intonational structure and discourse structure concentrate on intonational and informational units that either correspond to a clause (proposition) or to a single referent. However, intermediate phrases of the intonational phrasing often segment units that are smaller than a clause, but that do not introduce a referent. Even though they are acknowledged (cf. Selkirk's "sense units"), there are no approaches that account for their role in building the discourse structure. The paper presents a new approach that describes the representation of such intermediate phrases and accounts for their functions in the construction of a more fine-grained discourse structure.

## 1. Introduction

Intonation contours are represented by phonologists as a sequence of abstract tones consisting of pitch accents and boundary tones. Pierrehumbert & Hirschberg (1990, 308) assign discourse functions to the particular tones: "Pitch accents convey information about the status of discourse referents (...). Phrase accents [= boundary tones of intermediate phrases] convey information about the relatedness of intermediate phrases (...). Boundary tones convey information about the directionality of interpretation for the current intonational phrase (...)." The status of discourse referents can be accounted for in terms of given vs. new; the boundary tones of intonational phrases indicate how the proposition expressed by the whole phrase is integrated into the discourse. Similarly, boundary tones of intermediate (or phonological) phrases that correspond to a full proposition indicate the way these propositions are interpreted with respect to the linguistic context, as illustrated in (1) and (2).

However, in this view there is no account of treating intermediate phrases that correspond to units below the clause level and above the level of simple discourse referents, such as the modification "im achtzehnten Jahrhundert" ("in the eighteenth century") or the unsaturated phrase "lebte in Frankreich" ("lived in France") in example (3):

(1) (George ate chicken soup) (and got sick)
**L** **LL%**

(2) (George ate chicken soup) (and got sick)
**H** **LL%**

(3) [(Im achtzehnten Jahrhundert) ~(lebte in Frankreich)] | [(ein Mann,)
( ~der zu den genialsten und abscheulichsten Gestalten dieser an genialen
und abscheulichen Gestalten nicht armen Epoche gehörte.)
"In the eighteen century France there lived a man who was one of the most gifted and abominable personages in an era that knew no lack of gifted and abominable personages"

In order to account for these intermediate units and their functions in building a discourse structure, I modify the general assumptions of discourse theories, namely that the discourse structure is exclusively realized between propositions (Hobbs 1990, Roberts 1996, Büring

2000 among others), and the view of DRT (Kamp & Reyle 1993) that discourse structure only relates discourse referents to each other. I extend Asher's (1993, 1999) segmented DRT (SDRT) by assuming that we can also create discourse relations between sub-clausal elements such as modifications or unsaturated clauses.

The remainder of the paper is organized as follows: In section 2, I discuss different approaches to the function of intonational contours. I show that no attention is given to intermediate phrases and their discourse function. In section 3, I present one family of approaches to discourse structure: DRT, a theory that focuses on anaphoric relation in terms of accessibility relations between discourse referents. In section 4, I introduce Asher's segmented DRT, a modification of classical DRT that allows to express relations between propositions in a discourse. In section 5, I modify Asher's discourse model in order to implement even smaller units – those units that correspond to the intermediate phrases of the intonational structure.

## 2. The meaning of intonational structure

Pierrehumbert (1980) represents an intonational contour by a tune consisting of abstract tones (4), which are generated by a finite state grammar (5) that combines the tones listed into legal tunes:

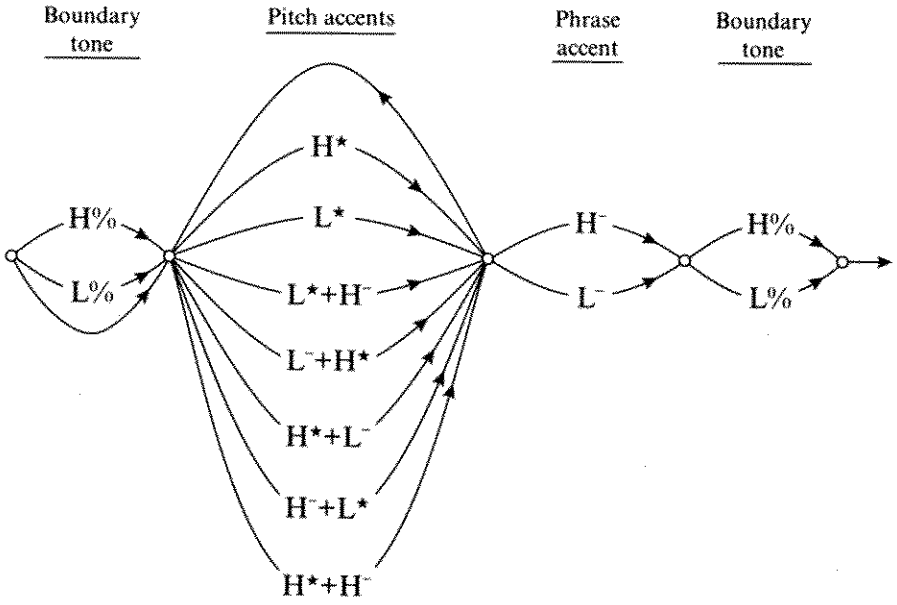
(4) *Phonological tones* (Pierrehumbert 1980)

