What are Little Texts Made Of?
A Structural and Presuppositional Account Using Lexicalised TAG

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1 Introduction

In a series of recent papers (Cristea and Webber, 1997; Webber and Joshi, 1998; Webber et al., 1999a; Webber et al., 1999b), we have argued for starting the analysis of discourse in the same way as one starts the analysis of a clause, looking at how its syntax and semantics project from the lexicon. This is complementary to the issue of discourse pragmatics – how these small syntactic units of discourse are used in achieving communicative intentions – and to other discourse processes that provide additional organisational overlays on these units.

Intuitively, these small units of discourse correspond to multi-clause descriptions of entities, including individuals, sets, eventualities, situations, etc. These descriptions can involve both first-order and higher-order predicate-argument relations and modal operators, forming the content of communicative intentions.

A key feature of our analysis is that semantic discourse relations are associated with both syntactic structures and anaphoric links, and that the properties of the two are (not surprisingly) different. Together, they allow more complex semantics to be conveyed through simpler structure.

For English, we have given linguistic evidence for our analysis in terms of (a) the similar behavior of intra-sentential clausal connectives (i.e., subordinate conjunctions) and inter-sentential connectives (i.e., parallel structures cued by "Not only ... But also ...", "On the one hand, ... On the other hand, ...", etc.); (b) the similar behavior of "nominal parataxis" in English (i.e., noun-noun modifiers) and clausal parataxis; and (c) the ability of the analysis to explain the presence of multiple discourse connectives in a clause.

In contrast with Rhetorical Structure Theory (Mann and Thompson, 1988), what the current approach offers is a decoupling of discourse semantics from discourse syntax, rather than what is essentially a "semantic grammar" for discourse – i.e., one that merges syntactic-semantic patterns into a single description, with re-write rules such as

> *non-volitional_cause* :=
> *caused_situation causing_situation* |
> *causing_situation caused_situation*.

We have attempted to show that decoupling discourse syntax (however simple it may be) from discourse semantics allows one to better see how lexico-syntactic elements project discourse semantics, just as they project discourse syntax, and how discourse semantic relations arise (or are realised) through different means – in particular,

- through the structures and structure-building operations of a lexicalised grammar such as Lexicalised Tree-Adjoining Grammar (Joshi, 1987; Joshi and Vijay-Shanker, 1999);
- through particular lexical items, which we call *p-bearing*, that convey a semantic relation between the interpretation of the clause they are structurally part of and a propositional interpretation that is *anaphorically presupposed* (Van der Sandt, 1992), just as the referent of a pronoun or definite NP is anaphorically presupposed.[1]
- through inference based on world knowledge, usage conventions, etc., that makes defeasible contributions to discourse interpretation that go beyond the non-defeasible propositions otherwise contributed.[2]

[1]Presupposition has been implicated in other aspects of discourse connective interpretation, such as causal connectives presupposing defeasible causal rules (Knott, 1996; Lagerwerf, 1998), but we have not addressed these aspects in our work.

[2]Implicature also contributes to discourse interpretation, but as we have not yet come across any cases where implicature contributes additional semantic *relations* between propositional/clausal interpretations, we have not yet paid it much attention.

We only comment briefly in this paper on interactions among these elements, since we feel that there is still much that needs to be learned about them from empirical and experimental studies. However, our use of anaphoric presupposition in an account of discourse relations suggests a unified account of discourse connectives, tense (whose anaphoric nature has long been argued for – cf. Partee (1984) and Webber (1988) *inter alia*), modality (which Stone (1999) proposes to also treat anaphorically, parallel to tense), presuppositional determiners such as "other", "another", "similar", etc., and *focus particles* such as "even" and "only", which Stede has suggested can sometimes be used to convey the same meaning as a discourse connective, as in

(1) a. They laid waste to the park land.
    b. *Moreover*, they began cutting down trees.
    b'. They *even* began cutting down trees.

In this paper, we briefly set out our framework and illustrate it through two minimal pairs of examples that bring out its major features. We conclude with a suggested program of future work. The presentation draws heavily on (Webber et al., 1999b).

2 Framework

The approach uses the elementary trees of a Lexicalised Tree-Adjoining Grammar (LTAG) and LTAG operations (adjoining and substitution) to associate structure and semantics with a sequence of discourse clauses.

