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Subordinating and coordinating discourse relations

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Abstract

This paper studies the distinction between subordinating and coordinating discourse relations, a distinction that governs the hierarchical structure of discourse. We provide linguistic tests to clarify which discourse relations are subordinating and which are coordinating. We argue that some relations are classified as subordinating or coordinating by default, a default that can be overridden in specific contexts. The distinction between subordinating and coordinating relations thus belongs to the level of information packaging in discourse and not to the level of information content or the semantics of the relations themselves.

Keywords: Discourse structure; Discourse relations; Discourse topic; SDRT

1. Introduction

Many of those who work on the analysis of discourse (e.g., Hobbs, 1985; Polanyi, 1988; Grosz and Sidner, 1986; Mann and Thompson, 1987; Asher, 1993; van Kuppevelt, 1995) assume that a discourse has a hierarchical structure. Their view that information in a discourse is richly structured contrasts with the static, traditional conception of information in a discourse as a conjunction of propositions or just a set of possible worlds. It also contrasts with the dynamic semantic view of text information as a sequence of information updates. A key feature of this rich structure, we argue, is a distinction reminiscent of one in syntax between two types of discourse relations. This is the distinction between subordinating and coordinating relations, a distinction that is central to Segmented Discourse

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Representation Theory's (SDRT) view of discourse structure (Asher, 1993) and one that we aim to sharpen in this paper.

The distinction between two sorts of discourse relations or rhetorical functions has an intuitive motivation: some parts of a text play a subordinate role relative to other parts. To give a simple grade school example, the lead sentence of a paragraph gives that paragraph's main idea, while other sentences in the paragraph should elaborate or support that idea with arguments. Further, these other bits of information often come at the same ''level'' of detail and coordinate together to amplify on or support the lead sentence which motivates our understanding of them as coordinating.

These intuitions about different rhetorical functions, on the other hand, are difficult to make precise. Clearly, we don't need to single out Elaboration or Support as distinct somehow in nature from other discourse relations to build up a rich discourse structure. Instead we could treat all discourse relations in the same way, but allow discourse relations arguments with which we associate more complex discourse structures. So we could approximate the structure of a paragraph in an expository essay by having a relation of Elaboration hold between a segment representing the content of the lead sentence and a ''complex'' segment representing the contribution of the rest of the paragraph, this complex segment most likely have constituents of its own related by various discourse relations.

The account of Webber et al. (2001) using just tree adjunction or insertion, doesn't appear to distinguish between different sorts of discourse relations, and so would be an example of this view of discourse structure (though they adopt this idea only at a ''syntactic'' level of description). The structure obtained is essentially linear, except for the presence of complex sub-structures.

This approach runs into trouble when we attempt to use our hierarchical structure to make certain predictions about the interpretation of discourse. For instance, some researchers (principally those using SDRT though not only those) have hypothesized that discourse structure affects semantic and pragmatic phenomena like anaphora resolution, in which a pronoun gets assigned an antecedent that specifies its semantic contribution. More generally, the structure affects how new information can contribute to the meaning of the discourse. Part of this influence is theoretically accounted for by the ''right-frontier-constraint'' (Polanyi, 1988).[1] Only the discourse constituents on the right frontier of the graph may provide attachment points for new information. Consider (1), for example.

(1)
a. John had a great evening last night.
b. He had a great meal.
c. He ate salmon.
d. He devoured lots of cheese.
e. He then won a dancing competition.
f. ? Then he had a great dessert.
f′. # It was a beautiful pink.
f″. John had lots of fun.

[1] In SDRT we use something very close to the right frontier, in fact indistinguishable for these examples. We will clarify some differences below.

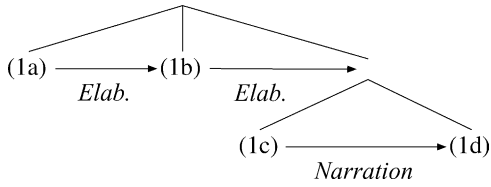

Fig. 1. Simple hierarchical structure of example (1).

Clauses (1c–d) elaborate the meal (1b), which in turn elaborates the evening (1a). (1e) also elaborates the evening, but unlike (1c–d) it doesn't elaborate the meal. Rather, it forms a narrative with (1b). So (1e) shouldn't be considered part of the same "segment" as (1c–d). But now if we consider our simple-minded structure where all relations are treated similarly in a linear fashion, it's clear that (1b) doesn't end up on the right frontier, after we finish constructing the representation for (1a–d), as can be seen on Fig. 1.

So by the right frontier constraint, we can't attach (1e) to (1b). There is an alternative; we could turn our simple approach "on its head", and in effect make the right frontier all the elements of the text, but then we'd predict (1f) to be fine, which it isn't. The trouble is that an approach that doesn't distinguish between different types of rhetorical relations either doesn't make enough elements available for attachment or it makes too many available.

Supposing that we keep the right frontier hypothesis, we need to complicate our hypothesis about discourse structure. Let's suppose, in line with Hobbs (1985) and Asher (1993), that the discourse relation of *Elaboration* induces "subordination" in discourse segmentation, whereas *Narration* induces "coordination". Then graphically, the correct hierarchical structure of (1a–d) and (1a–e) can be represented as in Fig. 2, using vertical (or oblique) arrows for subordinating relations and horizontal ones for coordinating relations.

