
Invited Talk:

A Note on the relationship of discourse structure to information structure

LIVIA POLANYI

FXPAL, 3400 Hillview, Palo Alto, CA 94304

polanyi@pal.xerox.com

MARTIN VAN DEN BERG

FXPAL, 3400 Hillview, Palo Alto, CA 94304

vdberg@pal.xerox.com

DAVID AHN

Department of Computer Science, University of Rochester, Rochester, NY 14627

davidahn@cs.rochester.edu

1 Introduction

Although it is generally accepted that a sentence's information structure (IS) is determined by its relationship to previous text, the question of how to establish the appropriate discourse context for IS assignment is never raised. Analyses of IS normally assume that that sentence is a question and the target sentence is the answer to that question [1]. The assumption is always that the prior context for a target sentence is the immediately preceding sentence. While this assumption may be a convenient convention for investigating the subtler aspects of intrasentential IS, serious problems arise in analyzing actual texts when the critical context for assigning IS is not part of the immediately preceding sentence. For these cases, it is necessary to have a theory of how discourse structure (DS) constrains the choice of possible contexts for determining sentential IS. This note addresses how discourse structure and information structure (IS) are related and sketches an integrated approach to the phenomena of discourse continuity.

In brief, our claim is that DS constrains the set of possible constituents in a discourse that can provide the relevant context for structuring information in a target sentence, while IS critically constrains DS ambiguity. To develop an argument

to support this claim, we rely upon the Linguistic Discourse Model (LDM) as a theory of DS [2], and follow Steedman in assuming that sentence IS consists of a theme and rheme, each further subdivided into background and focus [3, 4].

2 Discourse Structure and Information Structure

Under the LDM, the representation of a discourse is constructed incrementally using information in the surface structure of incoming utterances together with discourse construction rules and inference over the meaning of the utterances to recursively construct an open-right tree of discourse constituent units (DCUs). This tree indicates which units are accessible for continuation and anaphora resolution. All nodes on an LDM tree are first class objects containing structural and semantic information; terminal nodes correspond to the strings of the discourse, while non-terminals are constructed nodes labeled with a discourse relation (coordination, subordination, or n-ary). IS is represented at terminals and non-terminals as well. A C-node inherits the generalization of the themes of its constituent nodes and of their rhemes. An S-node inherits the IS of its subordinating daughter directly.

Our initial hypothesis, illustrated by the example text and accompanying chart¹, is that the attachment is (1) a C-node if the theme of the main clause of the new sentence matches thematic information available at the attachment point or (2) an S-node if the theme of the main clause of the new sentence matches rhematic information available at the attachment point².

In analyzing a discourse, discourse syntax assigns each incoming sentence its place in the emerging discourse tree. In current approaches, lexical information, syntactic and semantic structure, tense and aspect, and world knowledge are used to infer the attachment point and relation (c.f. [5]). However, after exploiting these resources, attachment ambiguities often still remain. Given that normal language users seldom experience discourse attachment ambiguities, additional sources of information must be used in attachment decisions. We believe that the IS of both the incoming sentence and accessible DCUs provides information critical for disambiguation. The problem of identifying the target DCU that provides the context for IS assignment for an incoming sentence is analogous to anaphora resolution: the target unit must be along the right edge of the tree and therefore accessible [6].

From a discourse perspective, the IS of an incoming sentence divides it into a theme, which must be linked back to the preceding discourse, and a rheme, which need not be. Establishing a link between the theme of the main clause of a new sentence and information available at an accessible node in the tree determines

¹Here, for the sake of presentational simplicity, constituents are assumed to be sentences. however, under the LDM, the much more finely-grained DCU segmentation conventions enable subordinate clauses to serve as attachment points for the main clauses of subsequent sentences.

²Here we will not discuss n-ary nodes that are used to represent the structure of discourse genres as well as conversational adjacency structures and logical relations further. It is enough for our purposes to mention that they follow more ad-hoc, though well-defined, rules.

the sentences attachment point. The type of attachment, coordination, subordination, or n-ary, reflects the themes relation to the IS of the DCU represented at the attachment node.

3 Analysis of an example text

In the example, themes are marked with a θ ; rhemes are unmarked. Words receiving stress are in SMALL CAPS.

