Multiple Discourse Connectives in a Lexicalized Grammar for Discourse

Bonnie Webber (bonnie@dai.ed.ac.uk), Alistair Knott (alik@atlas.otago.ac.nz) and Aravind Joshi (joshi@linc.cis.upenn.edu)
University of Edinburgh, University of Otago and University of Pennsylvania

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Abstract. Approaches to discourse that directly compute the "discourse relation" that holds between adjacent units of text, have a problem with clauses that contain more than one discourse connective: the situation seems to allow such a clause to relate in more than one way to more than one other unit of text. We show how this is not a problem for an approach based on lexicalized grammar and a lexical semantics for discourse connectives. The result is an argument for syntax not stopping at the sentence boundary and for discourse not starting there.[1]

Keywords: Discourse, Semantics, Lexicalized Grammar

1. Introduction

Lexicalized grammars such as TAG (Joshi, 1987; XTAG-Group, 1998) and CCG (Steedman, 1996) have been very successful in showing how clause-level syntax and semantics project from the lexicon. What drives the current enterprise is the hypothesis that the same can be shown true, at some level, for discourse syntax and semantics. Here we demonstrate our initial effort to

- extend a lexicalized grammar (LTAG) to discourse;
- use the same compositional semantics on syntactic structure that is used in lexicalized grammars (Steedman, 1996; Joshi and Vijay-Shanker, 1999; Stone and Doran, 1997; Stone and Webber, 1998);
- extend to discourse connectives the idea that the meaning of a lexical element can involve an *anaphoric link* to the previous discourse;
- exploit similar inference mechanisms for defeasible aspects of both sentence-level and discourse semantics.

[1] The original paper that appeared in the **Proceedings of IWCS-3** (Webber et al., 1999a) has been updated in light of simplifications that have been realised through further work (Webber et al., 1999b; Webber et al., 1999c; Webber et al., 2000).

Our focus here is on discourse structure and discourse semantics (i.e., the meaning of a text independent of the speaker's use of it). In the long run, a complete account of discourse connectives must also address speaker *intentions* (i.e., the realm of discourse pragmatics). This is not only because many connectives have pragmatic force, but also because the process of recognizing discourse structure and semantics and that of recognizing speaker intentions are intimately intertwined, so that recognizing the former can inform recognition of the latter, and vice versa (Moore and Pollack, 1992). However, as discussions of modularity in the 1980's showed for syntax and semantics, this does not imply that one cannot distinguish the structures and computations used by each. So we take it as valid to develop an account of discourse structure and semantics, which can later be integrated with (or compiled into) an account of speaker intentions.

With respect to teminology, the *discourse connectives* of the title also go under such other names as *discourse markers* (Schiffrin, 1987), *clausal connectives* (Knott and Mellish, 1996), *discourse cues*, *cue phrases* (Knott, 1996) and *clue phrases* (Cohen, 1987). They comprise words and phrases whose use requires an on-going discourse (i.e., the presence of at least one clause other than that to which the connective is attached) and whose meaning involves (in part) that discourse.

The particular phenomenon considered here – clauses and sentences containing multiple discourse connectives such as

(1) Why don't we go to the National Gallery.
Then,for example, we can go to the White House.

(2) a. The car was finally coming toward him.
b. He finished his diagnostic tests,
c. feeling relief.
d. *But then* the car started to turn right.

has rarely received mention in the literature. The only previous mention of this phenomenon that we know of is in a workshop paper by Wiebe (1993), which uses example (2) to question the adequacy of a simple tree structure for discourse. Wiebe notes that the discourse connectives *but* and *then* appear to link clause 2(d) to two different things – "then" to clause 2(b) – i.e., the car starting to turn right occurring after the diagnostic tests have been finished – and "but" to clause 2(a) and possibly 2(c) – i.e., the car starting to turn right failing the expectation of its continuing in the same direction and being the awaited car. In Section 4, we will show that a simple tree structure does suffice for such examples, when coupled with a formulation of discourse connective semantics in terms of their anaphoric properties, as well as what they contribute compositionally.

The structure of the paper is as follows. In Section 2, we briefly describe the lexicalized tree-adjoining grammar (LTAG) for discourse that we use as a framework for discourse semantics.[1] In Section 3, we then sketch out the mechanisms used in associating semantics with a LTAG derivation. The semantics we assume for discourse connectives approximates the detailed analyses found in (Knott and Mellish, 1996), (Grote, 1998), (Jayez and Rossari, 1998a; Jayez and Rossari, 1998b), (Sanders, 1997), (Lagerwerf, 1998), (Grote et al., 1997), and (Degand, 1998). Our more cursory treatment reflects our focus on laying down an overall framework and showing in Section 4 that it affords a simple treatment of sentences containing multiple discourse connectives. We conclude with a summary of our main points and the evidence we have provided for them.