In a lexicalized TAG, each elementary tree has at least one anchor. In the case of discourse, the anchor for an elementary tree may be a lexical item, punctuation or a feature structure that is lexically null. The semantic contribution of a lexical anchor includes both what it presupposes and what it asserts (Stone and Doran, 1997; Stone, 1998; Stone and Webber, 1998). A feature structure anchor will either unify with a lexical item with compatible features (Knott and Mellish, 1996), yielding the previous case, or have an empty realisation, though one that maintains its semantic features.

The *initial* elementary trees used here correspond, by and large, to second-order predicate-argument structures – i.e., usually binary predicates on propositions or eventualities – while the *auxiliary* elementary trees provide further information (constraints) added through adjoining.

Importantly, we *bar* crossed structural dependencies: the branches of trees cannot cross. To see this, consider the parallel constructions anchored by feature-structures realisable as "On the one hand ... On the other hand ..." and "Not only ... But also ..." (Webber and Joshi, 1998; Webber et al., 1999a). The arguments to these constructions cannot cross, as the following example shows:

(2) a. On the one hand, John likes beans.
    b. Not only does he eat them for dinner.
    c. On the other hand, he's allergic to them.
    d. But he also eats them for breakfast.

Here, the "not only" construction begun in clause 2(b) seems incomplete, while clause 2(d) seems more easily interpreted with respect to clause (c) than the clause it is intended to complement – clause (b).

Thus one diagnostic for taking the argument to a predicate to be *anaphoric* rather than *structural* is whether it can derive from across a structural link. To see this, consider "then", which we take to be a *p-bearing* adverb that asserts that one eventuality (β) starts after the culmination of another (α), and that has only β (i.e., the interpretation of the clause it is adjoined to) coming structurally. The other argument is presupposed and thus can derived from an interpretation across a structural boundary, as in

(3) a. On the one hand, John loves Barolo.
    b. So he ordered three cases of the '97.
    c. On the other hand, he had to cancel the order
    d. because he *then* found that he was broke.

Here, the event that "then" asserts the "finding" event in (d) to follow is the ordering event in (b). This requires crossing the structural link in the parallel construction, confirming that this argument comes *non-structurally* through anaphoric presupposition.[3]

3 Examples

Now we illustrate briefly, using a pair of minimal pairs, how short discourses built from LTAG constituents get their semantics. The first pair (4a–4b) illustrates how minimally different texts get (approximately) the same interpretation, while the second pair (4c–4d) shows how the *p-bearing* element "for example" adds to the interpretation of both. For more detail, see (Webber and Joshi, 1998;

[3]The fact that the events deriving from (b) and (d) appear to have the same temporal relation in the absence of "then" just shows that tense is indeed anaphoric and has no trouble crossing structural boundaries either.

Webber et al., 1999a). For more information on compositional semantic operations on LTAG derivation trees, see (Joshi and Vijay-Shanker, 1999).

(4) a. You shouldn't trust John because he never returns what he borrows.

b. You shouldn't trust John. He never returns what he borrows.

c. You shouldn't trust John because, for example, he never returns what he borrows.

d. You shouldn't trust John. For example, he never returns what he borrows.

Here *A* will stand for the LTAG parse tree for "you shouldn't trust John" and α, its derivation tree. Similarly, *B* will stand for the LTAG parse tree for "he never returns what he borrows" and β, its derivation tree.

Example 4a involves an initial tree (γ) anchored by "because" (Figure 1). Its derived tree comes from *A* substituting at the left-hand substitution site of γ (index 1) and *B* at the right-hand substitution site (index 3). By virtue of the semantics of γ, the interpretation of the derived tree is that the situation associated with the argument indexed 3 (the interpretation of *B*) is the cause of that associated with the argument indexed 1 (the interpretation of *A*). (A more precise interpretation would distinguish between the direct and epistemic causality senses of "because", but the derivation would proceed in the same way. Following Lagerwerf (1998) and others, one might also say that γ carries the presupposition that the interpretation of the derived tree follows from a more general defeasible rule. But as this does not add to discourse connectivity, we have ignored this type of presupposition in our work.)

Example 4b employs an auxiliary tree (γ) anchored by "." (Figure 2). Its derived tree comes from *B* substituting at the right-hand substitution site (index 3) of γ, and γ adjoining at the root of *A* (index 0). Semantically, adjoining *B* to *A* via γ simply implies that *B* continues the description of the situation associated with *A*. The general inference that this stimulates leads to a defeasible contribution of causality between them, which can be denied without a contradiction – e.g.