(i) Each phrase requires at least one pitch accent (for English: H*, L*, or bitonal as H*+L, H+L*, L*+H, L+H*, and H*+H)

(ii) Each phrase receives a phrase accent ($H^-$, $L^-$) at the end of the word that is associated with the last pitch accent

(iii) Each phrase ends with a boundary tone (H%, L%)

(5) The finite state grammar of Pierrehumbert (1980)



This grammar accounts for the legal tune and therefore describes the possible composition of tones to tunes. However, Pierrehumbert (1980) does not account for the relations between the elements in the tune.

There have been different suggestions how to interpret the relation between the elements of the tune and their functions: (i) The most classical description is in terms of phonological words, a tradition going back to Liberman's view of the contour as 'ideophonic word'. (ii) Steedman (1991, 2000) describes the pitch accent as functions that require an argument in order to yield a tune. His approach reflects the reconstruction of linguistic configurations in categorial grammar. (iii) Pierrehumbert & Hirschberg (1990) propose that the different tones have independent functions ranging over different domains.

## 2.1 The tune describing an ideophonic word

Hayes & Lahiri (1991) execute the program of the intonational lexicon proposed by Liberman (1975) in the most comprehensive way. They account for the different tunes in Bengali and decompose the tunes into intonational *stems, suffixes* and *prefixes* (they use *I* for intonational phrase and *P* for phonological or intermediate phrase (*ip*)):

(6) The intonational lexicon of Bengali Hayes & Lahiri (1991)

| | | |
|---|---|---|
| a Accents ("stems"): | L* | question accent |
| | H* | declarative accent |
| | $L^*H_P$ | focus accent |
| b Boundary Tones ("suffixes"): | $L_I$ | neutral |
| | $L_I H_I$ | continuation rise |
| | $H_I$ | offering |
| | $H_I L_I$ | yes/no |
| c Prefix: | L+ | finality marker (form L+H* when attached to H*) |

These tones combine to the following tunes, assuming that there are three pitch accents, and optional $T_P$ and one obligatory $T_I$ (Hayes & Lahiri 1991, 72). Note that a focused phrase is marked by a L*-pitch accent and an obligatory $H_p$ boundary tone (of an intermediate phrase)

(7) Possible tunes in Bengali

| | |
|---|---|
| $L^*H_I$ | Offering |
| $L^*H_IL_I$ | Yes/no question |
| $L^*H_PH_I$ | Focus |
| $L^*H_PL_IH_I$ | Focus with continuation rise |
| $H^*L_I$ | Declarative |
| $H^*L_IH_I$ | Declarative with continuation rise |
| $L+H^*L_I$ | Downstep |
| $L+H^*L_IH_I$ | Downstep with continuation rise |

This view is influenced by the phonological tradition of analyzing units like the syllable or the phonological word, which consist of one prominent part and other more or less important parts. Here, the pitch accent constitutes the central part and the boundary tones additional affixes.

## 2.2 Tune representing the functional contribution to the utterance

Steedman (1991, 2000) executes Halliday's thematic structure in terms of combinatory categorial grammar (CCG). This can be illustrated with the following example which receives the thematic structure in *theme-rheme*. Both thematic units are further divided into given material and new material; the latter is associated with the pitch accent.

