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# Entangled Information Structure: Analysis of Complex Sentence Structures

NOBO KOMAGATA

Department of Computer and Information Science, University of Pennsylvania

komagata@linc.cis.upenn.edu

**ABSTRACT.** While information structure has traditionally been viewed as a single partition of information within an utterance, there are opposing views that identify multiple such partitions in an utterance. The existence of alternative proposals raises questions about the notion of information structure itself and also its relation to discourse structure. This paper supports the traditional view by observing contextual requirements and linguistic phenomena associated with information structure for each alternative.

## 1 Introduction

Traditionally, information structure (IS) has been viewed as non-recursive, matrix-level organization of information within an utterance (e.g., Mathesius 1975). According to this approach, even a complex utterance has only one IS partition as can be seen below (adapted from Lambrecht 1994).

(1) *Q*: Why did you hit him?

*A*: [I hit him]<sub>Theme</sub> [because he insulted me]<sub>Rheme</sub>.

Here and throughout this paper, the IS labels ‘theme’ and ‘rheme’ (*T* and *R*, respectively, in later examples) are used instead of more overloaded terms, e.g., ‘topic’ and ‘focus’, most closely following Steedman (2000). Although the notions associated with various terms may differ in many respects, we try to limit our discussion to the essential properties of theme and rheme involving binary informational contrast between them (cf. Communicative Dynamism of Firbas 1964).

In contrast to the traditional view, some researchers observe multiple IS partitions within an utterance. For example, Kruijff-Korbayová and Webber (2001) propose the following analysis.

(2) Although [Clyde married]<sub>T</sub>[BERTHA]<sub>R</sub>, [he]<sub>T</sub>[did not inherit a PENNY]<sub>R</sub>.

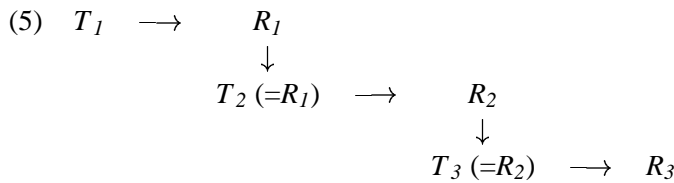
SMALL CAPITALS are used to indicate pitch accents. In addition, Partee (1996) considers even a recursive IS such as the following.

- (3) [What convinced Susan that [our arrest]<sub>T</sub>[was caused by HARRY]<sub>R</sub>]<sub>T</sub>[was a rumor that [someone]<sub>T</sub>[had witnessed Harry’s confession]<sub>R</sub>]<sub>R</sub>.

Naturally, the existence of three competing views poses a challenge to the definition of IS.<sup>1</sup> In addition, this issue is also relevant to the analysis of the relation between IS and discourse structure (DS). To see this point, let us first classify the above-mentioned three approaches by referring to the span of a theme-rheme pair as ‘domain of IS’.

- (4) a. Traditional view: Domain of IS = utterance  
 b. Kruijff-Korbayová and Webber: Domain of IS = clause  
 c. Partee: Domain of IS = utterance *and* clause (recursive)

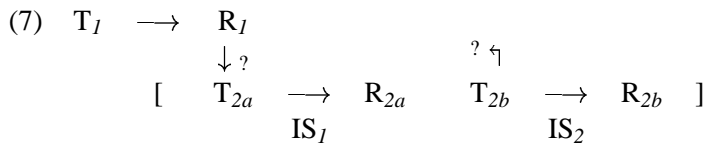
We then observe the idea of ‘thematic progression’ studied by Daneš (1974), which is schematically shown below.  $T_i$  and  $R_i$  refer to the theme and rheme, respectively, of the  $i$ th utterance in a discourse.



If we assume that DS is the organization of discourse units *corresponding to clauses* (e.g., Grosz and Sidner 1986), thematic progression seems to be able to characterize the IS-DS relation quite well, especially if all sentences are simple. Daneš’s idea can also be interpreted in the following way:

- (6) The DS of a discourse can be determined by the DS prior to the current (last) utterance and the IS of the current (last) utterance.