In the first graph of Fig. 2, (1b) is a possible attachment point for (1e). Further, only the discourse constituents on the right frontier of the resulting second graph (here, (1a) and (1e)) may provide attachment points for the next constituent. This explains the awkwardness of (1a–f): having dessert is usually part of a meal, but since neither (1d) nor (1b) are on the right frontier, (1f) cannot be attached at one of these points to further elaborate (1b), the meal. The right-frontier constraint, together with some additional "accessibility constraint", also explains the incoherence of (1a–f′), i.e., why we cannot identify *it* with *salmon*. On the other hand, if we consider the discourse (1a–e, f″), then assuming that *to have fun* has an anaphoric component (i.e., John had fun in some eventuality), we could resolve the anaphoric element in that component either to the eventuality introduced in the

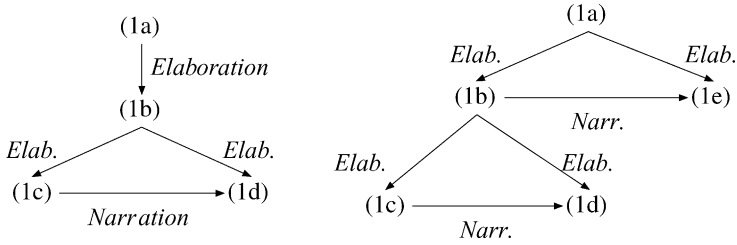

Fig. 2. Hierarchical structure of example (1).

top constituent (*a lovely evening*) or in a lower level constituent (*a dancing competition*). Whether the lower constituent's antecedent was permissible or not given the right frontier constraint would depend on where (1f″) was attached in the structure, i.e., (1a) or (1e).

These observations provide evidence for a richer view of discourse structure, with both complex sub-segments and the distinction between subordinating and coordinating relations. But despite the pervasive assumption of hierarchical structure in the literature, and even though some proposals have been made regarding what exactly are coordination and subordination, there hasn't been a systematic investigation into *which discourse relations* are subordinating and which are coordinating nor have any general tests or criteria been devised to test hypotheses about coordinating and subordinating conjunctions.

This paper makes a start in classifying which discourse relations are subordinating and which are coordinating, and which may be either. We will use criteria pertaining to certain semantic effects of discourse structure that we can reasonably easily observe. One of our findings is that some relations aren't *per se* subordinating or coordinating; whether they are subordinating or coordinating depends on the circumstances of their use. This leads us to argue that the notions of coordination and subordination don't pertain to a class of discourse relations with a common underlying content to be explained model theoretically; rather, these notions are a feature of the *structure* of the discourse representation or logical form of a discourse, which we take to be part of the level of information packaging or how the information is presented. Nevertheless, while subordination and coordination are properties of how content is represented or packaged, the distinction between subordinating and coordinating discourse relations has semantic effects—viz. on a variety of anaphoric phenomena. Criteria for subordinating and coordinating elements in discourse structure that exploit these indirect semantic effects will emerge from the discussion.

2. SDRT

To carry out this investigation properly, we need to settle on a theory of discourse representation and interpretation. We will choose SDRT, a theory that offers a formal account of the hypothesis that discourse has a hierarchical structure upon which interpretation depends. For our purposes we will need the following features of SDRT (see, e.g., Asher, 1993, 1996; Busquets et al., 2001 for details):

- SDRT's semantic representations or logical forms for discourse, SDRSs, are recursive structures. A basic SDRS is a labeled logical form for a clause, and a complex SDRS will involve one or more discourse relation predications on labels, where each label is associated with a *constituent*, i.e., a perhaps complex SDRS.
- An SDRS for a discourse is constructed incrementally within a logic of information packaging that uses several information sources and that is responsible for the final form of the SDRS. The logic of information packaging, which reasons about the structure of SDRSs, is distinct from the logic of information content, in which we formulate the semantic consequences of an SDRS.
- The discourse relations used in SDRT, which have definite semantic(e.g., spatio-temporal, causal, etc.) effects, are binary and either *coordinating* (Coord) or *subordinating* (Subord). Some coordinating relations require a topic; i.e., there must be a

simple, constituent, a common ''topic'', that summarizes the two related constituents and that is linked to them via the subordinating *Topic* relation. If this third constituent has not been explicitly given in the previous discourse, it must be ''constructed''.

- Something close to the right-frontier rule governs attachment of new information: sites open for attachment are the simple constituents either directly linked to the last entered constituent or that dominate it via some subordinating relation.

  In most cases, this translates to the open sites lying along the right frontier of an SDRS's graph, in which coordinating relations yield horizontal edges with the newer constituent to the right, and subordinating relations vertical edges with the newer constituent below.
- A ''look-left-one-step-only-or-look-up'' rule on the SDRS governs referent accessibility for anaphora resolution:referents in the constituent where we attach to the current one are accessible (one step, left or up) as well as those of all constituents that dominate the current constituent (up).

In addition to the right frontier and accessibility constraints, the following are either explicit principles of SDRT (e.g. Continuing Discourse Patterns) or follow from principles and choices about how the representations of logical forms in SDRT are constructed. These principle limit what hypotheses we can make about subordinating and coordinating relations.

- *Continuing Discourse Patterns (CDP)*: If $R_1(\alpha, \beta)$ and $R_2(\beta, \gamma)$ and $\mathrm{Subord}(R_1)$ and $\mathrm{Coord}(R_2)$ then $R_1(\alpha, \gamma)$ and $\mathit{Continuation}(\beta, \gamma)$ (in addition to $R_2(\beta, \gamma)$). *Continuation* is a coordinating relation whose sole semantic content is to mark that its terms bear the same discourse relation to a dominating constituent. This implies that coordinated constituents of a sub-structure must behave in a homogeneous fashion with respect to a dominating constituent.
- Any two relations holding between the same two constituents are of the same type: If $R_1(\alpha, \beta)$ and $R_2(\alpha, \beta)$ then $\mathrm{Subord}(R_1)$ iff $\mathrm{Subord}(R_2)$.[2] In other words, you can't have both a vertical edge and an horizontal one between the same two nodes on the graph.

