Abstract

This paper analyzes systematic cases of revision of the discourse structure entailing a modification of the right frontier. We show that the coordinating or subordinating nature of discourse relations plays a major role in this revision, examining in particular a relation typical in narratives, Result, as well as a family of dialogues relations: content-relations introduced by interrogatives. Their complex behavior shows that the Right Frontier Constraint, a major principle in most discourse theories, needs to be handled with care. We also generalize the discussion about problems due to the multiplication and the sophistication of discourse principles operating within SDRT, in particular the Maximize Discourse Coherence principle which constitutes an important improvement of the theory but also introduces some methodological issues.

1 Introduction

The Right Frontier Constraint (RFC) on accessibility and possible discourse continuations, introduced in [Webber, 1988, Polanyi, 1988], is exploited in several theories of discourse. The notion of right frontier refers to the tree-like structure of a discourse representation, which in all theories involves the notion of complex segment. In SDRT [Asher, 1993, Asher and Lascarides, 2003], the theory that will be discussed in this paper, discourse segments are represented by constituents which accordingly are either (i) simple constituents having a propositional content, typically representing a single sentence or utterance, or (ii) complex constituents corresponding to larger segments, that are some kind of container for other (sub-)constituents and the discourse relations that relate them.

Like SDRT, most discourse theories do use discourse relations, and in several of them, such relations also affect the hierarchical discourse structure and as a result the definition of the right frontier. For instance, LDM
[Polanyi, 1988], Grosz and Sidner’s theory [Grosz and Sidner, 1986], RST [Mann and Thompson, 1987] and SDRT all make use of two kinds of relations behaving differently in the discourse structure. SDRT has extensively exploited this difference in behavior to explain many phenomena at the semantics-pragmatics interface [Asher and Lascarides, 2003]. In SDRT, a coordinating relation pushes the right frontier to the right, closing-off its attachment point, while a subordinating relation extends the right frontier downward\(^1\) and leaves open its attachment point for further attachments.

In order to discuss the RFC on clear solid ground, we propose in Def 1 our definition of the constraint directly inspired from [Asher and Lascarides, 2003], pp148\(^2\).

**Def 1 Right Frontier Constraint**

The available attachment points in the discourse structure for a new constituent are those of the right frontier, i.e.,

1. the last simple constituent introduced in the structure, and
2. any constituent dominating the last one,

where dominance between constituents is defined by the transitive closure of direct dominance: A constituent \(\beta\) is directly dominated by a constituent \(\alpha\) iff \(\beta\) is attached to \(\alpha\) by a subordinating relation, or \(\beta\) is a sub-constituent of the complex constituent \(\alpha\).

The discourse referents available for anaphora resolution are those which are DRT-accessible\(^3\) within the constituents of the right frontier from the attachment point up.

The “coord/subord” distinction is considered by most authors to be part of the definition of the discourse relations in a stable way. In other words, a given relation is by essence of a given kind. However, studying the actual substance of the “coord/subord” distinction, [Asher and Vieu, 2005] have shown that there are cases in which coordinating relations may become subordinating. This means that a given continuation can make a coordinating attachment become subordinating. It can revise the structure and change the right frontier, opening an attachment point that was closed.

We will see in this paper that the opposite change can occur as well. In dialogs, questions are attached to the context with a \(Rel_q\), the question version of the relation \(Rel\) that would have attached an answer to the question to the same context. Answering the question brings in both a relation between the question and the answer \((QAP)\), and the relation \(Rel\) between the

---

\(^1\)Without necessarily introducing a complex segment, a difference with other theories.

\(^2\)The original definition makes use of other concepts that we will like to pass over for the sake of concision since they do not concern our point here.

\(^3\)See [Kamp and Reyle, 1993] for the notion of accessibility in DRT.
context and the answer. Since relations $Rel_q$ are proved to be subord (see [Asher and Lascarides, 2003]:pp332), if the corresponding assertive relation $Rel$ is coord, answering a question modifies the right frontier, closing off an open attachment point.

In the next section we will describe and discuss the right frontier change when a coordinating relation, $Result$, becomes subordinating. Then, we will examine the dialog relations $Narration_q$ and $Explanation_q$ to show how, in some cases, answering a question alters the right frontier. We will end this paper by more general methodological questions on how theoretical discourse constraints such as the RFC can be evidenced and formulated, especially in the case of theories making use of several interdependent such constraints.