I would like to see this as the primary contact point between the notions of IS and DS. However, once complex sentences are involved, the situation appears more complicated. For example, the analysis of Kruijff-Korbayová and Webber (2001) involving two IS’s in a single utterance might be represented as follows, where the example (2) would correspond to the lower level:



<sup>1</sup>As pointed out by one of the reviewers, these different views may reflect the black-and-white situation involving IS. But pursuing one position against others without accepting the mixed view seems essential for a deeper understanding of the subject. Although one of the reviewer states that it is “quite plausible that clauses have IS”, I do not think such ‘plausibility’ has ever been demonstrated.

With multiple IS's in a single utterance, the description (6) would no longer hold in its given form. We may need to ask questions such as the following. Would the DS analysis proceed in two steps, i.e.,  $IS_1$  is used to form the DS up to that point *not* including  $IS_2$ ? Or, would some form of complex IS ( $IS_1$  and  $IS_2$ ) be used to form the DS up to and including  $IS_2$  all at once? The former analysis would raise a question about the role of the subordinator (at the beginning of the first clause), which is supposed to connect the two clauses. The latter analysis would raise a question about the relation between the two IS's in connection to DS. The situation would be even more complicated with the analysis of Partee.

Between the three alternatives, this paper supports the traditional view of IS through an equivalent proposition: there is exactly one IS partition even for a complex utterance. The present position is also related to the idea: linguistic marking of information structure is a matrix-level phenomenon (Komagata 1999, p. 37). One of the consequences of this position is that the domain of IS is not fixed to the unit of DS (i.e., clause). In other words, the IS domain would appear *entangled* around clause boundaries. However, this potential complication seems to be inevitable for developing a DS out of both simple and complex utterances in a way consistent with the view (6).

The constructions we focus in this paper are complex structures involving subordinators such as *although* and *because*. The (sentence) coordinate structure is not discussed in this paper as it is fundamentally different from the subordinate structure (e.g., Quirk et al. 1985, pp. 920). It can be considered as a sequence of utterances, each of which may contain its own IS. Furthermore, if a multiple-clause structure is considered as coordinate structure, e.g., nonrestrictive sentential relative clause, there can be a separate IS for each utterance.

The second qualification is that we do not discuss a special case of IS partition within an embedded clause such as the following.

(8) *Q*: What did you think Marcel proved?

*A*: [I thought Marcel proved]<sub>T</sub>[completeness]<sub>R</sub>.

While this type of 'non-traditional' constituents are fairly common (Steedman 2000), they do not appear in the type of complex structures discussed in this paper.

The organization of this paper is as follows. Section 2 discusses problems with (2). Section 3 points out problems with (3). In Section 4, we support the traditional view of IS, mainly by discussing potential counterexamples.

## 2 IS Partition within the Subordinate Clause

### 2.1 Semantic Motivation

The main point of Kruijff-Korbayová and Webber (2001) is that we can explain the semantics of *although* if we consider an IS partition for each clause as in (2).

Roughly, their idea is that the conventional implicatures for *although* can be specified in terms of the alternative sets associated with the themes and the rhemes, for the two readings of *although*, i.e., denial of expectation and concessive opposition.

Their approach adopts the framework of Steedman (2000), which is based on alternative semantics (Rooth 1985), and does clarify the interpretation of *although*. But the question here is whether the effect is due to IS. To see this point, let us now examine the following example.

(9) The marriage of Clyde to BERTHA did not let him inherit a PENNY.

This sentence seems to be substitutable for (2) in virtually any context. In particular, both sentences contain the same contrastive situation involving Bertha in relation to the proposition that Clyde is married to Bertha. In (9), the subject-predicate relation is no longer based on *although*, but depends on the contrastive semantics associated with *Bertha* as in (2), which occurs within a noun phrase (with no embedded clauses). I do not know of any proposal for an IS partition within this type of noun phrases. Although one may contest this assumption, it seems that such a move would lead to a major revision of the standard view of IS. Thus, the contrast observed in (9) and (2) must be represented semantically regardless of the presence of an IS.