SDRT provides an analysis of many examples that motivate this formal proposal, including a variant of (1) above (Lascarides and Asher, 1993). These analyses, as well as most of those based on other theoretical frameworks that countenance a distinction between coordinating and subordinating discourse relations, take for granted that Narration is a paradigm coordinating relation and Elaboration a paradigm subordinating one. On the basis of the SDRT principles we have just mentioned, we want to develop more definite tests for establishing whether one of the many discourse relations is subordinating or coordinating.[3] We'll look mainly at narratives, although the goal of this work is to cover other forms of monologues and dialogues as well.

[2] This possibility applies in SDRT but not, for instance, in RST. In RST we have only one relation, subordinating or coordinating, at a time. Because of the underlying non-monotonic inference system used to infer discourse relations in SDRT, as many discourse relations between constituents are inferred as are consistent with the context.

[3] Except perhaps for the technical relation of Continuation, which is assumed to be coordinating.

3. Previous theoretical proposals

3.1. Previous classification of discourse relations

In articles on discourse relations (many but not all using the framework of SDRT) we come upon the following, largely unjustified, classification for coordinating and subordinating relations:

- *Coordinating:* Narration, Background, Result, Continuation, Parallel, Contrast.[4] In dialogue, Question-Coordination and Correction have also typically been assumed to be coordinating.
- *Subordinating:* Elaboration, Instance, Topic, Explanation, Precondition, Commentary. For dialogue, we would include Question-Elaboration and (Indirect) Question-Answer Pair as well.

3.2. General characterization of coordination and subordination

While coordination and subordination intuitively have to do with the structure of a discourse representation, many have thought that semantic features support this distinction (see, e.g., for an overview van Kuppevelt, 1995). In the literature, we find four main characteristic elements:

1. Subordination and coordination affect the temporal order of (narrative) texts. With coordination, there is a temporal progression of the events presented, whereas with subordination, this progression is broken.
2. Subordination and coordination affect discourse intentions. With coordination, the ''communicative intention'' of the first segment needs to be satisfied before that of the second segment. On the other hand, satisfying a subordinate constituents' communicative intentions fully contributes to satisfying that of the dominating one (cf. Grosz and Sidner's (1986) satisfaction-precedence and dominance).
3. Subordination and coordination affect topicality. If the topic of the segment alters the topic of the segment it is linked to and therefore fully contributes to the topic of the larger segment, then the two segments are coordinately linked. If the topic of one constituent is simply a sub-topic of the one it is linked to, it is subordinate (cf. van Kuppevelt, 1995; Asher, 1993).
4. Subordination and coordination affect functional symmetry. If the segments linked are on an equal footing, they are coordinated; if there is an asymmetry between them, one is subordinate to the other, and this allows us to preserve coherence after deletion of

[4] Asher (1993) actually distinguishes between the structural relations (currently only three of them: Contrast, Parallel and Correction) and other discourse relations whose definition directly depends on and affects the prepositional content of the constituents. The structural relations, whose triggering conditions have to do with the *form* of what is said, have typically been understood to be coordinating as well, but the way anaphoric dependencies work with them depends more on how the relation is determined than on the simple right frontier constraint (Asher, 1993). Thus, we will keep them apart as special cases and in what follows we will look only at the distinction between coordination and subordination among those relations whose semantics and triggering conditions have to do with *what* is said in the two related constituents.

the subordinated segment (cf. Mann and Thompson's, 1987 multinuclear and nucleus/satellite relations).

These four criteria are quite diverse. Criteria 1 and 4 indeed involve the semantics of discourse relations themselves. Criterion 2, on the other hand, operates at a level of discourse intentions, arguably a distinct level from the semantics of the relations themselves; and criterion 3 involves an interaction between the notion of topic and the coordination/subordination distinction. Both criteria 2 and 3 are problematic in at least two respects: they link the distinction that we want to clarify with notions like discourse topic and discourse intentions that are at least as mysterious; further it's hard to see how these distinctions by themselves link up to particular discourse relations. Thus, criteria 2 and 3 are not particularly useful.

This leaves us with the hope that criteria 1 and 4 suggest a semantic distinction underlying subordinated and coordinated constituents. Something that's crucial to both of these is that given that they define the subordination/coordination distinction in terms of the *semantic* properties of discourse relations, if a discourse relation is coordinating, it is *always* coordinating or coordinating on every instance of use. The same goes for subordinating relations. This implication is one that we'll see later on is open to doubt and hence vitiates the force of these proposals. But before we get to that, let's try to work out what sort of semantic properties these criteria rely on. The fourth criterion is quite hard to make precise, but we might try to sharpen the observations therein by supposing a certain sort of conditional dependence between superordinate and subordinate constituents: if A is subordinate to B, then there's a conditional dependence of A on B (but not vice-versa). This could explain why we can eliminate A and preserve coherence but not if we eliminate B without eliminating A. Making precise this vague idea of conditional dependence between such constituents or their discourse segments is going to be difficult, however, if we countenance the particular discourse move in (1b) or (1c); the discourse move doesn't have any natural conditional interpretation; rather it should be interpreted as having a conjunctive entailment—both of the contents associated with its arguments hold; in SDRT's terms, the relation is *veridical*.

Despite the difficulty of a conditional interpretation of subordination, there are other semantic distinctions one could appeal to. Asher (1993) gave the first coordinating/subordinating distinction in SDRT and used the symbol $\Downarrow$ to mark a subordinating discourse relation. In (Asher, 1993), a relation is considered as subordinating just in case it combines with $\Downarrow$ whose semantic definition below is disjunctive:

$\Downarrow(\alpha, \beta)$ iff the main eventuality described in β is a subsort of the main eventuality described in α or the proposition associated with β defeasibly implies that associated with α.

