Troubles on the Right Frontier
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1. Overview
The Right Frontier Constraint, originally proposed by Polanyi in the eighties is one of the central empirically motivated constraints on discourse update and anaphora resolution in SDRT. In this paper I want to look at some challenges to this constraint. I’ll begin with an overview of SDRT and the right frontier constraint as it’s formalized there. I’ll then go on to look at some of the challenges to the constraint. I’ll argue that the constraint survives these challenges but they lead us to look at new constraints on update and anaphora resolution.

2. Discourse Structures in SDRT
A discourse structure in SDRT or sdrs is a triple \( \langle A, F, \text{Last} \rangle \), where:

- \( A \) is a set of labels.
- \( \text{Last} \) is a label in \( A \) (intuitively, this is the label of the content of the last clause that was added to the logical form); and
- \( F \) is a function which assigns each member of \( A \) a member of a formula of the SDRS language, which includes formulas of some version of dynamic semantics (DRT, DPL, Update Semantics, MLTT, etc.)

This notion of discourse structure is very abstract and so very general. One important distinction for SDRT (and for many other theories of discourse structure) that needs to be added to understand the notion of a right frontier is the distinction between two types of discourse relation. There are subordinating discourse relations and coordinating discourse relations. Asher and Vieu (2005) provide some theory internal tests as to whether a given discourse relation is subordinating or coordinating. These tests confirm that the discourse relation of Narration is a prime example of a coordinating relation, while the relation of Elaboration is a prime example of a subordinating relation. The difference between coordinating and subordinating relations for defining the right frontier constraints is best understood by moving from the abstract definition of an SDRS to a graphical representation of an SDRS. Here’s the algorithm for constructing a graph from an SDRS understood as above.

- Each constituent (or label) is a node
- Each subordinating relation creates a downward edge
- Each coordinating relation creates a horizontal edge.

This graphical representation immediately imposes some constraints on what sort of SDRSs are possible.

- No two nodes can be connected by both a subordinating and coordinating relation
- Several edges (of the same type) are possible between 2 constituents
- Many SDRSs can be represented as trees (Danlos 2003, Baldridge 2005) but some cannot.

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• Anaphora resolution and SDRS update are dependent on the graph structure.

These graphs are also useful in that they represent discourse coherence via their connectedness; the degree of connectedness of the graph is one measure of coherence. However, SDRT allows for underspecified graph connections as well as underspecified anaphoric connections. These lead to a scalar notion of coherence (Maximize Discourse Coherence–MDC). Roughly a discourse structure is maximally coherent if it has the fewest underspecifications, the maximal number of connections and the least number of nodes.

Here is a simple example of a discourse structure, familiar from Asher and Lascarides (2003):

(1)  \[ \pi_1. \text{ John bought an apartment} \]
    \[ \pi_2. \text{ but he rented it.} \]

Here is (1)'s discourse structure:

(1')

- \( A = \{\pi_0, \pi_1, \pi_2\} \)
- \( F(\pi_1) = \exists x \exists e(e < \text{now} \land \text{apartment}(x) \land \text{buy}(e, j, x)) \)
- \( F(\pi_2) = \exists e'(e' < \text{now} \land \text{rent}(e', j, x)) \)
- \( F(\pi_0) = \text{Narration}(\pi_1, \pi_2) \land \text{Contrast}(\pi_1, \pi_2) \)
- \( \text{Last} = \pi_2 \)

Here’s another familiar, but slightly more complex example.

(2)  \[ \pi_1. \text{ John had a great evening last night.} \]
    \[ \pi_2. \text{ He had a great meal.} \]
    \[ \pi_3. \text{ He ate salmon.} \]
    \[ \pi_4. \text{ He devoured lots of cheese.} \]
    \[ \pi_5. \text{ He then won a dancing competition.} \]
    \[ \pi_6. \# \text{ It (# the salmon) was a beautiful pink.} \]

Here’s the SDRS for (2):

(2')  \( \langle A, F, \text{Last} \rangle \), where:

- \( A = \{\pi_0, \pi_1, \pi_2, \pi_3, \pi_4, \pi_5, \pi_6, \pi_7\} \)
- \( F(\pi_1) = K_{\pi_1}, F(\pi_2) = K_{\pi_2}, F(\pi_3) = K_{\pi_3}, F(\pi_4) = K_{\pi_4}, F(\pi_5) = K_{\pi_5}, F(\pi_6) = \text{Elaboration}(\pi_1, \pi_6), F(\pi_7) = \text{Narration}(\pi_2, \pi_5) \land \text{Elaboration}(\pi_2, \pi_7), F(\pi_7) = \text{Narration}(\pi_3, \pi_4) \)
- \( \text{Last} = \pi_5 \)

Here’s the corresponding graph of (2'):
With these examples, we can now describe the “right frontier” as it’s defined in SDRT (it’s actually more general and more precise than the notion of a right frontier in other discourse theories). This governs where new information can attach in SDRT. We define the set of available nodes for attachment as falling under the following possibilities.