Such a semantic effect can actually be accounted for by the analysis of Steedman (2000), which distinguishes two levels between IS and focus-background. Note that the notion of ‘focus’ here is as in (Rooth 1985) and is *not* the same as ‘rheme’. While ‘rheme’ is a component of IS, ‘focus’ is a notion tightly connected with a phonological prominence. Further, a focus can appear in a theme or a rheme as can be seen below.

(10) *Q*: I know that Marcel likes the man who wrote the musical.  
But who does he ADMIRE?

*A*: [Marcel ADMIRES]<sub>T</sub>[the woman who DIRECTED the musical]<sub>R</sub>.  
*theme-focus* *rheme-focus*

With appropriate semantic operations, both (2) and (9) could be analyzed in a similar way in terms of the contrastive situation. This paper does not show how this can be done as it is not our point. But it must be similar to the approach of Kruijff-Korbayová and Webber (2001), replacing the theme-rheme distinction with the focus-background distinction.

## 2.2 Availability of Contexts

In their paper, Kruijff-Korbayová and Webber (2001) consider a context for (2) such as a question “Is Clyde HAPPY?” (for the concessive-opposition interpretation). But it is not clear whether this or other questions can actually provide the right context for the proposed IS, which is assumed for both the denial-of-expectation and concessive-opposition interpretations. Before proceeding, we need

a few notes. The question test is useful in many cases. But it is always possible to respond to a question indirectly. In such a response, the IS cannot necessarily be identified based on the question. For a more precise discussion of IS, we may need to consider a more formal approach such as the one developed by Steedman (2000). But this paper remains open in this respect.

One point we can still make is that an isolated question can be used in support of an IS in a *direct* response to the question, as in (1). The following example (the denial-of-expectation interpretation), in conjunction with an additional utterance prior to the *wh*-question, can show a certain IS.<sup>2</sup>

(11) *Q*: I know Clyde married one of those rich women. But what happened to him after the woman died?

*A*: [Although Clyde married BERTHA]<sub>T1</sub>, [he]<sub>T2</sub> [did not inherit a PENNY]<sub>R</sub>.

Note that it is not crucial that there are two, discontinuous themes above.

However, it seems difficult to demonstrate an IS partition within the subordinate clause even with a direct question intended to single out a rheme in such an environment. As an attempt, let us consider Japanese in which a *wh*-word can be placed in a subordinate clause freely as in the following example (grammatical labels: TOP: topic/thematic, NOM: nominative, ACC: accusative, COP: copula, Q: question).

(12) Dare-ga Ken-o tasuketa-kara Naomi-ga koreta-no?  
 who-NOM Ken-ACC helped-because Naomi-NOM could.come-Q  
 “Naomi was able to come because Ken is helped by whom?”

An interesting point is that even this type of question cannot give rise to an IS partition within the subordinate clause. To see this, we use the property that no part of the rheme can be omitted in a response.

(13) *A*<sub>1</sub>: #Erika.

*A*<sub>2</sub>: Erika-ga tasuketa-kara.  
 Erika-NOM helped-because  
 “Because Erika helped (him).”

It is not possible to respond to such a question only with the constituent corresponding to the *wh*-word; the entire subordinate clause is needed in the response.

<sup>2</sup>One of the reviewers pointed out that the concessive-opposition may lead to separate utterances with their own IS's. Then, it would be analogous to the following type of parallel structure with two utterances and two IS's.

(1) *Q*: What's happened to John and Mary?

*A*: [John]<sub>T</sub>[went to the ZOO]<sub>R</sub>and [Mary]<sub>T</sub>[went to the MUSEUM]<sub>R</sub>.

If this can be shown, the IS analysis of (2) may be possible for concessive opposition. However, we note that (Kruijff-Korbayová and Webber) assume the same IS analysis for the both interpretations.



first is an analysis of Hajičová (1984), who argues that the distinction between presupposition and ‘allegation’ (potential presupposition, see below) is affected by IS. The second is that of Heim (1982), who adopts ‘tripartite structure’, a type of semantic structure closely associated with quantifier scopes, for her analysis of presupposition.

In order to discuss the issue at hand, let us observe an example from Hajičová (1984) (the possibility of the presupposition relevant to the current discussion is also shown to the right of each sentence).