2. Elements of a Lexicalized TAG for Discourse

A lexicalized TAG begins with the notion of a lexical *anchor*, which can have one or more associated tree structures. For example, the verb *likes* anchors one tree corresponding to *John likes apples*, another corresponding to the topicalized *Apples John likes*, and a third corresponding to the passive *Apples are liked by John.* There is a tree for each minimal syntactic construction in which *likes* can appear, all sharing the same predicate-argument structure. This syntactic/semantic encapsulation is possible because of the extended domain of locality of LTAG.

A lexicalized TAG contains two kinds of elementary trees: *initial* trees that reflect basic functor-argument dependencies and *auxiliary* trees that introduce recursion and allow elementary trees to be modified and/or elaborated. Unlike the wide variety of trees needed at the clause level, we have so far found that extending a lexicalized TAG to discourse only requires a few elementary tree structures. This may be because clause-level syntax exploits structural variation in ways that discourse doesn't, but for now we leave the question for further investigation.

We start with the initial trees of the grammar. In the large Lexicalized TAG being developed in the XTAG project (XTAG-Group, 1998), subordinate clauses are seen as *adjuncts* to sentences or to verb phrases – i.e., as auxiliary trees – because the verb (as predicate) defines the

[1] A lexicalized TAG for generating both individual clauses and multi-clause discourse is presented in (Danlos, 1998), but its semantics ignores the anaphoric properties of connectives, which is central to the results presented here. There are other differences as well, including differences in what are taken to be initial and auxiliary trees.

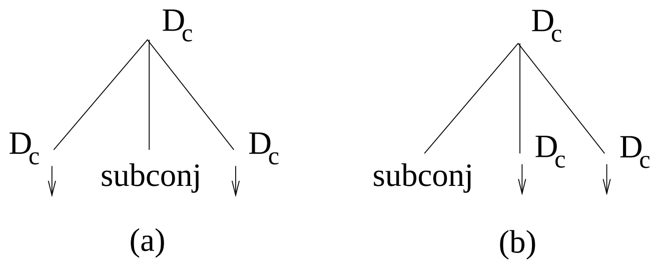

Figure 1. Initial trees (a-b) for a subordinate conjunction. Here, $\mathbf{D}_c$ stands for "discourse clause", ↓ indicates a substitution site, while "subconj" stands for the particular subordinate conjunction that anchors the tree.

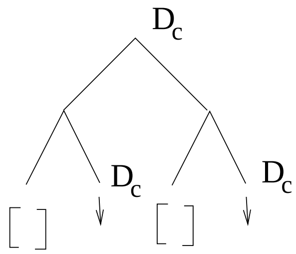

Figure 2. An initial tree for parallel constructions. [] stands for the feature structure that anchors the tree and which can be realised by any lexical item with a compatible feature structure.

domain of locality. From a discourse perspective, however, it is predicates on clausal arguments that define the domain of locality. Thus two clauses connected by a subordinate conjunction are more appropriately seen as forming an *initial tree* whose compositional semantics reflect the subordinate conjunction as predicate (or "functor") and the clauses as arguments. Figure 1 shows the initial trees for postposed subordinate clauses (a) and preposed subordinate clauses (b).[2] At both leaves and root is a *discourse clause* (D_c) – a clause or a structure composed of discourse clauses.

One reason for taking something to be an initial tree is that its local dependencies can be stretched long-distance. At the sentence-level, the dependency between *apples* and *likes* in *apples John likes* is localized in all the trees for *likes.* This dependency can be stretched long-distance, as in *Apples, Bill thinks John may like.* In discourse, local dependencies can be stretched long-distance as well – for example

[2] While Webber and Joshi (1998) discuss reasons for taking the lexical anchors of these initial trees to be, following the analysis in (Knott, 1996; Knott and Mellish, 1996), feature structures that may correspond to one or more subordinate conjunctions such as "if" and "when", here we just take them to be specific lexical items.

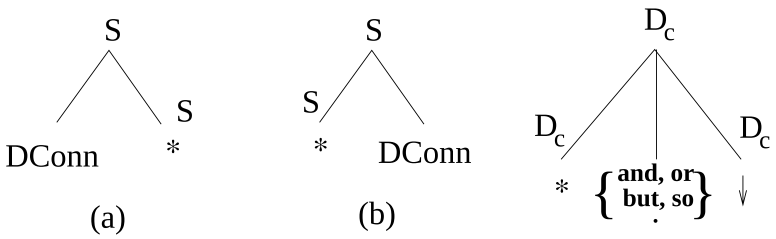

Figure 3. **Auxiliary Trees**. (a) and (b) are auxiliary trees for adverbial discourse connectives such as "then", "for example" and "otherwise", which serve to modify or constrain the relation holding between discourse units. The symbol $*$ indicates the *foot node* of an auxiliary tree, which has the same label as its root. (c) is the auxiliary tree for basic elaboration (continuation tree), anchored by punctuation or co-ordinate conjunctions such as *and*, *or*, *but* and *so*.