This definition appears to work fine with Elaboration, which includes the constructed topics of Asher (1993), and was the only explicit subordinating relation in (Asher, 1993). The sufficient or ''if'' part of the definition of $\Downarrow$ also seems to fit the relations that since (Asher, 1993) many have thought to be subordinating like Explanation, Consequence and Commentary, provided that we make the plausible assumption that if one of these relations holds between α and β, the contents associated with β presuppose and thus defeasibly entail

the contents associated with α. This assumption appears reasonable in view of the fact, for instance, that a particular *explanans* in an explanation must presuppose that of which it is an explanation. Similar reasoning applies to Commentary and Precondition, and perhaps also Consequence. Clearly this reasoning does not apply to relations like *Narration* or *Result*; these relations entail the truth of the contents associated with their terms but not any presupposition relation.

On the other hand, it's hard to see how to support the necessary or ''only if'' part of the definition above for subordination. In fact, as we'll see in Section 5, it doesn't appear to hold. More generally, we'll argue that there isn't any way to give a general semantic definition with necessary and sufficient conditions of subordinating or coordinating relations in discourse. Instead of looking for a distinction between subordinating and coordinating relations at the level of semantics or information content, as suggested before, we will develop a more syntactic characterization—one at the level of logical form—which in SDRT concerns the level of SDRS representation.

From this perspective, one could use the structural definition of subordination from (Busquets et al., 2001):

- a discourse relation is Subord/Coord if it is able/unable to have a complex SDRS associated with its second term.

This definition does distinguish between those relations that are considered to be subordinating and those that are coordinating at the level of discourse structure or logical form, but it's very close to the simple-minded view of discourse structure we started with (cf. Section 1 and Fig. 1). It only makes sense within the theoretical context of SDRT, and by itself doesn't offer any direct criterion for the classification, as one could depict any relation either as subordinating or coordinating.

3.3. Linguistic markers of coordination

Much more helpful is the proposal of Txurruka (2000). She argues that the connective *and* is a marker of coordination: all discourse relations that may hold between two clauses linked with *and* are coordinating. This provides a clear test without any theoretical baggage, though it doesn't in itself provide an explanation of what coordination and subordination are.

One might try to extend Txurruka's idea to a general correspondence between syntactic coordinating and subordinate conjunctions and types of semantic relations. From SDRT's perspective, however, this cannot be the case as, e.g., *for* (a coordinating conjunction) and *because* (a subordinate one) mark the same discourse relation of Explanation.

Either by associating particular discourse relations with particular cue phrases or by exploiting the related clauses, we can use Txurruka's test to check to a certain extent whether relations are coordinating or not. For instance, consider:

(2) a. John went home, and then he called Sam.
b. John went home, and as a result he didn't get sick.
c. John had a good time, * and for instance he had a great meal.

d. John had a good meal last night. He had the osso buco.
d′. John had a good meal last night, and he had the osso buco.
e. John fell, and Chris pushed him.

If *then* marks Narration, Txurruka's test on (2a) implies Narration is coordinating. Similarly, if *as a result* marks Result in (2b), Result is coordinating. If *for instance* marks a sort of Elaboration (Olman, 1998; Knott et al., 2001) in (2c), the *and* test implies that at least this sort of Elaboration is not coordinating. As for (2d–d′), there is a difference in the interpretation of these two discourses; in the first, a discourse relation of either Elaboration or Explanation holds between the two clauses, whereas in the second it is almost as if we have some sort of a Contrast or Correction—that is, it was unexpected that the osso buco be good or the goodness of John's osso buco last night contrasts with someone else's bad experiences with the osso buco. The last example (2e) does not have an Explanation reading where Chris's pushing explains John's falling—in contrast to what happens if the *and* is removed (Bar-Lev and Palacas, 1980; Blakemore and Carston, this volume). Consequently, Txurruka's test suggests here that Explanation is subordinating.

However, there are some examples that appear to cause some difficulty for Txurruka's test. Here is one due to Caroline Heycock:

(3) John fell, and it was Chris who pushed him.

Contrary to (2e), (3) exemplifies some sort of explanatory link between Chris's pushing John and John's falling, even though more is going on in this example. So here, the presence of *and* would imply that Explanation is coordinating.

There are three ways to defend Txurruka's test given contradictory examples such as (2d′) and (3): one is to revise it and to make the presence of *and* a defeasible test; the second, which is Txurruka's solution, is to relate the two clauses with some sort of coordinating relation (but not Explanation) and draw the explanatory link out as an entailment. Third, it may be that the presence of *and* coerces ordinarily subordinating relations into coordinating relations at least on this use. If we adopt this last defense, both (2d) and (2d′) could exemplify an Elaboration; the osso buco is part of what John ate, but the presence of the *and* coerces the relation into a coordinating one and gives it an additional contrastive or corrective meaning.

We shall not decide which way to interpret Txurruka's test here, because in any case by itself it is at best a partial indication of whether a relation is coordinating or subordinating. Especially if we follow a story about *and* as coercing coordination, we need another means for determining in the absence of *and* whether a discourse relation is subordinating or coordinating. It is to such a means that we now turn.

4. Four proposed linguistic tests

Our proposal to distinguish coordinating and subordinating follows the strategy of Dowty (1986) concerning thematic roles. We isolate below several criteria or tests for

subordinating versus coordinating relations. Given that Narration is the prototype of a coordinating relation and Elaboration that of subordinating ones, we show that these criteria are coherent in that these two relations satisfy all of the criteria for coordinating relations or none of them. We will then use these criteria to give an implicit definition of subordinating and coordinating relations. The next task will then be to put other relations to these tests.

These tests all locate the concepts of subordinating and coordinating discourse relations at the level of information packaging. These concepts thus affect how discourse update proceeds at the representational level and various processes like anaphora resolution that depend upon the particular way the representation of the discourse has developed.

