On the Semantics of Discourse Relations

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Abstract. In this paper, I examine the division of labour between discourse semantics and information packaging and reconsider the schemata for the semantics of veridical discourse relations given in SDRT. On the basis of studies of the phenomena of discourse relation blocking, I claim that one cannot reduce the semantics of discourse relations to their content-level semantic effects. I propose revised semantic schemata involving public commitment operators to characterize the rhetorical import of discourse relations within their semantics.

1 Introduction

Most theories of discourse structure [12, 10, 15, 2] assume that hierarchy in discourse results from a distinction within discourse relations, on top of the embedding between segments and subsegments.[1] The intuitive motivation is that some segments of a discourse play a subordinate role relative to previous, separate, segments they are connected to, while others are considered on a par, so this distinction is often called subordinating / coordinating [4]. Information-packaging features like this one show that the contribution of discourse relations is not purely semantic. For instance, *Narration* cannot be reduced to temporal precedence between the events described by the segments related, and *Result* and *Explanation* are not just a matter of causation between eventualities or facts. In particular, information packaging tells us that the two semantically much related relations *Result* and *Explanation* cannot be represented by a single relation, only varying the order of the arguments. Indeed, *Result* is by default coordinating while *Explanation* always is subordinating.

In this paper, I want to question how much does information packaging in distinguishing discourse relations and how much goes into the semantics of these relations. In particular, I will discuss whether the non-reducibility of discourse relations like *Result* and *Explanation* to one another is only a matter of information packaging or appears in their semantics as well.

I will focus here on veridical, content-level monologue discourse relations, i.e., those that presuppose that the propositional content of the segments they relate is true, and whose semantics typically involves the eventualities described in these propositional contents. The discussion will be developed within SDRT

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[1] An exception is D-LTAG [18] whose trees take only embedding into account. In such a framework, the role of information packaging is very limited.

[1, 2], for it is the theory of discourse structure that pays the most attention to discourse relation semantics, capturing it in formal terms. In addition, in SDRT there is a clear separation between information packaging, accounted for with a graph structure in the process of building a discourse representation as this graph governs the attachment of new segments and anaphora resolution, and the semantics of such representations.

2   Discourse Relation Semantics in SDRT

Perhaps with a cautious concern that not all has been yet uncovered regarding discourse relation semantics, in [2] SDRT models the relationships between discourse relations and their "semantic effects" using implications and not equivalences. The semantics of a veridical relation in [2] follows the simplified[2] axiom schemata (1) and (2):

(1) $\llbracket R(\alpha, \beta) \rrbracket = 1$ *iff* $\llbracket \mathcal{K}_\alpha \wedge \mathcal{K}_\beta \wedge \phi_{R(\alpha,\beta)} \rrbracket = 1$

(2) $\phi_{R(\alpha,\beta)} \rightarrow \langle R$'s semantic effects$\rangle$

where α and β are variables for segment labels and $\mathcal{K}_\alpha$ is α's propositional content.

For instance, for *Result* and *Explanation* such schemata boil down to :

(3) $\llbracket Result(\alpha, \beta) \rrbracket = 1$ *only if* $\llbracket \mathcal{K}_\alpha \wedge \mathcal{K}_\beta \wedge cause(e_\alpha, e_\beta) \rrbracket = 1$

(4) $\llbracket Explanation(\alpha, \beta) \rrbracket = 1$ *only if* $\llbracket \mathcal{K}_\alpha \wedge \mathcal{K}_\beta \wedge cause(e_\beta, e_\alpha) \rrbracket = 1$

where e_α and e_β are the "main eventualities" referred to in these segments.

By using an implication in (2), SDRT (in [2]) leaves what makes the difference between the semantics of relations *Result* and *Explanation* on top of argument order unspecified. A question then naturally arises: what else should be added to obtain a full characterization of the semantics of veridical discourse relations? This question is implicitly answered in papers such as [5] where the cautious attitude is dropped, for it is proposed to *define* the semantics of the *Result* and *Weak-Result* relations in terms of causal relations on eventualities. This amounts to substituting $\leftrightarrow$ for $\rightarrow$ in (2) and *iff* for *only if* in (3) and (4), and thus implies that the semantics of *Explanation* simply is that of a *Result* with switched arguments.