(3) a. Although John is very generous, he's a bugger to find.

b. Although John is very generous, *giving money to whoever asks him for it, when you actually need money*, he's a bugger to find.

Previously, (Cristea and Webber, 1997) showed that in discourse, the same long-distance stretching of local dependencies occurs with parallel constructions as well:

(4) a. On the one hand, John is very generous. On the other hand, he's a bugger to find.

b. On the one hand, John is very generous. *For example, suppose you needed some money. You would just have to ask for it.* On the other hand, he's a bugger to find.

Thus the grammar also contains initial trees for parallel constructions (Figure 2). Like some initial trees in XTAG (XTAG-Group, 1998), such trees have a *pair* of anchors. Since there are different ways in which discourse units can be parallel, we assume a different initial tree for *contrast* ("on the one hand" ... "on the other hand" ...), *disjunction* ("either" ... "or" ...), *addition* ("not only" ... "but also" ...), and *concession* ("admittedly" ... "but" ...). (Webber and Joshi, 1998) describe the distribution of anchors for these parallel structures and argue that it can be explained by treating the lexical anchors of initial trees as feature structures, following (Knott and Mellish, 1996), which can then unify with feature structures for discourse connectives.

Auxiliary trees are used in the grammar for constructions that provide more information. In particular, an auxiliary tree (Figure 3c) is

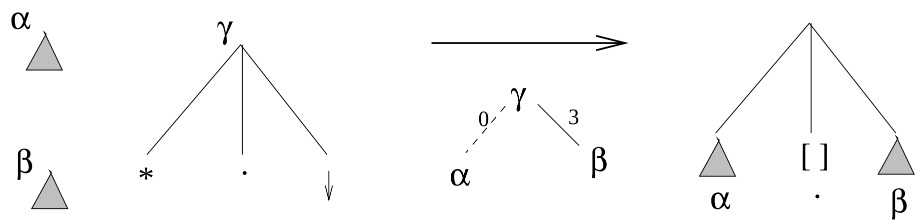

Figure 4. TAG derivation of Example 5

used to adjoin a discourse clause to a structure and continue the description of the situation that structure (partially) describes or the description of one or more of its specified entities (objects, events, situations, states, etc.)[3] For brevity, we simply call it a *continuation tree*. Continuation trees, anchored by punctuation (e.g. *period*, *comma*, *semi-colon*, etc.) or *and*, are used in the derivation of simple discourses such as:

(5) a. John went to the zoo.
b. He took his cell phone with him.

(6) Fred believes that John went to the zoo and that he took his cell phone with him.

Figure 4 shows the TAG derivation of Example 5. To the left of $\rightarrow$ are the elementary trees to be combined: α stands for the TAG tree for clause 5a, β, for clause 5b, and γ, for the continuation tree. In the derivation, the foot node of γ is adjoined to the root of α and its substitution site filled by β, to give the tree on the right of $\rightarrow$. (A standard way of indicating TAG derivations is shown under $\rightarrow$, where dashed lines indicate adjunction, and solid lines, substitution, with each line labelled by the Gorn number (address) of the argument at which the operation occurs.)

Finally, for adverbial discourse connectives, we follow the convention in XTAG (XTAG-Group, 1998) and treat them as simple auxiliary trees (Figure 3a-b) that can be adjoined to an initial tree or to a continuation tree, thereby contributing to how information conveyed by that tree relates to the previous discourse. We will see examples of this in the next section, and discuss how they contribute to discourse semantics.

[3] The latter use of an auxiliary tree is related to *dominant topic chaining* in (Scha and Polanyi, 1988) and *entity chains* in (Knott et al.,in press).

3. Semantic Mechanisms: Composition, Anaphora and Inference

Here we show that the mechanisms used at the clause level to associate a syntactic derivation with the logical form of its interpretation, also suffice for a discourse derivation:

- *semantic composition*, associated with the syntactic operations of adjunction and substitution (Joshi and Vijay-Shanker, this volume);
- *anaphoric links*, where resolving a discourse connective that has an anaphoric dependency enhances the coherence of the discourse and contributes additional elements to its interpretation;
- *inference*, that contributes additional, often only defeasible, assertions[4].

Our ideas on semantics have not yet developed to a state that would benefit from a precise and fully-specified representational system. Hence, our notation is rather informal. It assumes only that the meaning of a discourse clause can be represented as a *flat* set of propositions (as in the body of a Discourse Representation Structure (van Eijck and Kamp, 1997)), whose arguments select from a rich ontology of entities (Hobbs, 1985; Stone, 1998; Stone and Webber, 1998).

We begin with an account of the logical form of interpretations of simple sequences of clauses such as in Example 5. We then show how an adverbial discourse connective elaborates the minimal compositional semantics associated with a continuation tree. We close with a minimal pair of examples that illustrates the contrast between semantics derived simply through composition and that derived through a combination of composition and general inference.