(8) Q: I know that Mary's FIRST degree is in PHYSICS.
But what is the subject of her DOCTORATE?
A: (Mary's DOCTORATE) (is in CHEMISTRY)
L+H*LH% H* LL%
*Given* *New* *Given* *New*
*Theme* *Rheme*

The basic units are the theme and the utterance. All other parts are defined with respect to these basic elements. For example, the rheme is a function that takes the theme as argument yielding the utterance (this is of course, the instantiation of the subject-predicate structure in terms of functional application). Steedman now defines the function of the pitch accent L+H* as theme that misses a boundary tone, i.e. as a function that needs a boundary tone to yield a theme. Analogously, the pitch accent H* indicates a function that needs a boundary tone in order to yield a rheme. Thus in the description of tones, Steedman assumes the boundary tones and the whole tune as the primary units.

(9) Categorial functions of tones (Steedman 1991)

| | | |
|---|---|---|
| LH% | boundary tone | simple argument |
| LL% | boundary tone | simple argument |
| L+H* | pitch accent | function from boundary tone into theme |
| H* | pitch accent | function from boundary tones into rheme |
| L+H*LH% | contour | simple argument: theme |
| H* LL% | contour | function from themes into utterance. |

Steedman uses the terms *theme* and *rheme* as well as *given* and *new*. The first pair can be defined with respect to the sentence under analysis. Yet the second pair can only be defined by the discourse in which the sentence is embedded.

## 2.3 Tones representing different discourse functions

Pierrehumbert & Hirschberg (1990) give a list of functions of pitch accents and boundary tones. The latter indicate whether the phrase to which the boundary tone is associated should be interpreted with respect to the preceding discourse or to the following discourse. Pierrehumbert & Hirschberg (1990, 304) illustrate this point on the following contrast between (10) and (11). The low boundary tone L% in (10) indicates that this sentence is related to the discourse by its own, while the high boundary tone H% in (11a) indicates that it is to be interpreted with respect to the following sentence. This difference influences the choice of the antecedent of the pronoun *it*: In (10) it refers to the following proposition *I spent two hours figuring out how to use the jack*, while in (11) it refers back to the *new car manual*(see also example (1) and (2) above):

(10) a My new car manual is almost unreadable
**L L%**
b It's quite annoying
**L H%**
c I spent two hours figuring out how to use the jack
**L L%**

(11) a My new car manual is almost unreadable
**L H%**
b It's quite annoying
**L L%**
c I spent two hours figuring out how to use the jack
**L L%**

Pierrehumbert & Hirschberg (1990, 308) assign the following discourse functions to the particular tones:

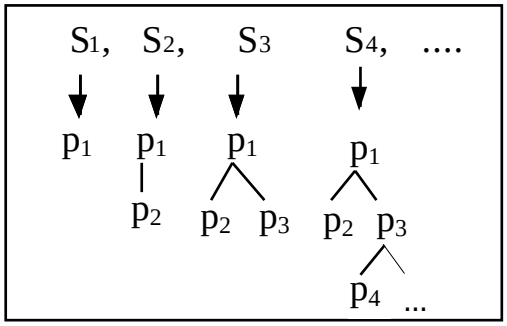
> Pitch accents convey information about the status of discourse referents, modifiers, predicates, and relationships specified by accented lexical items. Phrase accents convey information about the relatedness of intermediate phrases–in particular, whether (the propositional content of) one intermediate phrase is to form part of a larger interpretative unit with another. Boundary tones convey information about the directionality of interpretation for the current intonational phrase–whether it is "forward-looking" or not.

In explaining the function of intermediate boundaries tones (their "phrase accents"), they refer to the "propositional content" of the corresponding phrase. However, not all intermediate phrases express a propositional content, some might only refer to modifications such as "im achtzehnten Jahrhundert" ("in the eighteenth century") or the unsaturated phrase "lebte in Frankreich" ("lived in France") of example (3), repeated as (12). (12) is the first sentence in Patrick Süskind's novel "Das Parfum. ("Perfume") (the data are from Braunschweiler & Fitzpatrick & Lahiri 1998ff). Intermediate phrases in intonational structure not always correspond to propositions or to simple discourse referents. Therefore, we need a more fine-grained discourse structure that allows to construct corresponding discourse segments.