Assuming an equivalence in schemata (3) and (4) then leaves it only to information packaging to explain the non-equivalence of the two discourses (5-a), involving *Explanation*, and (5-b), involving *Result*. These two discourses indeed generate different graph structures, for directed edges encode argument order, and in addition *Explanation* is subordinating while *Result* here is coordinating, as evoked above. The SDRT information-packaging definitions of referent availability and of open attachment point do account for the necessary change in where pronouns appear, and for the fact that the continuation (5-c), referring to the pushing, is possible only with (5-a).

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[2] I'm ignoring here the dynamic semantic aspects.

(5)   a.   Paul fell. Sue pushed him. (Paul fell because Sue pushed him.)

          b.   Sue pushed Paul. He fell. (Sue pushed Paul. As a result, he fell.)

          c.   But it wasn't on purpose.

I the remainder of this paper, I will examine whether this division of labour between semantics and information packaging is faithful to the very notion of discourse relation.

3   Rhetorics

Beyond their content-level semantic effects, most discourse theories recognize the *rhetorical* nature of discourse relations. In SDRT, it is explicitly stated that discourse relations relate utterances, i.e., speech acts, and that they characterize the rhetorical role of a speech act in discourse, just as assumed in RST [14]. Discourse relations represent the rhetorical intentions of the speaker to relate their utterance to a previous one, adding new claims or public commitments [11] on top of those associated with the isolated utterance of an assertion [3].

So segments in SDRT are not simply dynamic predicate logic propositions. Each dynamic proposition is labelled by a different label which is the trace of a speech act, making thus the difference between a speech act α and its propositional content $\mathcal{K}_\alpha$ in the schemata above. Discourse relations do not simply relate propositions and add extra semantic conditions on their referents, they relate utterances, i.e, labels, and characterize the rhetorical role of these utterances. The speech act so characterized in a relation $R(\alpha, \beta)$ is β, the segment which is attached to some previous segment α.[3] This entails that discourse relations necessarily are focussed on their second argument, and in some sense asymmetric: $R(\alpha, \beta)$ cannot be equivalent to any $R'(\beta, \alpha)$ which would characterize the speech act of α.

This view on discourse relations is not universally adopted, but is quite clear in most writings on SDRT. However, it has surely not been emphasized enough since authors using SDRT have made proposals incompatible with this view. In [7], so-called "discourse verbs" like *to precede* or *to follow* are given a semantics in terms of discourse relations, thus considering the two discourses in (6) as equivalent.

(6)   a.   Ted left. Then Sue arrived.

          b.   Ted left. This preceded Sue's arrival.

Assuming that *to precede* denotes the *Narration* relation amounts to either ignore that discourse relations relate utterances and not eventualities such as those denoted by *Sue's arrival*, or assume that, for some unexplained reason, the second sentence in (6-b) takes a discursive value in such a way that the reference to the event in *Sue's arrival* should be ignored, dropping standard compositional

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[3] This observation straightforwardly applies to independent clauses. When subordinate clauses attach to their main clauses, determining which speech act is characterized actually is a complex matter, that I will ignore here.

semantics. In other words, such a proposal amounts to confuse the discourse and propositional levels.

In fact, it turns out to be inadequate, as it creates observable distortions in the discourse structure.[4] Continuations show that the relation involved in (6-b) cannot be the relation *Narration* appearing in (6-a). Whereas *Narration* always is a coordinating relation, the relation in (6-b) is a subordinating one: (6-b) can be continued by *And it followed Max's finishing up the wine*, while a continuation of (6-a) with *Max had finished up the wine* is unable to give the same reading, i.e., the same temporal order between events.