1. The label $\alpha = $ Last;

2. Any label $\gamma \geq_{D} \alpha$ where $\geq_{D}$ is defined recursively:
   
   (a) $R(\gamma, \alpha)$ is a conjunct in $\mathcal{F}(l)$ for some label $l$, where $R$ is a subordinating discourse relation (like Elaboration, Explanation or ↓);
   
   (b) $R(\gamma, \delta)$ is a conjunct in $\mathcal{F}(l)$ for some label $l$, where $R$ is a subordinating discourse relation and $\mathcal{F}(\delta)$ contains as a conjunct $R'(\delta', \alpha)$ or $R'(\alpha, \delta')$, for some $R'$ and $\delta'$; or
   
   (c) $R(\gamma, \delta)$ is a conjunct in $\mathcal{F}(l)$ for some label $l$, where $R$ is a subordinating discourse relation and $\delta \geq_{D} \alpha$.

For all relations other than structural relations, we can now also use the notion of the available nodes to constrain the resolution of anaphoric conditions in SDRT. Imagine the following situation:

- $\beta : K_{\beta}$;
- $K_{\beta}$ contains anaphoric condition $\varphi$.

The available antecedents then are:

1. in $K_{\beta}$ and dRS-accessible to $\varphi$

2. in $K_{\alpha}$, dRS-accessible to any condition in $K_{\alpha}$, and there is a condition $R(\alpha, \gamma)$ in the sDRS such that $\gamma = \beta$ or $\gamma \geq_{D} \beta$ (where $R$ isn’t structural).

The upshot of these definitions is that an antecedent for an anaphoric expression must be dRS-accessible on the right frontier.
3. The Challenge with Definites

The predictions of these constraints largely confirm intuitions. For instance, the availability constraint on anaphors predicts that \((2\pi_1 - \pi_6)\) is infelicitous; the relation between pronoun or the definite description and its antecedent violates the right frontier condition. Also the attachment doesn’t make sense. So this attachment is doubly damned according to the principle MDC.

However, if we replace \(\pi_6\) in (2) with \(\pi_7\) the discourse is much better. Why?

\[(\pi_7)\text{ The entire next day John kept remembering what a beautiful color his salmon had been.}\]

This is the first of the challenges for the right frontier constraint.

One thing to notice about definites is that they are complex and introduce in SDRT considerable underspecification. They also have a presupposed and an asserted component. More particularly, definites introduce presupposed constituents that must be attached via a relation like Consequence (binding) or Background (accommodation). They also require that the variable introduced by the definite must be related via some underspecified relation \(R\) (often identity unless we have a bridging definite) to some available antecedent. Here’s an example of the SDRT interpretation of a definite like \( \text{the salmon} \)

\[
\begin{align*}
\text{the salmon} & \rightarrow p : \exists x, y (\text{salmon}(x) \land R(x, y) \land y = ? \land R = ?), \\
\text{a} & : \lambda P(x)
\end{align*}
\]

Definites require a lot of processing in order to be fully integrated into the discourse context. Perhaps this processing can also lead to changes in the discourse structure that would make available antecedents that in the standard SDRS would not be.

Before we embark down such a path, let’s make sure that the phenomenon is robust. Consider the following example from LaureVieu and Laurent Prévot.

\[(3)\]

\begin{enumerate}
\item This morning, in the subway, I almost got robbed.
\item At some point, I noticed that a man was pulling at my purse.
\item I just froze, I couldn’t say a word.
\item Suddenly, a woman screamed.
\item The pickpocket (#he) let go of my purse and ran away.
\item I wanted to thank the woman (#her) but she had already disappeared into the crowd.
\end{enumerate}

The use of the definite as opposed to a simple pronoun markedly improves the discourse for most speakers of English. But given that the presupposed constituents are distinct, one hypothesis (admittedly a rather radical one) is that such constituents may in fact coerce the creation of topics to which they bind. The material of these topics is already implicit in the discourse, but the use of the definites somehow makes this material more prominent and suggests the following discourse structure for (3):
an almost robbery

Elaboration

pickpocket
arrives
Narration
a woman saves
me from him

Elaboration

he grabs purse
Narration
I freeze

Elaboration

she screams
Narr
pickpocket runs

Definites don’t always improve coherence; consider \((2 \pi_1 - \pi_6)\) with the definite the salmon. It’s hardly better than the discourse with the simple pronoun. Similarly, consider (4), also due to Laure Vieu and Laurent Prévot. (4efg) are all pretty awkward or marginal according to most speakers.