2 Chameleon relations in monologic discourse

In [Asher and Vieu, 2005], several criteria to decide whether a given relation is coordinating or subordinating are proposed, most of them relying on possible or impossible cases of anaphora resolution. On the basis of these criteria, it is also shown that some relations are only coordinating by default. Punctuation and coordination particles can force them to become subord, as shown for $Result$ on two examples taken from [Asher and Vieu, 2005] reported below:

\begin{enumerate}
\item a. Lea screamed ($\pi_1$), so the burglar ran away ($\pi_2$).
\item b. Lea screamed ($\pi_1$), so the burglar ran away ($\pi_2$). Max woke up ($\pi_3$). #She also got a sore throat ($\pi_4$).
\item c. Lea screamed ($\pi_1$), so the burglar ran away ($\pi_2$) but Max woke up ($\pi_3$). She also got a sore throat ($\pi_4$).
\end{enumerate}

In (1b), that Max woke up can’t be seen as a result of Lea’s scream. It is simply understood as a continuation of the story that is being told, i.e., $\pi_3$ is attached by $Narration$ to $\pi_2$. This is shown by the impossibility to continue the text with $\pi_4$, for the anaphor in the parallel-marker also can’t be solved. This contrasts with (1c) in which the punctuation and the connective but force the attachment of $\pi_3$ to $\pi_2$ by $Contrast$ as well as some kind of $Continuation$, creating a complex segment which can be seen as collecting all the consequences of Lea’s scream. In this context, it is now possible to continue to extend this complex segment with $\pi_4$. We see on example (1c) that $Result$ changes from coord to subord. As a result, the structure built with the attachment of $\pi_2$ to $\pi_1$, Fig.1:(1a), is revised when attaching $\pi_3$ to obtain that of Fig.1:(1c)1-3. The right frontier is modified, reopening $\pi_1$.

We would like to emphasize that we are not facing a new $Result$ relation when its coord/subord nature changes. The relation keeps the same
triggering rules and the same semantic effects. The semantics of a relation belongs to the information content level and remains unchanged with chameleon transformations. In fact, what changes only belongs to the information packaging level.\(^4\) The information-packaging level is generally considered as dealing with defeasible information, and this alone suggests that it is not absurd to consider that the coord/subord nature of a relation may change. As we have seen, Result changes in our example because of the presence of punctuation and connectives, which clearly affects information packaging; and it is very likely that the nature of a relation interacts with other information packaging ingredients, as intonation for instance.

In [Asher and Vieu, 2005], it is suggested to handle chameleon phenomena by stating that some relations (e.g., Result) are by default coordinating, and that this default can be overridden by more specific discourse clues such as punctuation and structural discourse markers (but and also in our examples). This proposal is not formally implemented in SDRT yet, but it would actually involve using revision mechanisms. Since revision mechanisms are in general best avoided, and since it would with no doubt be theoretically

---

\(^4\)In other theories, for instance in RST, the distinction corresponding to the coord/subord one in SDRT has been taken to be closely linked to the semantics of the relation. SDRT showed from the start the need to distinguish e.g., Result (coord) from Explanation (subord) whose semantic contents both refer to causality between eventualities.
simpler to assume that a given relation is always of a given hierarchical nature, we would like to examine now two possible alternative explanations. The first one extensively uses the notion of discourse topic while the second one tries to handle these problems with underspecification.

2.1 Topic Insertion?

In the case at hand, exemplified in (1-c), we have (i) two constituents ($\pi_2$ and $\pi_3$) that should be attached with the same relation to a third one ($\pi_1$), and (ii) this relation is coord. If the relation was subord, as we have just suggested, there would be no structural problem (cf. Fig.2:A). A solution that may come to mind, for keeping Result coord, would be to group the two constituents ($\pi_2$ and $\pi_3$) into a complex constituent dominated by a topic and to relate this topic constituent to $\pi_1$ with the original coord relation as shown on figure 2:B.