In the first three criteria, we try to test the type of a relation R_1, assuming that (i) we have two constituents, labeled with α and β for which $R_1(\alpha, \beta)$ is already established and (ii) we are now considering the possible extensions with a next constituent γ. The first test has to do with the attachment of possible γ and the right frontier constraint of SDRT:

- **Test 1**
  If you can attach some γ to α, then R_1 is Subord. If you can attach only to β, R_1 is Coord.

This test is useful but not always conclusive, since we don't always have hard and fast criteria for knowing when one is attaching to α and when not. However, one can have intuitions about what is in the scope of a particular discourse relation, intuitions related to all four general features underlying the notion of discourse hierarchization mentioned above. Some of these intuitions are correctly accounted for by SDRS construction mechanisms. For example in (1), it is clear that the information about the dancing competition should not attach to material elaborating the meal, but to the meal as the next part of the nice evening out. The triggering rules and semantics of Elaboration,[5] together with the CDP principle, imply these observations. The SDRS graph for (1) is shown in Fig. 3 (the graph in Fig. 2 did correctly show how SDRT deals with complex segments).

Applying Test 1, α is here π_b, the label for (1b), β is π_d for (1d), γ is π_e for (1e) and R_1 is the (implicit) arc connecting π_b to π_d. This test thus shows that R_1, that is, Elaboration, is subordinating. On the other hand, we can see that if we continue (1a–e) with something like (1f), trying to attach back to the meal after the dancing competition, we wouldn't be able to do it—clearly indicating that the relation Narration between π_b and π_e is coordinating.

When the relation between γ and its attachment point is lexically marked in γ, the semantics of this relation may rule out some possible attachment points, so that the test may easily apply. In (4), an example taken from (Knott et al., 2001), the connective *however* is a

[5] We will not discuss here the "triggering rules" or the semantics of various discourse relations; many SDRT articles have previously dealt with this (see, e.g., Lascarides and Asher, 1993; Asher et al., 1995).

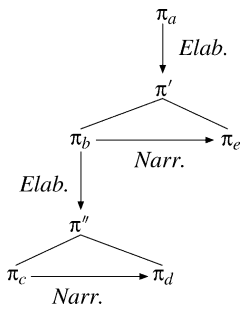

Fig. 3. Graph of the SDRS of example (1).

marker of the Contrast relation (Concession in RST's terms) and this relation requires an opposition in the propositional content of the two constituents (Asher, 1993), which we find only if we attach (4c) to (4a):

(4) a. Arts-and-Crafts jewels tend to be elaborate.
b. They are often mass-produced.
b′. Ornateness was the fashion at the turn of the century.
c. However, this jewel is simple in form.

Test 1 applied on this example shows us that the relation between (4a) and (4b), Description-Continuation,[6] is coordinating while the relation between (4a) and (4b′) Explanation, is subordinating. Indeed, the content of (4c) forces us to attach it to (4a), and (4a,b,c) is incoherent while (4a,b′,c) is coherent.

Test 1 also confirms that other relations like Commentary are subordinating: we can have several commentaries that bear upon the same event as in (5). This would not be possible according to the constraints in SDRT if Commentary were a coordinating relation.

(5) The Fed today lowered the prime interest again today for the third time in a month. Most economists greeted this with skepticism. Wall Street also displayed a lack of confidence, as stocks moved broadly lower. The President, however, remained optimistic that this would turn the economy around.

A variant of Test 1 exploits SDRT's construction of complex constituents and is therefore related to the Continuing Discourse Patterns principle, as well as to the definitions of coordinating and subordinating relations proposed in (Busquets et al., 2001) and described in the previous section. It is also related to van Kuppevelt's criterion about topic alteration and subtopic.

[6] Knott and al. called this relation ''Object-attribute Elaboration'', but we would rather distinguish it as some kind of Continuation rather than an Elaboration since both constituents play a similar role and could be swapped. We suggest thus to introduce a new relation of ''Description-Continuation''.

- **Test 2**
  Assume $R_1(\alpha, \beta) \wedge R_2(\beta, \gamma)$ with R_2 some kind of Continuation relation and $\neg R_2(\alpha, \beta)$. Exploiting the structural semantics of Continuation (cf. Section 2), and a version of CDP strengthened with SDRT's version of the right-frontier constraint, we can infer that R_1 is Subord. Conversely, if one cannot introduce information γ that "continues" β in its relation to α, then R_1 is Coord.

Again, the example (1) when used in conjunction with this test shows that Elaboration is subordinating, whereas Narration is coordinating.

This test is particularly useful, because it forces us to focus on a possible theoretical complication with the introduction of constructed topics. As mentioned above, some coordinating relations require a dominating "topic" constituent. Narration, for example, is of this kind, and the relation Description-Continuation introduced above for (4), too. Then, we can have a continuation of β, while attaching γ to the constructed topic and not to α. For instance, we have just seen that Test 1 tells us that Description-Continuation is coordinating and yet, we can continue (4a–b) with the following:

(4c′) They are often found in non-expensive jewelry shops.

This would yield the following structure:[7]

The important difference here is whether β and γ form a complex constituent that will attach to α, as hypothesized in Test 2 (by assuming that $R_2(\alpha, \beta)$ does not hold), or whether the three of them, α, β and γ are all immediate parts of a single, complex constituent (labeled π' in Fig. 4), dominated by a constructed topic constituent (π_{top} in Fig. 4).

Besides the obvious and much discussed question whether all coordinating relations require a topic or not—to which we tentatively answer "yes" here, this discussion raises another and less obvious question: Should we accept for any coordinating relation R_1, an associated coordinating and topic-requiring relation "R_1-Continuation", which would allow us to introduce a complex constituent constituted of β and γ and substitute it for β, along with a "topic" δ dominating the complex constituent, whose

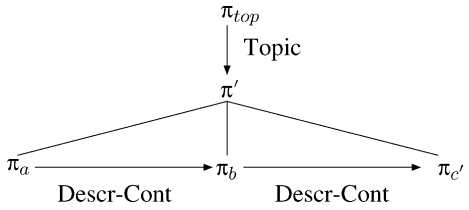

Fig. 4. Graph of the SDRS of example (4abc′).