- (17) *a.* This time John’s COUSIN caused our victory.  $\Rightarrow$  We won.  
 Negation: This time John’s COUSIN didn’t cause our victory.  $\Rightarrow$  We won.
- b.* This time John’s cousin caused our VICTORY.  $\Rightarrow$  We won.  
 Negation: this time John’s cousin didn’t cause our VICTORY.  $\nRightarrow$  We won.

The proposition “we won” is a presupposition of (*a*) but only an ‘allegation’ of (*b*) because its negation cannot entail the proposition. Hajičová’s argument is that when the presupposition-triggering material is in the theme (rheme), it results in a presupposition (allegation). Partee (1996) attempts to connect this analysis to Heim’s analysis of presupposition along the recursive tripartite structure. According to Partee, the presupposition/allegation distinction can be observed recursively just as the tripartite structure is.

But the presupposition/allegation distinction can be observed within a noun phrase as well, as shown below.

- (18) *a.* the RECORD of our arrest  $\Rightarrow$  We were arrested.  
 Negation: no RECORD of our arrest  $\Rightarrow$  We were arrested.
- b.* the record of our ARREST  $\Rightarrow$  We were arrested.  
 Negation: no record of our ARREST  $\nRightarrow$  We were arrested.

Thus, the distinction must be analyzed independent of IS as in the previous section. As pointed out by one of the reviewers, this distinction can be made in terms of the notions of CB (contextually-bound) vs. NB (non-bound) (e.g., Sgall et al. 1986). This situation seems to correspond to the point that the analysis of Kruijff-Korbayová and Webber (2001) could be cast within the foreground-background distinction of Steedman (2000).

The same recursive idea is discussed even further in Hajičová et al. (1998). Although they state that an IS can be associated with each embedded clause, this point was never emphasized in their earlier work (e.g., Sgall et al. 1986). In fact, Partee writes that she learned this point only after 1991 (Hajičová et al. 1998, p. 95). In addition, another paper of Hajičová et al. (1995) on a computational analysis of IS completely leaves out complex structures. This seems to imply that

the notion of recursive IS might not be as general or essential as argued in Partee (1996) and Hajičová et al. (1998)

Further, the growing trend in ‘interpreting’ IS is to adopt an informal, procedural view (Vallduví 1990) or a formal, dynamic view (Steedman 2000). The recursive approaches to IS have not discussed this aspect of IS analysis yet. The same comment also applies to another recursive approach of Hoffman (1995).

As in the case of (2), it hardly seems possible to come up with a question that directly confirm such an IS. Again, this does not reject Partee’s proposal. But as before, the motivation cannot be the presupposition/allegation distinction because it is independent of IS. From the discussion in this and the previous sections, I would like to present two conjectures. First, the semantic/pragmatic effect that can be observed entirely within a noun phrase cannot be an IS effect. Second, IS only provides a bound on the domain of tripartite structure, a much weaker view of the relation between IS and tripartite structure.

## 4 Subordinate vs. Coordinate Structures

We begin this section with potential counterexamples to the main point of this paper. Then, I will discuss examples in Japanese, German, and in English in support of our position.

### 4.1 Potential Counterexamples

Although the written form of English is not very rich in marking IS, topicalization and focus movement can be considered to mark IS (Prince 1984). Bonnie Weber [p.c.] points out that the presence of one of these constructions within an *although*-clause can be a counterexample to the proposed position, and provided with the following examples from the British National Corpus (BNC).

- (19) *a.* The shape seemed to be looking through a book, although what the book was Henry could not tell. [ASS 676]
- b.* His mother was always telling him that it was important for teachers to give, although what they were supposed to give she did not say. [HR 831]
- c.* Although what that could possibly be, I have no idea, Melissa thought to herself as she put down the phone. [GVP 1963]

First, I agree that topicalization/focus movement is a weak form of IS markers (Komagata 1999), but will question the status of the *although*-clauses observed in these examples. Next, in most of the potential counterexamples including (19 *a, b*), the *although*-clause follows the main clause. The only exception known to me is (19*c*). I would not provide a detailed explanation for this example at this point except for pointing out the following: the presence of topicalization/focus movement in the *although*-clause suggests that there is an IS division within the