![Figure 2: Topic insertion in example 1](image-url)

In SDRT, discourse topics are assumed to be propositional and are integrated in the discourse structure like any other constituent. Some discourse topics are explicit (e.g., when we have an Elaboration), but others are only implicit and have to be built from the contents of the segment it is a topic of, by some kind of subsuming operation [Asher, 1993, Asher, 2004]. In SDRT, discourse topics are essential ingredients of the discourse structure. For example, where a Narration is inferred, it is necessarily dominated by a discourse topic (either explicit or implicit).

A solution based on discourse topics as sketched above, raises two problems. First, the two structures depicted in 2:A and 2:B do not have the same availability properties. More precisely, in 2:A the referents in $\pi_1$ are available for $\pi_3$ while this is not the case in 2:B. Example (1-c) suggests that this availability link exists and therefore indicates 2:A as a more adequate solution.

The second point concerns the content of the topic constituent $\pi_{top}$. The relation Continuation does not have a semantics by itself, it is only a mark of the continuation of the Result relation in this span of discourse. Therefore the topic has to be built taking into account the Result relation. However,
this relation holds between $\pi_1$ and $\pi_2$ and $\pi_1$ and $\pi_3$ but not between $\pi_2$ and $\pi_3$. This implies that the topic constituent must somehow include some information from $\pi_1$ (what’s shared between $\pi_2$ and $\pi_3$ is that they both are consequences of $\pi_1$) which is clearly odd from a discourse topic building viewpoint.

For both these reasons, this approach does not seem suitable. In addition let’s note that, if we start using topics in such a way, there would be little point in keeping subordinating relations other than Topic in SDRT.

2.2 Under specification?

Another way of handling this issue could be to exploit the relatively recent Maximize Discourse Coherence (MDC) constraint of SDRT. We could leave the nature of Result by itself underspecified, and use additional clues to decide on the nature of the relation, possibly with the help of subsequent clauses. In this way, if the context supports an additional inference to Narration, as in (1-b), Result will be coord. But if the updated context supports the creation of a complex segment gathering several “results”, as in (1-c), Result will be subord. The version of MDC (Def 2) we use is based on the gloss given in [Asher and Lascarides, 2003]:pp234.

Def 2 Maximize Discourse Coherence

MDC is based on a coherence partial order on discourse structures. Maximizing coherence amounts to prefer discourse structures with the smallest number of nodes, the fewest semantic and pragmatic clashes, the largest number of rhetorical relations and the fewest number of underspecifications.

The introduction of MDC resulted in an important improvement of SDRT, allowing accounting for new phenomena and significantly simplifying the account of others. However, with this principle we have lost the possibility of accounting for the total incoherence of a given discourse. One structure is simply better than another one. Particularly for an unacceptable discourse it is possible to say that the best structure representing it still has some clashes and similar problems but not to reject it as incoherent by not being able to build any representation, as was done in earlier versions of SDRT.

The interesting counterpart of this potential problem is to offer the possibility of leaving discourse relations underspecified after an update, delaying the decision until enough information is available. This allows to deal with example (2), awkward at first but perfectly alright once completed (adapted from [Caenepeel, 1991] and [Asher and Lascarides, 2003]).
a. Joe was released from hospital ($\pi_1$). He recovered completely ($\pi_2$).

b. Joe was released from hospital ($\pi_1$). He recovered completely ($\pi_2$) and they needed the bed ($\pi_3$).

c. Joe was released from hospital ($\pi_1$). He recovered completely ($\pi_2$), then he resumed training ($\pi_3$).

In this example, the relation between $\pi_1$ and $\pi_2$ is underspecified before the utterance of $\pi_3$, which makes clear in (2-b) that it is an Explanation, a subord relation, and in (2-c) a Narration, a coord relation.

[Asher and Lascarides, 2003] do not discuss how to deal with such underspecification in details, although it is quite clear that this case isn’t dealt with the construction of a number of alternative SDRSs, as for truly ambiguous discourses. The constituent $\pi_2$ is surely attached to $\pi_1$ but since the relation is left underspecified, its nature is underspecified as well. One wonders then what are the sites available after this attachment, i.e., where is the right-frontier of such a discourse?

The formal definition of SDRS update in [Asher and Lascarides, 2003] considers that only coord relations induce a constraint; so an underspecified relation is dealt with as a subord one, leaving all the sites available. This seems quite reasonable in this example. But if the same is applied for the “underspecification” of the nature of Result, it amounts to consider Result as subord by default, rather than coord by default. This apparently clashes with the intuition that Result is usually coord, as assumed up to now in SDRT on the basis of quite a number of examples.