(5) You shouldn't trust John. He never returns what he borrows. But that's not why you shouldn't trust him.

The second minimal pair of examples focusses on what an auxiliary tree anchored by the *p-bearing* element "for example" (δ) adds to the clauses in the first minimal pair. In Example 4c, δ adjoins at the root of *B* (Figure 3). Like "then", it contributes both a presupposition and an assertion: "for example" *presupposes* a shared set of eventualities, and *asserts* that the eventuality associated with the clause it adjoins to, is a member of that set. (For more detail, see (Webber et al., 1999b).) In Example 4c, the set does not come from the interpretation of *A* alone. Rather, it comes from a combination of *A* and "because" – that is, the set of causes/reasons for the situation associated with *A*. Thus, associated with the derivation of (4c) are the assertions that the situation associated with *B* is a cause for that associated with *A* and that the situation associated with *B* is one of a *set* of such causes.

Finally, Example 4d adds δ to the elements used in Example 4b. As in Example 4b, the causal relation between the interpretations of *B* and *A* comes defeasibly from general inference. Of interest though is what licences the presupposition of "for example" – i.e., the set of eventualities that the interpretation of *B* is asserted to be a member of. Again, it does not come from *A* alone. Rather it comes from *A* and the defeasible causal relation that is inferred to hold – i.e., the set of causes/reasons for *A*. For this to be the case, the defeasible causal relation must be available as part of the interpretation when the presupposition of "for example" is resolved. Thus the relation between defeasible inference and anaphoric presupposition, including the time course of the reasoning involved, seems worthy of further study.

4 Related Work

Recently, Asher and Lascarides (1999) have described a version of SDRT that incorporates the semantic contributions of both presuppositions and assertions. In this enriched version of SDRT, a proposition can be linked to the previous discourse via multiple rhetorical relations such as *background* and *defeasible consequence*, which may be inferred, explicitly asserted or presupposed. Despite this similarity with our approach, the two differ in significant ways:

- The current approach focusses on the relationship between discourse syntax and discourse semantics, and glosses over the mechanisms that are Asher and Lascarides' primary con-

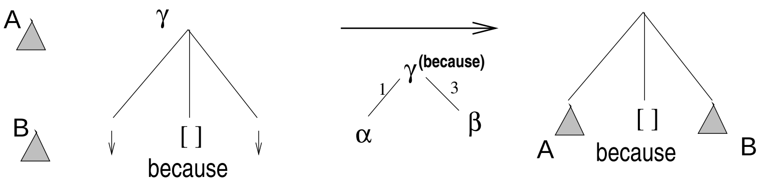

Figure 1: Derivation of Example 4a. The derivation tree is shown below the arrow, and the derived tree, to its right.

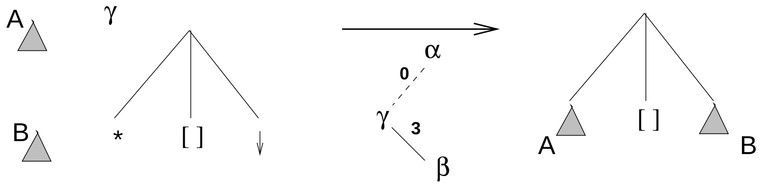

Figure 2: Derivation of Example 4b

cern, which involve the particular inferences that listeners draw. Our focus is on syntax, the ways in which discourse semantics resembles clausal semantics, and the way in which discourse syntax both facilitates and constrains discourse semantics.

- Asher and Lascarides take all connections (of both asserted and presupposed material) to be *structural attachments* through *rhetorical relations* to an evolving SDRT structure. The rhetorical relation may be inherent in the *p-bearing* element (as with “also”) or it may have to be inferred. The current approach does not make such demands: anaphoric links are not structural, and rhetorical relations (as some fixed set of predicates such as *background*, *narrative* etc.) do not drive the process. In the case of *p-bearing* elements, what drives the process is the need to ground the presupposed argument of whatever particular semantic relation the given *p-bearing* element conveys.
- Asher and Lascarides specify particular preferences on attachment sites (of either asserted or presupposed material), as well as constraints on attachment sites associated with the type of rhetorical relation involved. In the current approach, a structural connection can only be made if it doesn't lead to a crossing dependency, which essentially means a “right frontier” constraint on structural links. However, with presupposed arguments to *p-bearing* elements (as the case with pronominal and definite NP anaphora), we do not believe that enough is known yet about what propositions/eventualities a listener is attending to and how propositions/eventualities interfere with one another with respect to listener attention. So we have refrained from defining constraints and preferences on attachment sites until empirical studies provide relevant data.