(4) a. John experienced a shopping-therapy evening last night.
   b. He bought an expensive tuxedo.
   c. He booked a cruise to the caribbean.
   d. He ordered three cases of champagne.
   e. ??Early this morning, they were delivered to him.
   f. ?Early this morning, the ticket was delivered to him.
   g. #Early this morning, it was delivered to him.
   h. He immediately went to tell everything to his doctor.

These examples strongly suggest that it can’t be that definites can find their antecedents regardless of the position of the antecedent within the discourse, as long as that antecedent uniquely satisfies the descriptive content of the definite. So the question is, why do definites sometimes appear as though they violate the right frontier? My hypothesis is that in fact there are no Right Frontier Constraint violations with definites. Getting the appropriate antecedents requires a rearrangement of discourse structure, bringing elements into prominence. This can be done by adding structure into the SDRS beyond the minimal number of constituents derived from the text—viz., those constituents highlighted with underlining in the graph above. This would also explain speaker intuitions that these aren’t perfect discourses. To provide antecedents to bind the presuppositions introduced by the definites, these discourse structures are required to have more than the minimal number of nodes suggested by the explicitly given discourse constituents (marked for our purposes here by clauses).

Exploiting Parallel and Contrast helps make the antecedents available by improving discourse coherence. But in order to understand this part of the picture, we need to look at how structural relations like Parallel and Contrast affect availability. These relations give rise to some sort of matching condition, which consists in constructing a maximal partial isomorphism between the two related constituents. The matching process requires a common theme (for Parallel) or two contrasting themes (for Contrast) (see Asher 1993, or Asher, Hardt and Busquets 1997). The matching condition predicts that the two quantified constituents in (5ab) must have the same quantifier structure either \(\exists \forall\) or \(\forall \exists\). It also predicts that the antecedent of the deleted
VP in (5c) is in the consequent of the conditional, which would not be available, if we assume that some coordinating relation links the constituents provided by the subordinate and main clauses.

(5) a. Every doctor saw at least one patient, and every nurse saw at least one patient too.
   b. Every doctor saw at least one patient, and every nurse did too.
   c. When John goes to school, he normally brings his books. But when Samantha goes to school, she normally doesn’t.

The point I want to make about these themes in connection with definites is that they can be used as topics to help provide antecedents; this addition to discourse structure is an additional inference licensed by definites. But it doesn’t work when there is no parallelism or contrast to help us construct the themes. And that’s what’s key about the example (2π₁-π₅,π₁) versus (2π₁-π₆). The former contains enough material to build a weakly parallel constituent of John’s memories over to the events described in π₂ – π₅, attaching π₇ with Narration and Parallel to π₁. This isn’t possible in (2π₁-π₆). No Parallel or Contrasting structure suggests itself.

4. Another Challenge: Plural Anaphors and Quantifier Domains

Plural pronouns also constitute apparent violations of the right frontier.

(6) a. Yesterday, at the party, I met a lot of interesting people.
   b. I started out talking to a woman who knew a lot about discourse topic.
   c. Then I met a man who explained to me all about information structure.
   d. Later, I found out that ??she was married to him / ??he was married to her / they were partners.

I don’t think this example is perfect by any means, but many English speakers have the intuition that the continuation with the plural pronoun is far more felicitous than the alternatives with singular pronouns. Intuitively, it’s natural to see this discourse as singling out two people; and if anaphoric demands require it, we can construct a topic consisting of just these. There is quite a bit of parallelism in (6bc) that would facilitate constructing such a topic—two people working on discourse semantics. The discourse isn’t perfect, because we don’t really make much use of the explicitly given topic (or perhaps we modify it to just include the two people). If thinking along these lines is right, then such examples don’t constitute real violations of the Right Frontier Constraint any more than the examples with the definites.