1. (Japanese people occasionally choose to eat) θ NOODLES. 2. (Noodles are USUALLY eaten) θ for LUNCH or a light SNACK. 3. Depending on the SEASON, (noodles might be served) θ in a HOT SOUP or COLD like a salad. 4. (When noodles are served in a hot SOUP, θ) VEGETABLES, TOFU, and MEAT are ALSO found within the soup. 5. Several TYPES of noodles (are eaten IN JAPAN.) θ 6. (UDON) θ are THICK, WHITE noodles made fresh from wheat flour and are USUALLY served with a hot SOUP. 7. (SOBA) θ are THIN BUCKWHEAT noodles which are FIRMER than udon. 8. (They can be served in a SOUP like UDON, θ) but are USUALLY served as a COOL dish in the SUMMER. 9. (RAMEN) θ are very thin, CURLY wheat noodles served as a QUICK meal or a LATE night SNACK. 10. (Noodles are eaten) θ as a VARIATION for the daily MEAL.

Sentence #	1	2	3	4	5
Theme	Japanese people eat	Noodles ... eaten	Noodles ... served	Noodles ... hot soup	Eaten IN JAPAN
Rheme	NOODLES	LUNCH SNACK	SEASON ... HOT SOUP COLD	VEGETABLES TOFU MEAT ALSO	TYPES
Attachment	N/A	1	2	3	(S2 – (S 3–4))
Relation	N/A	S	S	S	C

Sentence #	6	7	8	9	10
Theme	UDON	SOBA	The ... SOUP ... [UDON]	RAMEN	Noodles ...
Rheme	THICK WHITE USUALLY SOUP	THIN BUCKWHEAT	USUALLY ... COOL SUMMER	VERY CURLY QUICK LATE	VARIATION ... MEAL
Attachment	5	6	7	(C 6–(S 7–8)) (S 5 ...)	(C (S 2 ...)–(S 5 ...))
Relation	S	C	S	C	C

As the chart indicates, (1)-(4) exhibit theme-rheme chaining, resulting in nested subordinations. For (5), the appropriate context for IS assignment is provided by (2), with a theme-theme link resulting in a coordination. The rheme of (5) intentionally introduces a set of *types of noodles* picked up as the theme alternative set

for (6), (7), and (9). The theme focus for each of these sentences (*udon, soba, ramen*) is presupposed to belong to this set. These sentences are therefore coordinated to each other and subordinated to (5). Processing (8) demonstrates that both DS and IS may operate autonomously. The IS of (8) is determined primarily by the conjunction *but* which acts with the possibility modal in its first conjunct (which provides an accessible set of possible worlds as the rheme alternative set) to construct a theme- rheme pair, while discourse attachment of (8) fulfills anaphora resolution requirements rather than IS. For (10), (5) provides the appropriate context for the IS assignment. The theme-theme link results in a coordination that pops the state of the discourse several levels.

4 Conclusion

Although the assignment of IS to a sentence depends on the DS, and the construction of the DS may depend on the IS of the units involved, the dependency between IS and DS is complementary and not circular. For the speaker, the DS provides a set of possible contexts for continuation while IS assignment is independent of DS. For the hearer, the IS of a sentence together with DS instructs dynamic semantics how rhematic information should be used to update the meaning representation of the discourse (c.f. [7]). Thus, the relationship between DS and IS reflects the different but deeply related tasks of speaker and hearer in a communicative situation.

References

- [1] Vallduví, Enric. (1994) Information Packaging: A Survey, Word Order , Prosody and Information Structure Project Report. University of Edinburgh.
- [2] Polanyi, L. and R. Scha (1984) A syntactic approach to discourse semantics, COLING'84.
- [3] Steedman, M. (1991) Structure and intonation, *Language*, 68.
- [4] Steedman, M. (to appear) Information structure and the syntax-phonology interface, *Linguistic Inquiry*, 31:4.
- [5] Lascarides, A. and N. Asher (1993) Temporal interpretation, discourse relations and Commonsense Entailment, *Linguistics and Philosophy*, 16:5.
- [6] Polanyi, L. and M. v. d. Berg (1999) Logical structure and discourse anaphora resolution, *ACL99 Workshop on Discourse/Dialogue Structure and Reference*.
- [7] Polanyi, L. and M. v. d. Berg (1996) Discourse structure and discourse interpretation, 10th Amsterdam Colloquium.

A number of text types are distinguished by being about one person. In an obituary or letter of recommendation, for example, no other person may even be