*although*-clause, but there is no further, direct evidence of double IS in this example; I conjecture that the the *main* clause in (19c) is an afterthought (and thus a part of the theme). The position that sentence-initial *although*-clauses are thematic is also related to the following. While not categorical, the first components in an utterance tends to be thematic, as Halliday (1967) pointed out. In addition, according to Quirk et al. (1985, p. 919), one of the semantic characterizations of subordination is that the subordinate clause presents information as if it is presupposed as given rather than asserted as new. This description seems to apply to the majority of *although*-clauses, especially when the subordinate clause precedes the main clause (57% of all the instances involving an *although*-clause in the ACLDCI corpus from LDC). As a consequence, this paper will still be left with one potential counterexample (but not a number of counterexamples as commented by a reviewer). The remaining wide range of potential counterexamples will be accounted for in a fairly systematic manner in the following subsections. Note that the above potential counterexamples do not directly support the particular IS analysis in (2).

There are other related constructions, which are occasionally misunderstood as IS markers. In particular, both *it*-clefts and pseudoclefts do not necessarily mark an IS partition, esp. in embedded environments. According to the findings of Prince (1978), Collins (1991), and Delin (1995), *it*-clefts serve heterogeneous functions of marking IS, contrastiveness, and referential status. Also due to Prince (1978) and Collins (1991), the free relative part of a pseudocleft is either ‘evoked’ or ‘inferred’, which is analogous to the referential status of the definite expression. As definite expressions can appear in themes and rhemes not marking information structure, pseudocleft cannot be a direct IS marker.

## 4.2 Morphology in Japanese

Next, we explore potential counterexamples in Japanese. This language has an explicit theme marker, i.e., the particle *wa* (Kuno 1973), which is useful for analyzing information structure. A caveat is that the same morpheme also serves as the contrastiveness marker. However, the contrastive case requires that there be a phonological prominence within the noun phrase that is suffixed with *wa* (summarized in Komagata 1999). Thus, the instances of *wa* suffixed to a non-prominent noun phrase can be considered thematic.

One of the properties of the thematic *wa* observed by several Japanese linguists including Kuno (1973) is that thematic *wa* cannot occur in the embedded environment. This is in accordance with our proposition. But Noda (1996) discusses a classification of subordinate clauses into the following categories, which include potential counterexamples.

(20)

Type	Examples	<i>ga</i>	<i>wa</i>
Strong	<i>(re)ba</i> “if”, <i>toki</i> “when”, <i>koto</i> “that” <i>node</i> (focal) “because”	yes	no
Weak	<i>node</i> “since”, <i>ga</i> “but”	yes	yes

Although Noda says that the thematic *wa* cannot be used in strong subordinate clauses, he also lists several examples that he considers exceptional. But the *wa*-marked subjects in these examples are either the subject of the main clause or contrastive. Thus, they are not exceptions at all.

In addition, Noda lists several examples of weak subordinate clauses that involve a thematic *wa*. One case involves the conjunctive particle *ga* “*but*” as the sentence connector. But these examples are better classified as coordinate structures. The other case involves a ‘subordinator’ particle, but lacks the main clause as follows:

- (21) *memorii-wa* ... *mottomo anzen-na basyo-dakara-da.*  
 memory-TOP      most      safe      place-because-COP  
 “Because the memory is the safest place (for viruses to stay).”

The subject NP suffixed with *wa* is considered as the theme of this utterance. Even though this sentence contains a subordinator-like particle, it is an independent utterance. Then, it is no surprise that there is an IS partition within it, and thus, it is not a counterexample to the current position. In this case, the subordinator-like particle *dakara* “*because*” is better considered a discourse connector.

### 4.3 Syntax in German

We next investigate the *obwohl* “*although*”-clause in German, which is particularly interesting because only the matrix clause exhibits the verb-second (V2) phenomenon.

While the *obwohl*-clause typically has the verb-final pattern (i.e., subordinate clause), Günthner (1996) observes the growing tendency of the V2 configuration in the *obwohl*-clause in spoken colloquial German as shown below.