An important question is why topics don’t help with the singular anaphoric pronouns. Asher (1993) hypothesized that this was because of the summary character of topics; they had to be simple and so when more than one thing of a particular type is mentioned they are typically summed together to create a plural entity in the topic, if they make it in there at all. To test this hypothesis, we might change (6) to include the mention of another woman working on, say, modal subordination. The plural personal pronoun in such an altered version of (6) would pick up all three people.

Quantificational DPs sometimes also seem to constitute a Right Frontier Constraint violation. Consider (4a-d,h). It’s much better than any of the alternatives. But everything here is a restricted quantifier; it ranges over all the events or actions that occurred during the shopping therapy. Following Stanley and Szabo (2000), let’s assume that the restrictor of a quantified
noun phrase contains a variable, but unlike them let’s further stipulate it that it has to recover its domain from the discourse context—i.e., it’s anaphoric (I’ll ignore here those cases where shared background beliefs specify the restrictor). Then it appears that such a variable can pick up the set of all of the entities mentioned in the discourse of the appropriate sort. Somehow a domain of quantification is established from the relevant entities introduced into the discourse there and the quantifier is restricted to those. One way to implement such an idea is to put more theoretical weight on a topic. A topic would contain not only a proposition, but a quantificational domain value that could be picked up anaphorically. In Asher (1993) the procedure for constructing discourse topic was in fact something that could be also used to build such a discourse domain.

In any case, the plural anaphora and quantificational cases don’t seem to be real violations of the Right Frontier Constraint either, though the reason they are not is distinct from the reason why some definites can apparently violate the right frontier. Definites provide an additional amount of content that can help set up the requisite partial isomorphism that is part of the definition of structural relations. Plural and quantificational cases rely more on the summary nature of topics.

5. Another Challenge: Sluicing

Sluicing is a kind of ellipsis that has always been thought to be governed by syntactic constraints. But a very recent paper of Romero and Hardt (2004) suggests that discourse constraints may also be at work in this phenomenon. The following are typical examples. Following the *wh* elements in (7) is deleted or missing material that must be recovered from context.

(7) a. John ate, but I never figured out what ∅ [John ate].
b. John ate. Sam ate. But I never figured out what ∅ [John ate and Sam ate].
c. John ate. But I don’t know what.
d. Mary kissed somebody. You’ll never guess who.

Sluicing can occur across separate sentences, so traditional syntactic theories, whose domain of inquiry is the syntactic structure of an individual sentence, can’t impose constraints on such anaphoric phenomena.

The Right Frontier Constraint operates on sluicing as well:

(8) a. John left and then Mary kissed someone. You’ll never guess who.
b. Mary kissed someone and then John arrived. #You’ll never guess who.
c. Mary kissed someone and then John arrived. You’ll never guess from where.
d. John arrived and then Mary kissed someone. #You’ll never guess from where.

By using the expression *and then* we’ve forced a Narrative relation on the discourses in (8). Given SDRT’s rules, this forces the right frontier to contain just the second clause of the first sentence as well as the constructed topic, required by the axioms for Narration (Asher and Lascarides 2003). The upshot of this is that only material in that clause is available for reconstructing the ellipsis.

Further evidence that the Right Frontier Constraint is operative (and not some simpler constraint like adjacency of discourse units) come from the following data:
a. Mary kissed someone because John left for some other party. You’ll never guess who.
b. ??Because Mary kissed someone, John left early. You’ll never guess who.
c. Mary kissed someone, He’s a student here. You’ll never guess who.

SDRT predicts (9a,d,e) to be OK. The reason is that in these examples subordinating discourse relations obtain between the first two clauses, and according to the Right Frontier Constraint this allows for accessibility to either constituent. (9b) is predicted to be bad, since there is violation of the Right Frontier Constraint.

Let’s now turn to single sentence examples like:

(10) a. *Mary arrived after John ate but it’s unclear what.
b. Mary arrived after John ate but it’s unclear what John ate.
c. *Mary arrived after John ate but it’s unclear what Mary arrived after John ate.
d. Agnes arrived while John was eating and I was trying to figure out what.
e. John ate before Mary arrived, but I never figured out what.

These simple sentences show a remarkable range of grammaticality. As Chung et al. point out, we cannot recover the material explicit in (10c) because that constitutes an island violation. But what syntactic constraints alone don’t at all explain is why (10a) can’t have the reading (10b), which is perfectly straightforward. Nor can syntactic constraints explain why the sluicing examples (10c,d) are OK when (10a) is ungrammatical. Semantic constraints on ellipsis don’t really help us here either. As Romero and Hardt note, off the shelf theories of ellipsis that exploit focus (like Rooth 1992, Fiengo and May 1994, etc) would predict that a matching content can be found between the ellipsis site and some content in the antecedent discourse. SDRT’s rules of attachment would predict that (10d) should be fine, but as of yet we do not have an explanation for (10a) and (10c)

The first observation to make is that the material in the after or before clauses is presupposed; it escapes the scope of negation and the interrogative force of a question:

(11) a. It’s not true that Mary arrived after John ate —> John ate.
b. Did Mary arrive after John ate? —> John ate.