We consider therefore that one should admit that there are such things as chameleon relations, to be dealt with some sort of revision mechanism. Changes are fortunately not so frequent, and always triggered by specific clues. [Asher and Vieu, 2005] suggests that Narration, a prototypical coordinating relation in narratives, is always coordinating, and that no subordinating relation can be turned into a coordinating one. We do not take issue on this precise point here, but, examining dialogs, we will now see that something very close to turning a subordinating relation into a coordinating one can occur and alter the right frontier accordingly.

3 Content relations and interrogatives

Some questions require from their answers to satisfy a given rhetoric relation with the previous discourse context. These questions (introducing relations like Explanation_q, Narration_q...) have been briefly presented in [Asher and Lascarides, 2003] but we believe that the structural aspect of their treatment in SDRT requires more attention, as it has been spotted in [Prévot et al., 2002, Prévot, 2004]. In order to show this, we are going to
consider interrogatives introducing subordinating or coordinating relations. We will pay a special attention to the state of the right frontier after the question resolution.

3.1 $Narration_q$ versus $Elaboration_q$

$Narration$ and $Elaboration$ are among relations that are assumed not to exhibit a chameleon behaviour [Asher and Vieu, 2005]. $Narration$ is coordinating while $Elaboration$ is subordinating. $Narration_q$, $Elaboration_q$ and $QAP$ have been shown to be subordinating [Asher and Lascarides, 2003].

In example (3), the subordinating nature of $Elaboration$, $Elaboration_q$ and $Background$ is coherent and predicts correctly that $\pi_5$ is open for pursuing the story (see fig 3).

(3)

\begin{align*}
A_1 &. Yesterday I visited Fez, it was great! \\
B_2 &. Really? Where did you go? \\
A_3 &. In the morning, I’ve been in the medina. ($\pi_3$) \\
A_4 &. I started by getting lost ($\pi_4$) \\
A_5 &. and then a child guided me to the souk. ($\pi_5$) \\
B_6 &. The tanner’s souk? ($\pi_6$) \\
A_7 &. No the shoemaker’s one. ($\pi_7$) \\
A_8 &. There were some wonderful babouches there! ($\pi_8$) \\
B_9 &. He took you to his uncle’s shop, right? ($\pi_9$)
\end{align*}

In example (4) the interrogative in (B6) introduces a $Narration_q$.

\footnote{In [Vieu and Prévot, 2004], we applied the test proposed in [Asher and Vieu, 2005] and we found out that $Background$ was a subordinating relation, contrary to what had been proposed up to now in SDRT but in agreement with RST’s viewpoint.}
In this case, the standard SDRT analysis [Asher and Lascarides, 2003] faces two problems. Firstly, the structure predicts wrongly the availability of $\pi_5$ for further attachments, for instance for $\pi_9$, which is unacceptable (see figure 4). Secondly, the subord nature of Narration$_q$ and QAP results in a puzzling subord Narration between $\pi_5$ and $\pi_7$ that cannot accommodate the topic constraint that is part of the semantics of Narration in SDRT. These two problems point towards the necessity of a coordinating attachment between $\pi_5$ and some other node. Indeed, since $\pi_5$ is not available for $\pi_9$ in example (4), the hypothesis that there is some node on its right would explain the blocking. We conjecture, as we will see now, that this additional node needs to be attached to $\pi_5$, instead of the answer, by a Narration relation.

3.2 A solution using a question-answer topic

The solution proposed, as presented in [Prévot et al., 2002, Prévot, 2004] is to assume that the question-answer pair generates a dominating discourse
topic. This topic is a simple constituent whose content is the resolved question/answer pair. In case of simple answers, the content of elliptical answers to questions is already reconstructed in the answer constituent and therefore the topic is only a copy of the answer. But in case of complex answers the topic is built as an abstraction over the answers, just as for narrative topics. The establishment of the QAP relation generates this topic over the question-answer sequence and this topic is attached to the previous discourse with the expected assertive relation, with its expected type of attachment (see Fig 5). In this figure, γ is the target of the question α, and β is the answer to α. The Topic-Question relation associates two constituents: τ*, which is a complex constituent for the segment consisting of the question and the answer, and τ, which is the topic itself, a simple constituent built from the question and its answer(s).