We start with Example 5 (repeated here as Example 7) and its syntactic derivation (Figure 4). A similar sequence of clauses is found in Example 8, with a similar syntactic derivation.

(7) a. John went to the zoo.
b. He took his cell phone with him.

(8) a. Shall we go to Washington?
b. We can see the White House.

If we interpret clause 7a (the tree labelled α in Figure 4) as

[4] The contributions of general inference may appear to completely dominate the non-defeasible contribution of semantic composition, but the two must nevertheless be kept distinct, as we will demonstrate.

$\text{go}(\text{e}_1, \text{j}, \text{zoo}_1)$

where e_1 is the event of John going to the zoo, and clause 7b (the tree labelled β in Figure 4) as[5]:

$\text{take}(\text{e}_2, \text{j}, \text{cell\_phone}(\text{j}))$

the interpretation associated with the derived tree would be something like:

$\text{go}(\text{e}_1, \text{j}, \text{zoo}_1)$
$\text{take}(\text{e}_2, \text{j}, \text{cell\_phone}(\text{j}))$
$\text{e}_1 \subset \mathbf{s}$
$\text{e}_2 \subset \mathbf{s}$

That is, the semantic contribution of adjoining to α, the continuation tree γ with β at its substitution site, is that β continues the description of the situation described in α. This is indicated here simply as the denoted events e_1 and e_2 being part of ($\subset$) the same situation $\mathbf{s}$. We assume that nothing more comes compositionally from adjoining a continuation tree: everything else that this discourse conveys – e.g., the temporal overlap between events – comes defeasibly from general inference constrained by the tense and aspect of the relevant clauses.

Example 8 is similar – going to Washington and seeing the White House are considered to be part of the same situation. Nothing more than this comes compositionally from adjoining the instantiated continuation tree. From general inference, one might derive a temporal (and contingent) relation between these events – that the possibility of seeing the White House occurs in the *consequent state* (Moens and Steedman, 1988) of going to Washington, under the plausible assumption that the White House under discussion is the one in Washington[6].

We now consider a variation on this example, which includes the adverbial discourse connective *for example*. We take the logical form of this connective to be a two-place predicate whose first argument is a set of eventualities, whose second argument is an eventuality interpretation of the clause it is adjoined to, and whose interpretation is that its second argument is a member of its first.[7] We have argued elsewhere (Webber et al., 1999c; Webber et al., 2000) that adverbial connectives like *for example* are not structural as are subordinate conjunctions or the connectives that anchor the initial trees of parallel constructions. Rather, the first argument of such connectives is resolved anaphorically, either directly or through bridging.[8] Our variation on Example 8 is:

[5] ignoring here how the pronouns are resolved

[6] Russia has its own "White House" in Moscow.

[7] "For example" can also be used with noun phrasesn, but we focus here on its clausal use.

[8] Evidence for this comes, *inter alia*, from the fact that the first argument of these connectives can come from a relative clause in the same sentence – e.g.

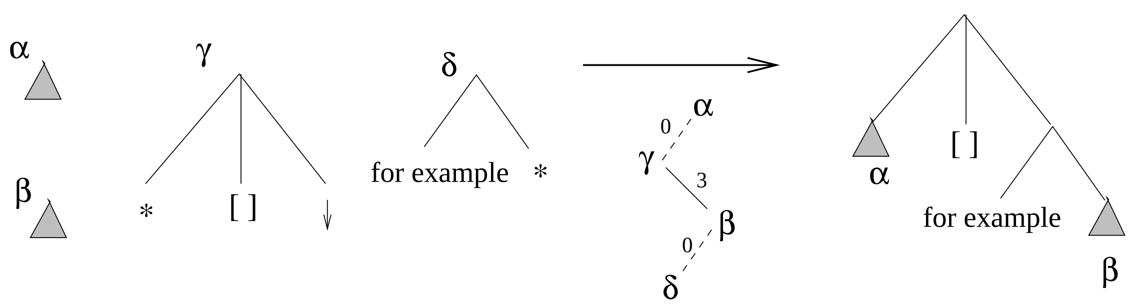

Figure 5. TAG derivation of Example (9)

(9) a. Shall we go to Washington.
  b. *For example*, we can see the White House.

with the syntactic derivation given in Figure 5.

Here, the second argument of *for example* is the interpretation of "we can see the White House" as an eventuality, say e_{wh}. Its first argument – the set of eventualities that it belongs to – derives anaphorically. From what? As already discussed, without *for example*, general inference sites e_{wh} as being in the *consequent state* of going to Washington – that of *being* in Washington. The relevant set of eventualities abstracts from e_{wh} with respect to this consequent state to the set of eventualities that being in Washington makes possible. That is, one example of eventualities made possible by being in Washington is seeing the White House.