[7] One important fact to note is that when $R(\alpha, \beta)$ requires a topic which is not already available in the structure, SDRT inserts a constructed topic by substituting α in the structure with the new constructed topic node along with the new complex SDRS constituted of α and β it dominates. In this figure, π' labels the complex SDRS constituted of π_a, π_b and π_c, while π_{top} labels the constructed topic constituent whose propositional content may correspond to *Description of Arts-and-Crafts jewels*.

content would amount to something like *That which is* R_1 *to* α? If the answer to this question is ''yes'', it would appear that we could turn any coordinating relation into one that was equivalent to a subordinating relation. For instance, these two structures, one in which R_1 is coordinating and one where it is not appear to be equivalent:[8]

Yet, they are not. For one thing, Test 1 can check whether α is open for attachment or not, which is false on the first structure and true on the second. Further, the accessibility from γ to referents in α also distinguishes between these structures; accessibility from γ to referents in α holds in the second structure but not in the first. We build in this test for accessibility into our third test for subordinating and coordinating relations below. Nevertheless, the mere possibility of having a relation like ''R_1-Continuation'' and a structure such as the first in Fig. 5 would preclude the use of Test 2 to conclude that a relation R_1 is subordinating—a problem that we'll consider again in the next section.

- **Test 3**
  Assume as before $R_1(\alpha, \beta)$. If for any γ attached to β no pronominal element in γ can be bound by referents in α, then R_1 is Coord. If some can, then it means R_1 is Subord.[9]

As with the other tests, we can use this test on variants of example (1), for instance (1a,b,c,d,f′), to show that Narration is coordinating.

Here too topic construction may render this test hard to apply. Suppose R_1 is coordinating and introduces a topic δ dominating α and β (as on Fig. 5). If the topic δ contains α's referents, which is not an unlikely case, then these are accessible from γ. Whether we attach γ to β by a subordinating or coordinating relation, δ's referents are accessible from γ: in the latter, coordinating case, by CDP, δ is a topic for γ as well.

A last test exploits SDRT's hypothesis that one cannot have a relation between two constituents that is subordinating as well as one that is coordinating.

- **Test 4**
  Use the fact that Narration is the Coord prototype to test compatibility with it: if $R(\alpha, \beta)$ and $Narration(\alpha, \beta)$ then R is Coord.

This test serves to pick out coordinating relations, though it would also work with subordinating relations, substituting Elaboration for Narration in its statement. For instance, Elaboration and Instance go together (Olman, 1998), proving that Instance is subordinating. Other applications of Test 4 include:

(6) I poured the liquid in and the mixture exploded.

which is an instance of Narration + Result and shows that Result is coordinating.

[8] It might be useful to recall here that standard SDRT allows complex SDRS as second argument of subordinating, but not coordinating, relations.

[9] There may be exceptions to the accessibility rule: definite descriptions, proper names and use of structural relations, and probably also an overriding rule like ''last constituent's referents are always accessible'' (even after a discourse pop), but these exceptions are not really a problem for this test.

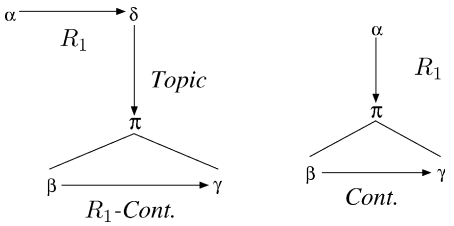

Fig. 5. Using Topic with Coord relations.

5. Looking at two relations in more detail: explanation and result

So far we have looked primarily at Elaboration and Narration, though we have also shown how our tests help classify other relations. We turn now to looking at two of them in some detail, Explanation and Result. One might think that these two relations are dual in the sense that Explanation $(\alpha, \beta) \leftrightarrow \text{Result}(\beta, \alpha)$. But actually, matters are more complicated. Using our tests on Explanation in (7), we get a corroboration of what Txurruka's test implies for Explanation with (2e):

(7) A: What happened?
B: A man decked while climbing a really difficult climb$_i$ (π_1). He didn't set a cam properly (π_2), and it failed to hold when he fell above the crux$_i$ (π_3). He broke his leg (π_4).

Intuitions dictate that (π_4) should attach to (π_1) with Result,[10] while (π_2) and (π_3) constitute the Explanation of why the man fell. But by Test 1, we can attach (π_4) to (π_1) only if Explanation is subordinating. Further, the definite description in (π_3) is anaphoric; the crux is the crux of the climb mentioned in (π_1). So this anaphoric link is only possible, according to Test 3, if the relation between (π_1) and (π_2) is subordinating. Test 2 also applies because we have a sort of continuation relation between (π_2) and (π_3), and indeed, provided we specify the value of the pronoun in (π_3), we get Explanation between (π_1) and (π_3). Further, discourse particles forcing Narration (such as *then*) in (π_2) make the text incoherent, and we do not seem to have any occurrences of Explanation with Narration; the incompatible temporal consequences of the semantics of these relations predicts this. Therefore, Test 4 also concurs that Explanation is subordinating.

Result poses some intriguing contrasts with Elaboration and Explanation. While Txurruka's test on example (2b), as well as Test 4 on (9), indicate that Result is coordinating, there are examples in which our tests, particularly Test 2, indicate that the relation is subordinating. For instance consider

[10] We leave out here details about the fine structure of (π_1) which would include a Background relation between the contents of the *while* clause and the main clause. See (Asher et al., 1995) for a discussion of such a relation.