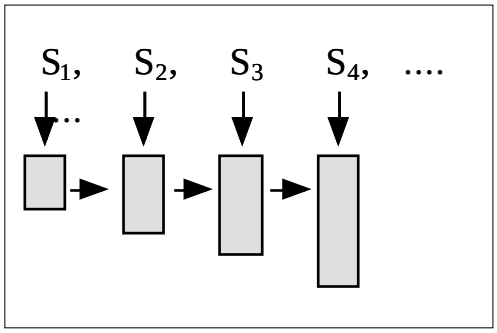
## 3. Discourse structure

There are two main families of approaches to discourse structure. According to one family, discourse structure is understood as realizing relations between propositions. Here the structure is represented as a tree of propositions (e.g. Hobbs 1990, Roberts 1996, Büring 2000) as illustrated in (13a). In the other view the discourse is incrementally (re)constructed, as illustrated in (13b). This program is executed in DRT (Kamp & Reyle 1993), which will be presented below.

(13a) Discourse structure as a tree




(13b) Incremental discourse structure




The initial problem that motivated discourse representation theories is the interpretation of nominal and temporal anaphora in discourse. The phenomenon of cross-sentential anaphora forces a semantics to extend its limits from the sentence to the discourse. The key idea in the approach to semantics of discourse, exemplified in (Heim 1982) and (Kamp 1981), is each new sentence or phrase is interpreted as an addition or 'update' of the context in which it is used. This update often involves connections between elements from the sentence or phrase with elements from the context. Informally described, a sequence of sentences *S1, S2, S3, S4* is interpreted by incrementally constructing a discourse representation as in (13b) above. Anaphoric relations and definite expressions are captured by links between objects in this representation. In order to derive the truth condition of the sentence, the representation is embedded into a model.

The DRS in (14a) graphically describes a discourse representation structure (in short DRS) with two parts. One part is called the *universe* of the DRS, the other its *condition set.* A DRS is an ordered pair consisting of its universe and condition set, written as $<U_K, Con_K>$. The DRS in (14a) has as its universe one *discourse referent* x and as its condition a set of properties that are ascribed to the discourse referents in the universe. In (14a) the property of being a man and of walking is ascribed to the discourse referent x.

(14) A man walks.

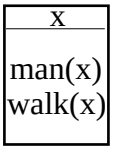
(14a)

| x |
|---|
| man(x)<br>walk(x) |

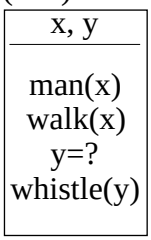
The sequence or conjunction of two sentences as in (15), receives a DRS incrementally. We start with the already established DRS for the first conjunct in (15a), then a new discourse referent for the pronoun *he* and a condition for the predicate *whistle* is added in (15b). The anaphoric link of the pronoun is graphically represented as *y=?,* indicating that the pronoun is still unresolved. The discourse referent which stands for an anaphoric expression must be identified with another *accessible* discourse referent in the universe, here the *y* is identified with the *x*, as in (15c).

(15) A man walks. He whistles

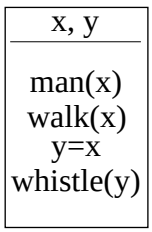
(15a)




(15b)




(15c)

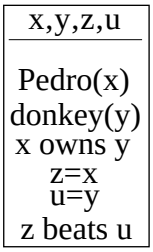



The new discourse referent introduced by the pronoun must be linked or identified with an already established and accessible discourse referent. DRT defines accessibility in terms of structural relations, i.e., the discourse referent must be in the same (or a higher) universe. With this concept of accessibility, the contrast between (16) and (17) can be described by the difference in the set of discourse referents that are accessible for the discourse referent *u* of the pronoun *it.* The construction rule for the negation in (17) creates an embedded discourse universe with the discourse referent *y* and the conditions *donkey(y)* and *x owns y*. The anaphoric pronoun *it* in the second sentence cannot find a suitable discourse referent since it has no access to the embedded discourse universe with the only fitting discourse referent *y*.

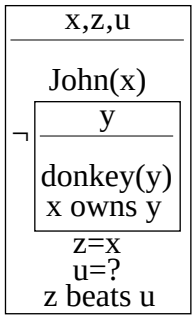
(16) Pedro owns a donkey. He beats it.

(17) John does not own a donkey. *He beats it.