We stress that the relation between the antecedent of the first argument of *for example* and the clause that *for example* adjoins to, is not structural. Although anaphors always have some *locality* within which an antecedent should be found and locality may be influenced by structure, an anaphoric link itself does not create any additional structure in the way that syntactic operations do.

Our final pair of examples shows that our approach can account for one additional feature of discourse connectives. Consider the minimal pair:

(10) a. I don't trust John.
  b. He's been known to cheat people.

(11) a. I don't trust John
  b. *because* he's been known to cheat people.

Both examples convey that (b) causes or explains (a), but do so in different ways. Underlying Example 11 is an initial tree anchored by

i. A person who seeks adventure might, for example, try sky-diving.
exactly as with a "donkey pronoun".

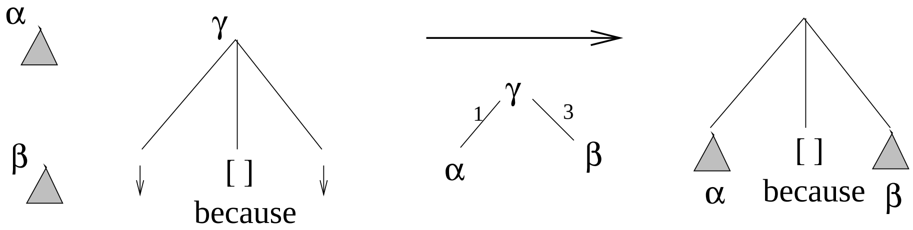

Figure 6. TAG derivation of Example 11

"because" (Figure 6), whose sense of causality/explanation is part of its compositional meaning. Example 10, on the other hand, involves a continuation structure (cf. Example 5, whose derivation is shown in Figure 4). Its compositional meaning is only that both clauses are true of the same situation. Its sense of causality or explanation comes from general inference, as described by, e.g., Hobbs et al. (1993) and Lascarides and Asher (1993).

This is the source of the difference between Examples (10) and (11): Compositional interpretations cannot be denied without a contradiction or correction, while inferred interpretations are *defeasible* and can thus be retracted. This can be seen by trying to continue each example with "But that isn't why I don't trust him." The extended version of Example (11) seems to contradict itself, while the extended version of Example (10), which involves inference, does not. Thus, to produce these desired results, the approach presented here based on a lexicalized grammar, is only part of a more extensive system that can interleave *hypothesizing* what elements to put together in a derivation, *deciding* how to resolve anaphor connectives, and *computing* appropriate inferences.

4. Multiple Discourse Connectives

So far the primary argument for our approach is greater *parsimony*: It does not require any machinery not already required for clause-level syntax and semantics. We now argue for its greater *power* as well, showing that it can handle cases involving multiple connectives, where an approach based on directly identifying the "discourse relation" that holds between clauses, simply fails.[9]

Consider the following pair of examples:

[9] Not all discourse clauses containing multiple discourse connectives cause problems for an approach that considers discourse relations to hold directly between clauses (cf. (Power et al., 1999)), which is why the kind of cases discussed here are so significant.

(12) Why don't we go to the National Gallery.
Then we can go to the White House.

(13) Why don't we go to the National Gallery.
Then, for example, we can go to the White House.

Example 12 contains the single discourse connective *then*, while Example 13 contains both *then* and *for example.* A discourse relation account would either have to say that *for example* is no longer a discourse connective, or it would have to postulate multiple discourse relations between the clauses. While Moore and Pollack (1992) cogently argue that both an *informational* (i.e., semantic) discourse relation and an *intentional* (i.e., pragmatic) relation may simultaneously and independently hold between two discourse clauses, in Example 13, two different *informational* relations appear to hold – in RST terms (Mann and Thompson, 1988), *exemplification* and *sequence.*

In our account, the semantics *for example* and *then* do most of the work. Like *for example*, *then* is taken to anchor an auxiliary tree and to have the logical form of a two-place relation whose first argument (a completed, i.e. *telic*, event) comes anaphorically from the prior discourse and whose second argument comes from the interpretation of the clause to which it is adjoined. Its interpretation is that the latter eventuality follows the telic event. In both Example (12) and (13), the first argument of *then* is the telic event associated with going to the National Gallery (that is, the completed going). In (13), the first argument of *for example* is *the set of possible worlds* compatible with that *consequent state*, a set that depends on the tense and modality of the first clause and the presence of *then* in the current one.

That this is the case can be seen by the fact that, without *then*, no anaphoric link makes sense, and the discourse is unacceptable.

(14) Why don't we go to the National Gallery.
#*For example*, we can go to the White House.

The anaphoric link also fails if the tense of the first clause is past:

(15) We went to the National Gallery.
?#*Then, for example*, we went to the White House.[10]

Example 16a shows that changing the order of *for example* and *then* yields a different interpretation: here, the first argument of *for example* derives from the first clause alone, with *then* (redundantly, because of the anaphoric nature of tense – cf. Example 16b) part of the description of the individual exemplar.