This comparison between (6-a) and (6-b) is based on information-packaging properties and shows that the graph structures of these two discourses are different. But it involves also the semantics of the discourse relations, since, even assuming that the semantic contribution of *Narration* in (6-a) and of the proposition involving the verb *to precede* in (6-b) are identical (which is something different than saying that this verb directly denotes a *Narration* relation) one cannot ignore the semantic contribution of the discourse relation actually appearing in (6-b), perhaps a *Commentary*.

Now, the crucial question at this point is: is the difference between the *Narration* relation and the verb *to precede* only a matter of information packaging? More generally, is the rhetorical role of discourse relations completely accounted for through information packaging? Shouldn't the semantics of discourse relations also reflect in some way this rhetorical role?

I will now show that this is indeed the case, on the basis of studies of the "blocking" effects in discourse.

4   Blocking

The discourse phenomenon of "blocking" brings the rhetorical content of discourse relations to light [17]. Blocking in discourse occurs when the semantics of a linguistic marker blocks the inference to discourse relations that would hold in its absence. For instance, the adverb *puis* (roughly equivalent to *then*) blocks *Result* in (7-b) [6]. The case of *puis* and *Result* is not isolated. Similar blocking effects have been observed in [9] for the conjunction *and*, and in [16] for the adverb *anyway*.

(7)   a.   *L'acide tomba dans le liquide. Une explosion se produisit.*
                 (The acid fell into the liquid. An explosion happened.)
         b.   *L'acide tomba dans le liquide.(1) Puis une explosion se produisit.(2)*
                 (The acid fell into the liquid. Then an explosion happened.)

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[4] In chapter 6 of [2], Asher and Lascarides follow Danlos's earlier work in giving a discourse semantics to causative verbs. This is done in a more indirect way than in [7], but the effects of introducing spurious discourse relations in the discourse structure have not been fully assessed. In any case, imparting a rhetorical contribution to verbs simply denoting temporal or causal relations between events is a doubtful move.

The *Result* relation, present in (7-a), is absent from (7-b). The reading obtained in this second variant is, like in (7-a), that the two events occurred in sequence, as *puis* marks *Narration* and the semantics of both *Result* and *Narration* entails precedence. However, unlike in (7-a), the speaker presents these events without any commitment regarding their causal relationship, and actually *with* a commitment not to claim anything in this respect. In other words, the speaker conveys something like "I don't want to claim that the two events are causally related".[5]

The blocking effect in (7-b) has a rhetorical import which needs to be accounted in some explicit way. It is not enough *not* to have a *Result* relation in the representation, as this would simply ignore the speaker's commitment not to claim any causal relation. There is a significant difference between conveying "I don't want to claim that the two events are causally related" and just not saying anything in this respect. Although we could consider using some specific formula like $Blocked(Result(\pi_1, \pi_2))$, let us first simply consider that we add in the SDRS for (7-b) the formula $\neg Result(\pi_1, \pi_2)$ to account for this blocking effect.

Now, let's turn back to the question whether the semantics of *Result* shouldn't include a rhetorical component, and at the same time to our earlier question in Section 2 whether the semantics of *Result* is fully characterized in terms of causation. If the schema (3) were to involve an equivalence, i.e., assuming $[\![Result(\pi_1, \pi_2)]\!] = 1$ *iff* $[\![K_1 \wedge \mathcal{K}_2 \wedge cause(e_1, e_2)]\!] = 1$, the SDRS for (7-b) would entail the negation of the causation predicate. Indeed, since we have $Narration(\pi_1, \pi_2)$ and *Narration* is a veridical relation too, $\mathcal{K}_1 \wedge \mathcal{K}_2$ is true, so we obtain $\neg Result(\pi_1, \pi_2) \rightarrow \neg cause(e_1, e_2)$. But obviously, the discourse in (7-b) may truthfully describe a world in which the two events do happen to be causally related. So we cannot have $\neg Result(\pi_1, \pi_2) \rightarrow \neg cause(e_1, e_2)$, that is, the semantics of *Result* cannot be reduced to causation.