(8) Lea screamed (π_1), and so the burglar ran away (π_2) but Max woke up(π_3). She also got a sore throat (π_4).

The coordinating construction between (π_2) and (π_3) suggests on at least one reading that we have a Continuation of the Results of Lea's scream. The presence of the particle *also* indicates that (π_4) continues the series of Results. Test 2 then implies that the Result relation here is subordinating, *despite* the use of *and*. But it seems that these results are due as much to punctuation and the clue words for Parallel and Contrast as anything else. A minimal change results in a coordinating structure as in the following example.

(9) Lea screamed (π_1), so the burglar ran away (π_2). Max woke up (π_3). She also got a sore throat (π_4).

It seems very difficult to continue the Result relation that obtains between (π_1) and (π_2) to (π_1) and (π_3) or (π_4), even though world knowledge and the Parallelism particle would suggest it. Rather we interpret Max's waking up as something that follows and is causally unrelated to the screaming and the burglar's running away. π_4 seems unconnected and threatens the coherence of the discourse. So by Test 2, Result is in this last example coordinating.

One worry for this hypothesis is that *Lea* serves as an antecedent to a pronoun in (π_4). Does this, with Test 3, entail that Result is then subordinating, and so that our tests diverge on example (9)? Not necessarily. This would only follow if the discourse referent associated with *Lea* were introduced in (π_1). But if we take seriously the presuppositions associated with proper names this won't happen. Contrast the example above with one in which an indefinite is used, as in (10). Indefinites, unless they are interpreted as specific indefinites, always introduce their associated discourse referents in ''the local constituent''. So in this case, we can be reasonably sure that the discourse reference introduced by *a woman* occurs in the universe of the DRS associated with π_1.

(10) A: What happened?
B: A woman screamed (π_1), so the burglar ran away (π_2). Max woke up (π_3). She also got a sore throat (π_4).

This discourse is even worse than (9). The anaphoric connection is forced, and indeed the whole discourse is threatened with incoherence. So Test 3 suggests that Result is coordinating, in contrast to example (7) with Explanation.

Abstracting from our discussion we conclude that Result is coordinating as a default. It may be subordinating, if punctuation, together with other clues like discourse particles that induce coordination like *but* and *and* force us to build a coordinated sequence of constituents all linked to another constituent via Result. In any case, it behaves quite differently from Explanation or Elaboration. What appears crucial to Result's role as a subordinating discourse relation is that using punctuation and other clues like discourse particles the author forces a Continuation between two constituents that both function as Results of a third. Another example of this phenomenon occurs below:

(11) Lea bought a new car (π_1). As a result, she'll be able to go to Mexico this Christmas (π_2), and she will get to work more quickly (π_3). It's a Subaru (π_4).

(11) strongly suggests that Result must be subordinating on this occasion. First, assuming that we have Result (π_1, π_2) due to the connective *as a result*, and that (π_3) continues (π_2), due to the presence of *and*, the temporal parallelism, punctuation and the frame adverbial, Test 2 shows that Result is subordinating. In addition, the *it* refers back to Lea's new car introduced in (π_1) and (common noun) discourse referents in (π_1) cannot be SDRT accessible from (π_4) unless Result is subordinating: we have to attach (π_4) to (π_1)—by Elaboration as dictated by intuition—which, with Test 1 requires again Result to be subordinating. Indeed, attaching to (π_3) is impossible as CDP would constrain (π_4) to be a Result of (π_1), which it isn't.

Suppose that we drop Test 2 and adopt instead the topic strategy evoked in the previous section, as an alternative analysis of the notion of continuation of a discourse relation. Result could be still a coordinating relation in this example, grouping the two effects of buying a new car under a topic of that name, as in the first structure on Fig. 5. But on such a structure, we cannot attach (π_4) to (π_1). The only way to account for the anaphora in (π_4) is then to suppose that the elaboration in (π_4) is an elaboration of the constructed topic—assuming that the topic constituent contains a discourse referent for the car. But that doesn't look right, since (π_4) elaborates on the sort of car that Lea bought, not on the effects of buying the car. So it appears that the topic strategy for coordinating relations cannot be equivalent to the supposition that Result is subordinating for this example. If this is right, then we have an argument that some relations like Result may be either coordinating or subordinating. This in fact makes some semantic sense too, since some causes can have complex effects that may itself take a complex representation to describe adequately. Future research will tell whether other relations have such a chameleon like quality. In any case, we should treat Test 4 with some diffidence until such further research confirms that Narration and Elaboration, as prototypes of coordinating and subordinating relations, are unable to change their usual behavior.

From the perspective of information content then, there is no intrinsic quality that subordinating relations share and that sets them apart from coordinating relations. Result, for instance, can be either coordinating or subordinating, depending on the surrounding context—although it appears to be coordinating by default, since it requires some specific punctuation patterns and discourse connectives to be subordinating. Elaboration, Explanation and Commentary are apparently always subordinating,[11] but they don't share any common semantic or information content properties that coordinating relations don't share. This confirms our hypothesis that relations aren't subordinating or coordinating in virtue of their content but rather in terms of how they are presented in the discourse. That the contribution of subordinating relations to discourse update differs from that for coordinating relations does not alter our argument; it still doesn't establish an intrinsic distinction between these types in terms of the contents of the particular relations that are

[11] Although further work is needed to conclude on the nature of the explanation in example (3).

either subordinating or coordinating. Whether a relation is subordinating or coordinating is, as Result shows, a matter of information packaging.

6. Applications to quantificational relations

From a discourse perspective, we can also glean some insight into the nature of quantificational relations and their related constituents. We can ask the question, for instance, whether DRT′s $\Rightarrow$ and monotone increasing quantifiers might be considered as subordinating discourse relations in view of attachment facts. Here, the semantics of these relations impose real constraints on attachment and anaphoric accessibility.