![Diagram](image)

Figure 5: Question-Answer attachment in the case of a simple Q-A pair

With our solution, what changes is the importance of the Relationq in the structure. It is in a first time crucial for tackling the coherence of the dialogue. And it becomes secondary once the structure is updated by the establishment of a satisfying answer to the question. The relation between and γ and β is actually established between γ and τ.

Surely Narrationq still holds between π5 and π6 in example (4) but it is no more important for availability issues. This Narrationq is only part of the dialogue history but still helps increasing the overall coherence for the MAXIMIZE DISCOURSE COHERENCE constraint which prefers discourse interpretations offering the highest number of rhetorical links (among other criteria). Instead, Narration between π5 and τ takes on a more important role for the RIGHT FRONTIER CONSTRAINT.
Applying our proposal to examples (3) and (4) leads to the discourse tree represented on figures 6 and 7 respectively. Figure 7 shows that we correctly model the fact that $\pi_5$ is not available anymore for further attachment once the question $\pi_6$ is answered and closed. We correctly capture the unavailability of the discourse referents introduced in this constituent for pronominal anaphora resolution.

![Figure 6: New structure for (3): $A_3 - B_9$](image)

4 More general and methodological issues

For accounting of the subtleties that appeared around the RFC, we proposed solutions that introduced modifications of the discourse structure. In particular, we use more and more implicit discourse topics that are not directly corresponding to the surface form. Such method is also followed in [Asher, 2004, Asher, 2005], essentially for dealing with definite descriptions. In Asher’s proposal, binding definite descriptions whose antecedents are not on the right frontier might force the creation of new implicit discourse topics. This path towards sophistication seems unavoidable but raises three main issues.

**Methodological confusion** The profusion of theoretical constraints and principles that could be extended or altered forces to choose among potential modifications for explaining any new phenomena at hand. For example, as we saw in the section 2, in order to explain the availability of discourse referents in example (1) one might decide to introduce chameleon relations,
another person to introduce more sophisticated topic management rules, while another might just let MDC do the job and simply introduce more underspecification. As we have seen, there seems to be reasons for preferring the first option, but we still believe that a clear methodological line for deciding when, where and how we should preferably integrate new elements into the system is lacking.

**Principle Interdependance** More sophistication results in a variety of principles that are more difficult to handle. Their complex interaction is difficult to deal with since all the constraints may move simultaneously. Namely, RFC, MDC, topic construction rules and the coord/subord distinction have all important consequences for the discourse structure and therefore for referent availability. We saw that topic construction rules and chameleon relations have important effects on the right frontier. Similarly, introducing more implicit topic nodes in the representations affects MDC, as this yields less preferred structures. If we modify these constraints without taking care of their interaction the risk is high to enter a long chain of modifications without succeeding in stabilizing the system.

**Acceptability criterion** The sophistication of the theory is unavoidable for accounting for more linguistic phenomena, i.e. analyzing a larger number of acceptable discourses as coherent. However extending the theory in this direction often means releasing constraints. And while releasing constraints, we have to make sure to remain able to analyze unacceptable discourses as incoherent. In particular, the MAXIMIZE DISCOURSE COHERENCE principle made us loose what was once our basic methodological rule: being able to ac-
count for the acceptability or unacceptability of a given discourse, analyzing it as coherent or incoherent (see Def. 2).

In spite of—and because of—its recent move introducing MDC, SDRT today requires a general reflexion on how to handle the scalarity of discourse acceptability. Some anaphora links seem to manage to violate RFC, as in example (5). Similarly, when looking for examples with interrogatives (for Section 3), we actually ended up many times finding examples that were strangely acceptable in spite of the theoretical unavailability of discourse referents. We believe that this is often due to complex phenomena occurring in the construction of discourse topics (not only for question-answer pairs), so, in essence, we agree with [Asher, 2005]. But overall, such difficulties point toward the scalarity in the acceptability of discourses, based on some kind of scalarity of availability of referents for anaphora resolution. This point constitutes a strong argument in favor of the MDC, although apparently at the cost of releasing RFC, at least in its referent availability point. Such a move is argued against in [Asher, 2005].