The obvious move is to consider that the semantics of a discourse relation includes the public commitment of the speaker towards its semantic effects, since this is what is negated in the blocking phenomena. Disputes in dialogue of course challenge the commitments of the other speakers, and dialogue modelling requires a proper account of the evolution of commitments as proposed in [13]. But here blocking shows that even for monologues involving standard content-level relations only, in which sincerity is not questioned, ignoring the speaker's public commitment involved in discourse relations by reducing their semantics to their standard semantic effects puts the theory into trouble.

Further, what blocking phenomena show is that a single commitment operator over a SDRS as a whole, i.e., globally over the conjunction of the propositional

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[5] Indeed **Puis le mélange réagit en explosant* (Then the mixture reacted by exploding) is contradictory. Continuing (7-b) with *En fait, l'explosion fut provoquée par le mélange* (Actually, the explosion was caused by the mixing) is possible but requires a marker of revision (*en fait* – actually). Adding, as suggested by one reviewer, a presupposition marker in the second sentence like in *Puis, bien entendu, une explosion se produisit* (Then, of course, an explosion happened) marks that the explosion is expected (as if an *Occasion* relation held), but doesn't presuppose a causal link.

content of all basic segments (involved in a veridical relation) and the discourse relations between the segments, as proposed in [3, 13] cannot do. Blocking a relation means stacking a commitment on top of the negation of a commitment to the semantic effects of that relation. That is, in the semantics of $\neg Result(\alpha, \beta)$, the negation operator should modify a commitment operator, so commitments are involved *within* the semantics of each discourse relation. I reckon that all commitments, to the truth of the propositional content of assertions, and to the truth of the semantics effects of all discourse relations, are better taken into account locally within the SDRSs.

Now, although commitments are of a clear rhetorical nature, since the propositional contents of assertions also come under a commitment operator, the rhetorical nature of discourse relations distinguishing the discourse level from the propositional level is not made so evident by just these commitment operators. What is really accounted for with this move is the difference between asserting that a certain causation doesn't hold (e.g., *The falling of the acid in the liquid didn't cause the explosion*, a commitment to $\neg cause(e_1, e_2)$) and blocking a *Result* relation between two speech acts (a commitment to the negation of a commitment to $cause(e_1, e_2)$). In fact, the commitment to the semantic effects of a content-level relation only involves eventualities and thus is not particularly focussed on the speech act characterized by the relation, i.e, its second argument. So we are still left with the following question: Are the rhetorical intentions of the speaker of β to relate his utterance to α—in other words, the fact that a relation $R(\alpha, \beta)$ rhetorically characterizes β and not α—completely accounted for by the corresponding directed edge in the graph structure, through information packaging?

Although additional studies should shed more light on this question, my preliminary answer is no. That no $R(\alpha, \beta)$ in a SDRS could be equivalent to some $R'(\beta, \alpha)$ is ensured by the SDRS graph structure through information packaging. But the blocking of a particular $R(\alpha, \beta)$ does not show at all in the graph structure governing attachment and anaphora resolution, which contains only realized attachments. Blocking is invisible to information packaging, it is a purely semantic matter. Therefore, if the semantics of $R(\alpha, \beta)$ were to be equivalent to the semantics of some $R'(\beta, \alpha)$, blocking $R(\alpha, \beta)$ would be the same as blocking $R'(\beta, \alpha)$. I doubt this is a desirable feature, as I take it for granted that a blocking is rhetorically focussed on an utterance too. I thus suggest to introduce an asymmetric element in the semantics of discourse relations to express the fact that the second argument is the utterance characterized by the relation.

5   Discourse Relation Semantics Revised

We are now in position to propose a revised version of the semantics of a veridical relation R, a version that fully characterizes its semantics. This revised version replaces the schemata (1) and (2) by $(1)'$ and $(2)'$:

$(1)'$ $[\![R(\alpha, \beta)]\!] = 1$ *iff* $[\![A(\alpha, \beta) \wedge C(S_\beta, \mathcal{K}_\alpha) \wedge C(S_\beta, \mathcal{K}_\beta) \wedge C(S_\beta, \phi_{R(\alpha, \beta)})]\!] = 1$

$(2)'$ $\phi_{R(\alpha,\beta)} \leftrightarrow \langle R\text{'s semantic effects}\rangle$

where $A(\alpha,\beta)$ stands for the fact that speech act β relates (attaches) to speech act α, S_β for β's speaker, and C for a public commitment operator.