(12) a. Many divers went to Acapulco. They wanted to go diving.
b. If John goes diving, he'll bring his wetsuit.
c. Many divers bring their wetsuits.
d. It's not the case that if John goes diving, he'll bring his wetsuit.

Some of these examples show that the left term of $\Rightarrow$ is a site for further attachment, thus allowing us to conclude via Test 1 that they are subordinating relations. This is particularly true of (12b–d), where we get a clear attachment of the presupposition that John/the divers has/have a wetsuit to the *antecedent* of the conditional. The fact that this is possible shows that the antecedent remains an open attachment site (for attaching the presupposition) after the attachment of the consequent and so the conditional relation itself, $R_{\Rightarrow}$, called Consequence, is subordinating in SDRT in very particular circumstances—to wit, when the right term is a presupposition. Similar attachment facts hold of various quantifiers; presuppositions in the nuclear scope can attach to the restrictor via a conditional or universal quantificational relation (which are pretty much equivalent in DRT).

The interesting thing is that such attachments are only possible with presuppositional information. Quantificational and conditional relations only allow attachment of asserted information to their second term and only those discourse referents introduced in their second terms or nuclear scopes are sometimes accessible to pronouns in asserted information. For instance in (12a), we cannot get the reading that many divers want to go diving; we only get the interpretation that many divers went to Acapulco and *all of those* divers who went to Acapulco wanted to go diving, an interpretation which is to be explained by some sort of dynamic treatment of plural anaphora. Whether a quantificational or implicational relation is subordinating or not depends on what sort of material is to be attached. If it is presupposed information then if we assume that presupposed information is attached before the asserted material, it would appear by Test 1 that such relations are subordinating; but if it is asserted information, then Tests 1 and 2 imply that the relations are coordinating. So we see that the type of information to be attached with a given relation can also be a factor in coercing the relation to be either a subordinating or coordinating relation.

Let's consider an example, (12b). Here is what the presupposed and asserted components of (12b) look like:

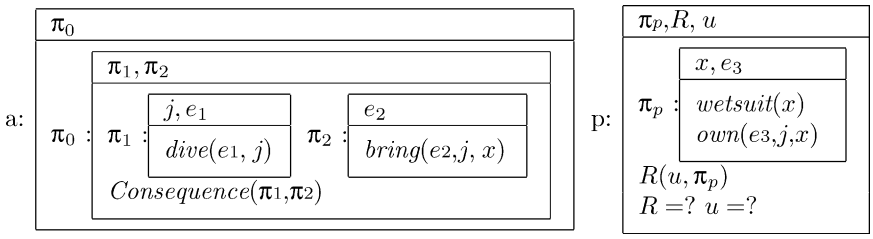

Fig. 6. SDRSs for asserted and presupposed components of example (12b).

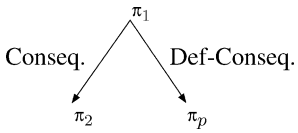

Fig. 7. Graph of the SDRS of example (12b).

After treatment of the presupposition (see Asher and Lascarides, 1998), we have the following structure (Fig. 6):

By treating the Consequence relation as subordinating at least for the purpose of treating presupposition information, we allow the attachment of the presupposition to the antecedent via Defeasible Consequence, and we get the appropriate interpretation of the presupposition—namely, that if John goes diving then normally he has a wetsuit. This in turn allows us to bind the variable x in (π_2) appropriately, if we make one other assumption. The availability of (π_p) referents from (π_2) in this structure is problematic unless we accord a special status to the condition Def-Consequence(π_1, π_p). This condition is itself presupposed as (12d) demonstrates, though this is not visible from the graph on Fig. 7. This means that the content of the presupposition, that if John goes diving, he has a wetsuit, combines together with the antecedent of the asserted conditional, so that that John goes diving *and* that John has a wetsuit are both connected to the consequent of the conditional (π_2), and this suffices to give the variable x in consequent of the asserted conditional a binding.

7. Conclusions

Our tests for subordinating or coordinating relations give a reasonably concrete and consistent picture of this distinction. Two tests, Test 1 and Test 3, are largely theory independent—Test 2 and Test 4 much less so. The former enable us to test instances of relations with respect to the very linguistic phenomena that motivated the theoretical distinction between coordinating and subordinating relations. The latter are perhaps more controversial, but as they embody different SDRT constraints based on the distinction, they might also be useful to test some SDRT hypotheses themselves and help to refine the theory.

Together, the tests give us in effect an implicit definition of these properties of relations at a token level. They provide a classification for the ''standard'' SDRT discourse relations, as well as others such as those proposed by Knott et al, which is coherent with the classifications proposed in earlier work. Our examination of relations has led us to a more context sensitive view of subordination and coordination in discourse: we've discovered that such a classification is only a default. Indeed, some relations like Result, Consequence, Def-Consequence, and relations generated by quantification, which are by default coordinating, can be coerced by a variety of means into subordinating relations on particular instances of use. One factor involved in coercion is the type of information to be attached, but punctuation, the presence of a coordinating conjunction like *and* and the use of the discourse relations Parallel and Contrast within subconstituents also are factors. Our Tests establish, not that a relation is always coordinating or subordinating, but that it is one or the other on that occasion of use. This leads us to the view that these properties are rather a matter of how relations are presented than a matter of their intrinsic semantics (at least in some cases), and that therefore a purely semantic approach as those based on criteria 1 and 4 of Section 3.2 is not appropriate. Distinguishing between coordinating and subordinating uses of discourse relations also leads to a solution of a puzzle in the theory of presuppositions, so this context sensitive notion of subordination may in fact be quite useful in the theory of discourse semantics.

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