[10] This would only be acceptable with a different sense of "for example", meaning "among other things".

(16) a. There's many things we can see after the National Gallery. *For example*, *then* we can go to the White House.

b. There's many things we can see after the National Gallery. *For example*, we can go to the White House.

Note that our success in handling Example 13 does not depend on a particular sense of *then*. Similar examples occur with the atemporal sense of *then*, whose logical form is also a binary relation whose first argument – a situation – is given anaphorically and whose second argument – the interpretation of the clause it is adjoined to – is taken to be a consequence of this situation – e.g.

(17) You're bored?
Then why don't you go to the National Gallery.

When atemporal *then* co-occurs with *for example*

(18) You're bored?
Then why, *for example*, don't you go to the National Gallery.

the first argument of *for example* is linked anaphorically to the set of possible worlds that *then* makes available. Unlike Example 15, past tense here *does* support a set of possible worlds – ones that are counterfactual to the real course of events:

(19) You were bored?
Then why, *for example*, didn't you go to the National Gallery.

But this whole range of examples involving possible worlds clearly needs further thought.

Further examples (20a and 21a) show that the first argument of *for example* can also involve the meaning of adjacent discourse connectives *because* and *so*. Informally, the former provides evidence for a set of reasons, while the latter, for a set of consequences. Of interest for future study is that a similar set of reasons is available through the *inferred* causal connection between the clauses in Example 20b, while it is unclear whether a similar set of consequences is available through an inferred consequence connection in Example 21b.

(20) a. I don't trust John *because*, *for example*, he's been known to cheat people.

b. I don't trust John. *For example*, he's been known to cheat people.

(21) a. John has been known to cheat people. *So*, *for example* you shouldn't trust him with anything valuable.

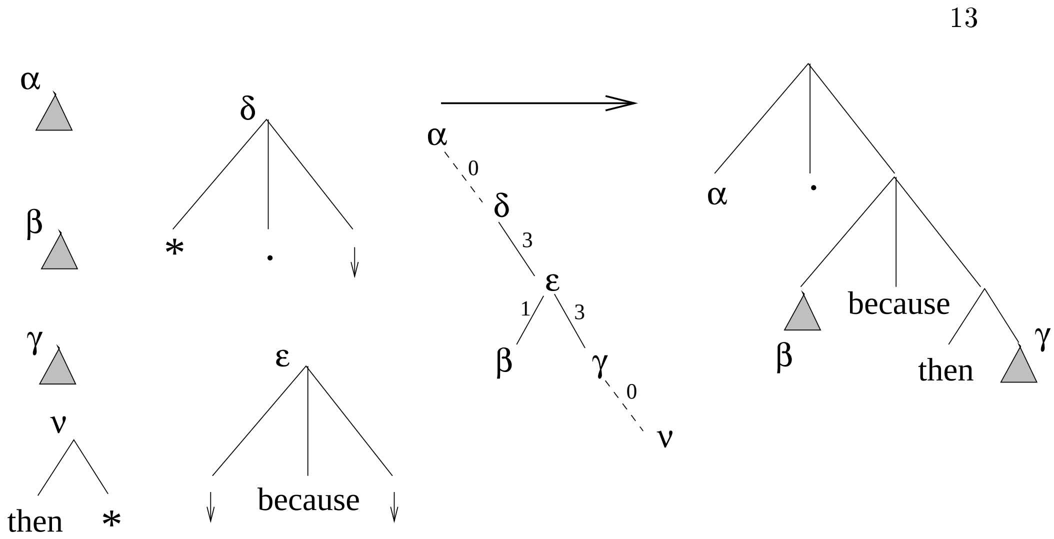

Figure 7. TAG derivation of Example 22

b. ?#John has been known to cheat people. *For example* you shouldn't trust him with anything valuable.

In future work we will attempt to provide an account of the range of inferred relations on which *for example* can piggy-back.

We conclude now with an example similar to Example (2), which Wiebe (1993) suggested might call into question the adequacy of a simple tree structure for discourse:

(22) a. John arrived from Turkey on Tuesday.
b. His mother didn't get a chance to talk with him
c. *because* he *then* left for Alaska.

Here the two discourse connectives ("because" and "then") link the interpretation of clause (c) to different things – "because" to clause (b) – i.e., his mother's not getting a chance to talk with him – and "then" to clause (a) – i.e., John's arriving from Turkey on Tuesday.[11] Our syntactic analysis of Example (22) is given in Figure 7. Corresponding to this analysis, the interpretation takes clause (22b) to continue the description of the situation (partially) described in (22a). Specifically, clause (22b) describes a state, and defeasible reasoning will take it to hold in the *consequent state* (Moens and Steedman, 1988) of the telic event described in clause (22a). The interpretation of the initial tree

[11] We choose not to analyse Wiebe's original example here because it requires discussion of what has been called *result-driven 'but'* and defeasible rules associated with causal connectives (Lakoff, 1971b; Lakoff, 1971a; Knott, 1996; Lagerwerf, 1998). This is complex material, and would distract from the simpler point we are trying to make in the current paper.

anchored by *because* into which clauses (22b) and (22c) substitute is that the eventuality described in (22c) is the reason for that described in (22b). The adjoined *then* connective adds that the event of leaving for Alaska comes after some anaphorically derivable telic event – in this case, John's arrival from Turkey (noted in 22a). But because this first argument of *then* derives anaphorically, it does not compromise the adequacy of tree structures for such examples.