(16a)




(17a)

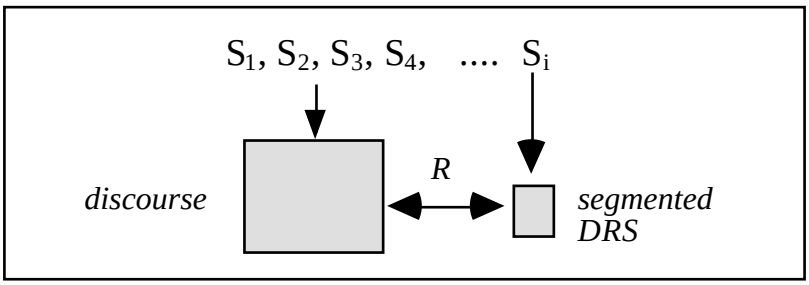



## 4. Segmented DRT

Asher (1993; 1999) develops the extension "segmented DRT" (=SDRT) that is not confined to the incremental composition of DRSs, but also captures discourse relations between the sentences in the discourse. He revises the classical DRT of Kamp (1981) and Kamp & Reyle (1993). Since the meaning of each sentence is construed as a function from truth conditions to truth conditions, the truth conditional content of the whole discourse is reconstructed by the sequential application of these functions. Asher (1993, 256) notes that "the notion of semantic updating in the original DRT fragment of Kamp (1981) (...) is extremely simple, except for the procedures for resolving pronouns and temporal elements, which the original theory did not spell out. To build a DRS for the discourse as a whole and thus to determine its truth conditions, one simply adds the DRS constructed for each constituent sentence to what one already had. (...) This procedure is hopelessly inadequate, if one wants to build a theory of discourse structure and discourse segmentation."

In SDRT, each sentence $S_i$ is first represented as a particular SDRS for that sentence. The SDRS can than interact with the already established DRS reconstructing a discourse relations *R*, such as causation, explanation, coherence, elaboration, continuation, as informally sketched in (18). Only in a second step the representation is integrated into the already established representation.

(18) Construction of a segmented DRS in SDRT




To summarize this very short presentation of DRT: The discourse structure of DRT provides not only a new structure but also introduces new semantic objects, the discourse referents, the conditions and the discourse domains ("boxes"). DRT explains semantic categories such as definiteness and anaphora in terms of interaction between these representations. Furthermore, the extension to SDRT allows expressions of discourse relations between whole propositions as well.

## 5. Phrasing and Segmentation

The basic assumption of this paper is that intonational structure reflects discourse structure. Thus each element of the intonational structure must be assigned a function in constructing the discourse. Pitch accents introduce or refer to discourse referents, boundary tones of intonational phrases relate the content of these phrases, a proposition, to other propositions. However, there has been no function for phrases that do not express a propositions. The investigation of Hayes & Lahiri (1991) have shown that such boundary do function in discourse structure, e.g. as right edge of a focused phrase (cf. (6) and (7)). However, there is no general approach to these boundary tones in terms of discourse semantics. Here I sketch a new analysis of intermediate intonational phrases and the corresponding discourse segments:

I introduce a mapping relation from intermediate intonational phrasing to the string (surface structure) of the sentence under discussion. For example, the short pauses indicated by "~", and the long ones ("|") in (3), repeated as (19), yield the segmentation in (20). Second, each segment receives a discourse representation. Third, we can establish relations between the discourse representation of the sub-clausal units and the of the established discourse structure, as in (21). I assume the following two relation for modifications: (i) modifying an already existing discourse referent; (ii) setting the stage for a discourse referent to be introduced. Modificational relation allows that the information is integrated into the already established discourse. Fourth, after having established these relations, the rest of the sentence can be

analyzed, and finally the representation of the whole sentence is integrated into the discourse structure, as in (22):

(19) [(Im achtzehnten Jahrhundert) ~(lebte in Frankreich)] | [(ein Mann,)
( ~der zu den genialsten und abscheulichsten Gestalten dieser an genialen
und abscheulichen Gestalten nicht armen Epoche gehörte.)
"In the eighteen century France there lived a man who was one of the most gifted and abominable personages in an era that knew no lack of gifted and abominable personages"

(20)

| Im achtzehnten Jahrhundert | lebte in Frankreich | ein Mann |
|---|---|---|
| der zu den genialsten und abscheulichsten Gestalten ... gehör | | |

(21) Discourse Relation: "setting the stage"


(22) Adding the representation for the whole sentence


I have proposed an extension of Asher's SDRT with smaller discourse representations and new relations between sub-clausal discourse representations. This allows to assign discourse functions to intonational phrasing, including boundary tones for intermediate phrases.

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