- (22) A: DU ich brauch en kleinen STIFT  
 “hey I need a small pencil”  
 B: moment mal  
 “just a second”  
 A: obwohl NE eigentlich weiß ichs auch AUSwendig glaub ich  
 “although no actually I do know it by heart”

Günthner argues that this type of *obwohl*-clauses form a coordinate structure rather than a subordinate structure. Then, *obwohl* can be considered as a discourse connector. Günthner also analyzes the condition for using subordinate *obwohl*-clauses as follows: the relation between the main clause and the *obwohl*-clause is very loose (or independent illocutionary force for the *obwohl*-clause). According to Günthner, the availability of the two patterns and the condition for the *weil* “*because*”-clause are analogous to the *obwohl*-clause.

From the examples in Japanese (previous subsection) and German, we may infer the following. First, subordinate(-like) clauses can exist on their own (without the main clause) or weakly connected to the main clause. Second, this type of clauses can actually be considered as utterances and thus they may contain IS partitions.

#### 4.4 *Although*-clause as a Coordinate Structure

The use of subordinate(-like) clauses as an independent utterance can be observed in English as well (Quirk et al. 1985, p. 564). For example, the word *because* here can be analyzed as a discourse connector because it connects the proposition “he did it” with the response as the reason for the proposition.

- (23) Q: Why did he do it?  
A: Because he was angry.

Similarly, the following example seems possible.

- (24) A: I heard that you went to the park yesterday.  
B: Although it was raining.

This example can be considered completely in parallel to (23). Such an example might be found in spoken corpora, but I have not been able to check this possibility. The word *although* is a concessive, discourse connector. For this type of utterance, it is natural to consider an IS that is felicitous to the context. While the distinction between coordinate and subordinate structures is not necessarily clear in English (e.g., Quirk et al. 1985, p. 927), the analogous distinction is clearly seen in the German examples because of the V2 phenomenon. While IS-marking too is not necessarily clear in English, this aspect is observed in the Japanese example.

Let us now turn to the case where the subordinate clause follows the main clause with particular placements of phonological prominence such as the following (Quirk et al. 1985, p. 1077).

- (25) a. Raven didn't leave the party early because CAROL was there.  
b. Raven didn't leave the party EARLY, because CAROL was there.

In fact, the same pattern seems possible with *although* as well (replacing *because* with *although* above). While the scope of the negation includes the subordinate clause in (a), it is not the case in (b). This suggests that there is a difference between (a) and (b) with respect to the strength of the connection. Analogous to the observation of Günthner (1996) in German, we may consider the entire sentence (a) as a single utterance, but the sentence (b) possibly as a coordinate structure consisting of two utterances. Although this analysis depends on the degree of connectiveness between the two clauses, such an analysis would be possible as in Günthner (1996).

In summary, the presence of independent IS in the subordinate(-like) clause in the potential counterexamples is actually not inconsistent with the current position, and thus is not considered as counterexamples. I suggest that the analysis of complex structures proposed here is not specific to the *although* and *because*-clauses but applicable to subordinate clauses headed by various subordinators. In addition, we can make a related prediction based on the IS-related distinction between *since* (only thematic) and *because* (Quirk et al. 1985; Lambrecht 1994): the *since*-clause would not give rise to an independent utterance as the *because*-clause does.

## 5 Conclusion

This paper supports the traditional view of IS as a non-recursive, matrix-level phenomenon, and argues that the alternative views are not sufficiently motivated and that potential counterexamples to the traditional view can be analyzed in a systematic manner.

Structurally speaking, the domain of IS based on the traditional view is not fixed with respect to the DS unit (i.e., clause). As a consequence, IS appears *entangled* around clauses. Nevertheless, this type of entanglement seems inevitable to maintain the simple view of IS-DS relation (6) in the spirit of Daneš (1974). One implication of the current position with respect to NLP system design is as follows: due to the entanglement of IS's with clauses, we cannot arrange IS and DS processing sequentially. In order to deal with complex sentences, the IS and DS processing must proceed in parallel at some point.

In this paper, we discuss examples in English, German, and Japanese. Although the data are fairly consistent in my view, examples from other languages may reveal more about the issues under investigation. Thus, it would be very interesting to compare a larger number of languages along the current line.

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