5. Summary

We take the view that syntax makes similar contributions to discourse as it does to individual clauses: it specifies how predicate-argument structures and modifiers can be realized and guides the mechanisms involved in interpretation. As part of our argument for syntax not stopping at the sentence boundary and discourse not starting there, we showed that a lexicalized grammar could be extended in a principled way to discourse and that the same three semantic mechanisms used in clause-level grammar – composition, anaphoric links and general inference – suffice for discourse semantics as well. The specifics of a semantics (and semantic representation) adequate for both the interpretations sketched out here and the "full" lexical semantics of the discourse connectives that research has revealed, await proper formalization. But we believe that the paper and the approach can contribute to what we hope is a growing acceptance of a lexical approach to discourse parallel to the growing consensus on a lexical approach to sentence-level grammar and an end to the feeling that discourse is something outside mainstream syntax and semantics.

Acknowledgements

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References

Cohen, R.: 1987, 'Analyzing the Structure of Argumentative Discourse'. *Computational Linguistics* **13(1–2)**, 11–24.

Cristea, D. and B. Webber: 1997, 'Expectations in Incremental Discourse Processing'. In: *Proceedings of the 35th Annual Meeting of the Association for Computational Linguistics (ACL97/EACL97)*. Madrid, Spain, pp. 88–95.

Danlos, L.: 1998, 'G-TAG: un formalisme lexicalisé pour la génération de textes inspiré de TAG'. *Traitement Automatique des Langues - T.A.L* **39**(2). Available in English translation as 'G-TAG: a Formalism for Text Generation inspired by Tree Adjoining Grammar'.

Degand, L.: 1998, 'On Classifying Connectives and Coherence Relations'. In: *Coling/ACL Workshop on Discourse Relations and Discourse Markers*. Montreal, Canada, pp. 29–35.

Grote, B.: 1998, 'Representing Temporal Discourse Markers for Generation Purposes'. In: *Coling/ACL Workshop on Discourse Relations and Discourse Markers*. Montreal, Canada, pp. 22–28.

Grote, B., N. Lenke, and M. Stede: 1997, 'Ma(r)king concessions in English and German'. *Discourse Processes* **24(1)**, 87–118.

Hobbs, J.: 1985, 'Ontological Promiscuity'. In: *Proceedings of the 23rd Annual Meeting of the Association for Computational Linguistics*. Palo Alto, CA, pp. 61–69, Morgan Kaufmann.

Hobbs, J., M. Stickel, P. Martin, and D. Edwards: 1993, 'Interpretation as Abduction'. *Artificial Intelligence* pp. 69–142.

Jayez, J. and C. Rossari: 1998a, 'Pragmatic Connectives as Predicates'. In: P. Saint-Dizier (ed.): *Predicative Structures in Natural Language and Lexical Knowledge Bases*. Dordrecht: Kluwer Academic Press, pp. 306–340.

Jayez, J. and C. Rossari: 1998b, 'The Semantics of Pragmatic Connectives in TAG: The French *donc* example'. In: A. Abeillé and O. Rambow (eds.): *Proceedings of the TAG+4 Conference*. Stanford CA: CSLI Publications.

Joshi, A.: 1987, 'An Introduction to Tree Adjoining Grammar'. In: A. Manaster-Ramer (ed.): *Mathematics of Language*. Amsterdam: John Benjamins.

Joshi, A. and K. Vijay-Shanker: 1999, 'Compositional Semantics with Lexicalized Tree-Adjoining Grammar (LTAG): How much underspecification is necessary?'. In: *Proceedings of the Third International Workshop on Compuational Semantics*. Tilburg, Netherlands. Revised version appears in this volume.

Knott, A.: 1996, 'A Data-driven Methodology for Motivating a Set of Coherence Relations'. Ph.D. thesis, Department of Artificial Intelligence, University of Edinburgh.

Knott, A. and C. Mellish: 1996, 'A Feature-based Account of the Relations Signalled by Sentence and Clause Connectives'. *Language and Speech* **39(2-3)**, 143–183.

Knott, A., J. Oberlander, M. O'Donnell, and C. Mellish: in press, 'Beyond Elaboration: The interaction of relations and focus in coherent text'. In: T. Sanders, J. Schilperoord, and W. Spooren (eds.): *Text Representation: Linguistic and psycholinguistic aspects*. Benjamins.