Both (11a-b) entail that John ate, and these are classic tests for presupposition. Now in discourse presuppositions have a strong preference to attach high up in the structure; and in any case the material in the third clause with the ellipsis (which is asserted) cannot attach to the presupposed material. Only additional presupposed material (as in (10d)) can attach to presuppositional material. One additional SDRT hypothesis is required to make sense of the data. The theory of ellipsis resolution proposed in Asher (1993) requires that ellipsis material be recovered from the discourse constituent to which the constituent containing the ellipsis is attached. This is because constituents with ellipsis always attach at least with the structural relations Parallel or Contrast (though they may attach with more relations). The discourse structures for (10cd) are both ones where the ellipsis clause attaches to the constituent with the relevant matching material though in (10c) the ellided constituent is asserted and attaches to the assertion that John ate, while in (10d) the ellided constituent is part of the presupposition.

Things, however, aren’t quite as neat as I’ve made out. Consider (12ab) due to Bernhard Schwarz.

(12) a. *Mary arrived after John ate but it’s unclear what.
b. Mary arrived after John ate but it’s unclear what John ate.
c. *Mary arrived after John ate but it’s unclear what Mary arrived after John ate.
d. Agnes arrived while John was eating and I was trying to figure out what.
e. John ate before Mary arrived, but I never figured out what.

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Things, however, aren’t quite as neat as I’ve made out. Consider (12ab) due to Bernhard Schwarz.
(12a) a. John died after he ate something poisonous, but I’m not sure what.
   b. ??John survived after he ate something poisonous, but I’m not sure what.
   c. John left after Mary kissed somebody. You’ll never guess who.

(12a,c) don’t pattern at all with the other sluicing examples and seem to go against the picture that I’ve sketched so far. What seems to be different is that there is a causal connection between clauses in (12a,c) missing in (12b) and (10a). The discourse relation that holds between the clauses in (12b) and (10a) is Background, with additional temporal information being given by the adverbial clause. Now SDRT predicts that causal relations, as well as relations like Elaboration or Explanation can’t bind presuppositions. Causal links are part of the foreground. So if these clauses trigger presuppositions, it would appear that the material is both part of the foreground (giving us the causal link) as well as being presupposed.

One test for this hypothesis is to think about how attachments are affected by such causal links. It appears that we can’t use Result, Explanation or Elaboration to attach to presupposed material straightforwardly, but we can when the material, ordinarily presupposed, itself has causal links to material in the foreground.

(13) a. John left ($\pi_1$) after Mary ate ($\pi_2$). She had an aioli ($\pi_3$). (Explanation($\pi_1$, $\pi_3$), not Elaboration($\pi_2$, $\pi_3$))
   b. John left ($\pi_1$) after Mary ate ($\pi_2$). ?She was very happy ($\pi_3$). (?Explanation($\pi_1$, $\pi_3$), not Result($\pi_2$, $\pi_3$))
   c. John died ($\pi_1$) after he ate something poisonous ($\pi_2$). He had blowfish ($\pi_3$). (Elaboration($\pi_2$, $\pi_3$))

Given these observations, we now seem to have an explanation of the apparently contrary data. In (12a) the modifier clause remains part of the assertion and so is also available for attachment with new asserted material. Since according to SDRT the Parallel matching conditions are satisfied, the Sluicing is predicted to be OK.

6. Conclusions

The Right Frontier Constraint remains an important constraint on anaphora. It appears to be pretty much absolute for anaphors that are pure pronouns. However, definite descriptions do seem to behave differently. The explanation proposed here is that the additional content provided by definite descriptions sometimes provides just enough material to construct a structural relation that licenses the anaphoric link. The Right Frontier Constraint also has apparent difficulties with quantificational domains and plural pronouns, but there the problem is not so much with the constraint, I argue, but with how we conceive of topics. Finally, we’ve seen that even highly constrained phenomena like sluicing provide interesting evidence for the Right Frontier Constraint and also indicate that we must attend to the presuppositional status of information in attachment.

References