5 Conclusion

In this paper, we have summarised arguments we have presented elsewhere for a level of discourse structure and semantics that uses all and only the same mechanisms that are already needed within the clause. In particular, we have invoked the notion of *anaphoric presupposition* (Van der Sandt, 1992) to explain how various discourse connectives get their interpretation. Since these presuppositions are licensed by eventualities taken to be shared knowledge, a good source of which is the interpretation of the discourse so far, anaphoric presupposition can be seen as carrying some of the burden of discourse connectivity and discourse semantics, in a way that avoids crossing dependencies.

There is, potentially, another benefit to factoring the sources of discourse semantics in this way: while cross-linguistically, inference and anaphoric presupposition are likely to behave similarly, structure (as in syntax) is likely to be more language specific. Thus a factored approach has a better chance of providing a cross-linguistic account of discourse than one that relies on a single premise.

We believe that systematic study, perhaps starting with the 350 “cue phrases” given in (Knott, 1996, Appendix A), will show which of them use presupposition in realising discourse relations. It is likely

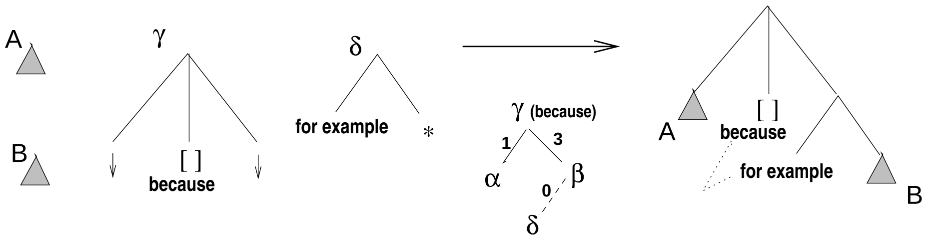

Figure 3: Derivation of Example 4c

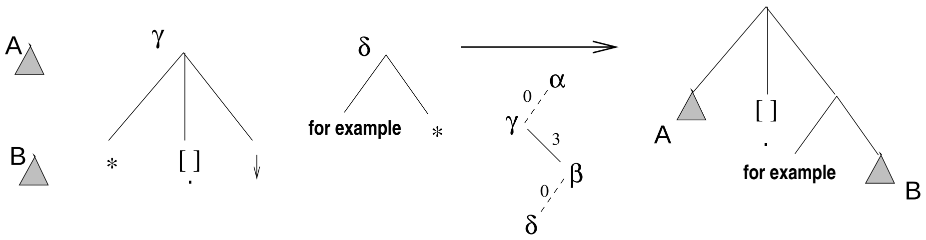

Figure 4: Derivation of Example 4d

that these might include:

- temporal conjunctions and adverbial connectives such as "when", "then", "later", "meanwhile", "afterwards", "beforehand"';
- adverbial connectives presupposing shared knowledge of a set, such as "for example", "first...second...", "for instance";
- adverbial connectives presupposing shared knowledge of an abstraction, such as "more specifically", "in particular";
- adverbial connectives presupposing a complementary modal context, such as "otherwise";
- adverbial connectives presupposing an alternative to the current eventuality, such as "instead" and "rather".[4]

For this study, one might be able to use the structure-crossing test given in Section 2 to distinguish a relation whose arguments are both given structurally from a relation which has one of its arguments presupposed. (Such a test won't distinguish *p-bearing* connectives such as "meanwhile" from non-relational adverbials such as "at dawn" and "tonight". So the latter will have to be excluded by other means.)

This is one of several directions in which results are needed. Others include

- achieving a precise semantics for connectives, as in the work of Grote (1998), Grote et al. (1997), Jayez and Rossari (1998) and Lagerwerf (1998).
- understanding the *attentional characteristics* of their presuppositions. In particular, preliminary study seems to suggest that different *p-bearing* elements may have different constraints on what can license them, where this source can be located, and what can act as distractors for such a source. This suggests a *corpus annotation* effort for (anaphoric) presuppositions, similar to ones already in progress on co-reference.
- determining whether the approach has practical benefit for NL understanding and/or generation.

But the work to date surely shows the benefit of an approach that begins the analysis of discourse in the same syntactic and semantic terms as one does for the clause.

[4]Gann Bierner, personal communication

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