Lagerwerf, L.: 1998, *Causal Connectives have Presuppositions*. The Hague, The Netherlands: Holland Academic Graphics. PhD Thesis, Catholic University of Brabant.

Lakoff, G.: 1971a, 'If's, and's and but's about conjunction'. In: C. Fillmore and T. Langedoen (eds.): *Studies in Linguistic Semantics*. Holt, Rinehart and Winston, pp. 114–149.

Lakoff, R.: 1971b, 'The role of deduction in grammar'. In: C. Fillmore and T. Langedoen (eds.): *Studies in Linguistic Semantics*. Holt, Rinehart and Winston, pp. 62–70.

Lascarides, A. and N. Asher: 1993, 'Temporal Interpretation, Discourse Relations and Commonsense Entailment'. *Linguistics and Philosophy* **16(5)**, 437–493.

Mann, W. and S. Thompson: 1988, 'Rhetorical Structure Theory: Toward a Functional Theory of Text Organization'. *Text* **8(3)**, 243–281.

Moens, M. and M. Steedman: 1988, 'Temporal ontology and temporal reference'. *Computational Linguistics* **14**, 15–28.

Moore, J. and M. Pollack: 1992, 'A problem for RST: The need for multi-level discouse analysis'. *Computational Linguistics* **18(4)**, 537–544.

Power, R., C. Doran, and D. Scott: 1999, 'Generating Embedded Discourse Markers from Rhetorical Structure'. In: *Proceedings of the Seventh European Workshop on Natural Language Generation*. Toulouse, France, pp. 30–38.

Sanders, T.: 1997, 'Semantic and Pragmatic Sources of Coherence'. *Discourse Processes* **24**, 119–148.

Scha, R. and L. Polanyi: 1988, 'An Augmented Context Free Grammar for Discourse'. In: *Proceedings of the* 12^{th} *International Conference on Computational Linguistics (COLING'88)*. Budapest, Hungary, pp. 573–577.

Schiffrin, D.: 1987, *Discourse Markers*. Cambridge: Cambridge University Press, second edition.

Steedman, M.: 1996, *Surface Structure and Interpretation*. Cambridge MA: Linguistic Inquiry Monograph 30, MIT Press.

Stone, M.: 1998, 'Logical Modularity for Disjunctive Logic Programs'. Submitted to LICS.

Stone, M. and C. Doran: 1997, 'Sentence Planning as Description Using Tree Adjoining Grammar'. In: *Proceedings of the* 35^{th} *Annual Meeting of the Association for Computational Linguistics (ACL97/EACL97)*. Madrid, Spain, pp. 198–205.

Stone, M. and B. Webber: 1998, 'Textual Economy through Closely Coupled Syntax and Semantics'. In: *Proceedings of the Ninth International Workshop on Natural Language Generation*. Niagara-on-the-Lake, Canada, pp. 178–187.

van Eijck, J. and H. Kamp: 1997, 'Representing Discourse in Context'. In: J. van Benthem and A. ter Meulen (eds.): *Handbook of Logic and Language*. Elsevier Science B.V., pp. 181–237.

Webber, B. and A. Joshi: 1998, 'Anchoring a Lexicalized Tree-Adjoining Grammar for Discourse'. In: *Coling/ACL Workshop on Discourse Relations and Discourse Markers*. Montreal, Canada, pp. 86–92.

Webber, B., A. Joshi, and A. Knott: November 2000, 'The Anaphoric Nature of certain Discourse Connectives'. In: *Semantics: from Lexeme to Discourse*. Groningen, The Netherlands.

Webber, B., A. Knott, and A. Joshi: 1999a, 'Multiple Discourse Connectives in a Lexicalized Grammar for Discourse'. In: *Third International Workshop on Computational Semantics*. Tilburg, The Netherlands, pp. 309–325.

Webber, B., A. Knott, M. Stone, and A. Joshi: 1999b, 'Discourse Relations: A Structural and Presuppositional Account using Lexicalised TAG'. In: *Proceedings of the* 36^{th} *Annual Meeting of the Association for Computational Linguistics*. College Park MD, pp. 41–48.

Webber, B., A. Knott, M. Stone, and A. Joshi: 1999c, 'What are Little Trees Made of: A Structural and Presuppositional Account using Lexicalised TAG'. In: *Proceedings of International Workshop on Levels of Representation in Discourse (LORID'99)*. Edinburgh, pp. 151–156.

Wiebe, J.: 1993, 'Issues in Linguistic Segmentation'. In: *Workshop on Intentionality and Structure in Discourse Relations, Association for Computational Linguistics*. Ohio StateUniversity, pp. 148–151.

XTAG-Group, T.: 1998, 'A Lexicalized Tree Adjoining Grammar for English'. Technical Report IRCS 98-18, University of Pennsylvania. See ftp://ftp.cis.upenn.edu/pub/ircs/98-18.