The attachment predicate in schema $(1)'$ is meant to reflect the fact that the relation $R(\alpha,\beta)$ rhetorically characterizes the utterance β, not α. Further work is required to analyze what exactly this predicate is. This attachment predicate as well as the commitment operators prevent from drawing equivalences between the semantics of a discourse relation and its semantics effects. There is then no limitation in fully describing the semantics effects of a relation $\phi_{R(\alpha,\beta)}$ with the use of a biconditional instead of an implication, as in $(2)'$. In particular, the semantics of the *Result* relation is now:

$(3)'$ $[\![Result(\alpha,\beta)]\!] = 1$ *iff*
$[\![A(\alpha,\beta) \wedge C(S_\beta, \mathcal{K}_\alpha) \wedge C(S_\beta, \mathcal{K}_\beta) \wedge C(S_\beta, cause(e_\alpha, e_\beta))]\!] = 1$

Since commitments are now distributed, to account for the positive commitment of a blocking phenomenon, we should use a $Blocked(R(\alpha,\beta))$ formula rather than the simple $\neg R(\alpha,\beta)$. Presupposing that blocking is still focussed on the second argument, the semantics of this formula is:

(8) $[\![Blocked(R(\alpha,\beta))]\!] = 1$ *iff* $[\![A(\alpha,\beta) \wedge C(S_\beta, \neg C(S_\beta, \phi_{R(\alpha,\beta)}))]\!] = 1$

In addition to the question of what exactly is the attachment predicate, the question of which public commitment operator is suitable remains. An obvious requirement is that $\neg C(\phi)$ be non equivalent to $C(\neg C(\phi))$, i.e., be non Euclidean. This might not be trivial. For instance, the proposals in [3, 13] and in [8] fail to meet this requirement. Public commitment is defined in [8] as the public grounding of a belief and assumes that both public grounding and belief are KD45 modalities; but then the Euclidean character of commitment comes as a theorem. So either the definition of commitment or the axiomatics of public grounding should be changed. This also suggests that the public character of public commitment should be investigated further; its need to be grasped through other properties than Euclideanity means that it differs from introspection.

With this revised semantics and the distribution of the commitments within the SDRSs, the account of the dynamics of speakers' commitments in dialogue, driven by acknowledgements and corrections, given in [3, 13] should be revised as well. This clearly falls beyond the scope of this paper, though.

6   Conclusion

In this paper, I examined the division of labour between discourse semantics and information packaging. I have shown that the rhetorical nature of discourse relations is only partially accounted for through information packaging. Blocking phenomena prove that the semantics of a discourse relation involves a rhetorical component, the speaker's public commitments to the truth of standard, content-level, semantic effects of the relation. I also suggested that it is necessary to

account within the semantics of discourse relations for their "asymmetry", i.e., the fact that they rhetorically characterize their second argument, the speech act with is attached to a previous one. Finally, I proposed new schemata for the semantics of veridical discourse relations in SDRT, revising those proposed in [2].

This of course only is a preliminary study, as I do not give here the semantics nor the axiomatics of the attachment predicate and the public commitment operator. This study though reveals a constraint on commitment, which will hopefully be taken into account in future formal characterizations of public commitment.

More generally, my hope is that the rhetorical nature of discourse relations be payed attention to whenever discourse semantics is at stake. There are still too many works, even in the SDRT framework, in which the propositional or content level and the rhetorical level of discourse are confused, not only regarding the admittedly subtle semantic issues examined in this paper, but too often simply ignoring information packaging. Having clear the distinction between the propositional and the rhetorical levels, as well as what are the respective roles of information packaging and discourse semantics in accounting for this distinction, will prove essential to the analysis of discourses in which the two levels deeply interact. This is the case, for instance, when the propositional content of a speech act describes the very structure of the discourse to which this speech act belongs; see the paper by Vergez-Couret et al. in this volume.

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