(5)  
   a. This morning, in the subway, I almost got robbed.  
   b. At some point a man started pulling at my purse.  
   c. I just froze.  
   d. A woman screamed,  
   e. and the pickpocket escaped.  
   f. I wanted to thank her but she had disappeared.

(6)  
   \[ \pi_1 \]. On his birthday, John had a great evening.  
   \[ \pi_2 \]. He started by winning a dance competition.  
   \[ \pi_3 \]. His partner was very seductive  
   \[ \pi_4 \]. and she gave him her phone number.  
   \[ \pi_5 \]. Then he had a great dinner and party with some friends.  
   \[ \pi_6 \]. The entire next day John kept hesitating about calling her.

In fact, according to [Asher, 2005], the pronouns in bold in examples (5) and (6) yield unacceptable discourses, while the same examples with definite descriptions would be acceptable. We agree that such discourses are more awkward than others but we believe that a deep corpus search is bound to exhibit similar examples\(^6\). Moreover it is important that the theory explains why such forced examples are still better than very bad examples like (7).

\(^6\)It is clear that finding authentic corpus examples of similar anaphora patterns is necessary. However spotting such phenomena is rather difficult because there are a lot of pronouns in the data and most of them do not qualify for testing our propositions. Most pronouns are either clearly linked to a referent in the discourse topic or in the last utterance. In order to facilitate the research one needs a corpus annotated with anaphoric links, discourse structure, and more particularly discourse pop-ups.
The scalarity of acceptability is also signalled by the fact that disagreements exist between naive readers (both on French and English language examples) according to the acceptability. What needs to be discovered is whether such scalarity is part of RFC or is accounted by MDC, less satisfactory “forced” anaphoras bringing less satisfactory structures. The second option looks more elegant but we need to be sure that it can explain why examples like (5)-(6) are less acceptable than perfectly “well-formed” discourses and more acceptable than totally mistaken ones such as (7). In order to do so, MDC, i.e., the coherence partial order on discourse structures which combines several possibly non-converging criteria, needs now to be more systematically tested, including on corpus examples.

(7) [Asher and Lascarides, 2003]
\[ \pi_1 \]. John had a great evening last night.
\[ \pi_2 \]. He had a great meal.
\[ \pi_3 \]. He ate salmon.
\[ \pi_4 \]. He devoured lots of cheese.
\[ \pi_5 \]. He then won a dancing competition.
\[ \pi_6 \]. # It (# The salmon) was a beautiful pink.

5 Conclusion

This paper has shown some limit cases for the Right Frontier Constraint. RFC in SDRT is founded on the coordinating/subordinating nature of relations and we explained that this nature, situated at the information packaging level, is not as stable as believed. Moreover the importance of a given coherence relation might evolve during the interpretation of discourses, as shown on content-level relations introduced by interrogatives in dialogues. RFC is therefore a discourse principle that needs to be used with care. In order to make its use more reliable, we must (i) examine systematically each relation under the light of [Asher and Vieu, 2005] tests for their nature, (ii) clarify the interaction between the nature of relations and other information-packaging phenomena and, (iii) propose a new revision mechanism to be integrated within SDRT for dealing with chameleon relations. We then need to pursue the work on topic construction started by Asher in [Asher, 2004, Asher, 2005], as the insertion of implicit topics in discourse structures, a crucial method for handling a number of phenomena in SDRT, also affect RFC.

However, we also discussed the difficulties due to the multiplication of interacting principles when elaborating SDRT for increasing its coverage of acceptable discourses, as we have just done in this paper. In particular, we noticed the loss of clear-cut acceptability/unacceptability criterion with
MDC. This last principle is powerful but requires from our point of view a systematic evaluation of its application on various examples of good, merely correct and odd discourses.

This paper thus contributes to show that a sophisticated theory like SDRT is in need of general methodological principles on how to handle the evolution of its own foundations, i.e, discourse constraints such as RFC and MDC. This is especially true now that the use of SDRT is spreading in the community.

Acknowledgments

The authors would like to thank Isabel Txurruka, Nicholas Asher, Philippe Muller and Nicolas Maudet for discussions related to the topic of this paper, and the “Constraints in Discourse” reviewers and participants for their questions, comments and suggestions.

References


