Modelling Discourse in STAG:
Subordinate Conjunctions and Attributing Phrases

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Abstract

We propose a new model in STAG syntax and semantics for subordinate conjunctions (SubConjs) and attributing phrases – attitude/reporting verbs (AVs; *believe*, *say*) and attributing prepositional phrase (APPs; *according to*). This model is discourse-oriented, and is based on the observation that SubConjs and AVs are not homogeneous categories. Indeed, previous work has shown that SubConjs can be divided into two classes according to their syntactic and semantic properties. Similarly, AVs have two different uses in discourse: *evidential* and *intentional*. While evidential AVs and APPs have strong semantic similarities, they do not appear in the same contexts when SubConjs are at play. Our proposition aims at representing these distinctions and capturing these various discourse-related interactions.

1 Introduction

A text as a whole must exhibit some coherence that makes it more than just a bag of sentences. This coherence hinges on the *discourse relations* (DRs), that express the articulations between the different pieces of information of the text. There is still debate about the number and the nature of DRs, yet typical DRs include *Contrast*, *Consequence* or *Explanation* (Asher and Lascarides, 2003). In this paper we consider that DRs are two-place predicates that structure the text at the discourse level (1a) but also at the sentence level (1b). In these two examples, the *Consequence* relation is *explicit*, i.e. lexically signalled, but a DR can also be *implicit*, i.e. semantically inferred. This is for instance the case when *therefore* is removed

from (1b) to produce (1c).[1]

(1) a. *Fred was ill*. <u>Therefore</u>, **he stayed home**.

    b. *Fred was ill*, **he** <u>therefore</u> **stayed home**.

    c. *Fred was ill*, **he stayed home**.

Therefore is a *discourse connective* (DC), a group of lexical elements whose function is to signal that a DR holds between two spans of text.[2] DCs can be of different syntactic categories; we are specifically concerned here with subordinate conjunctions (SubConjs). SubConjs are generally considered a homogeneous category although previous work such as (Haegeman, 2004) has shown they can be divided into two classes with distinctive syntactic and semantic properties. Such properties are the possibility or impossibility of cleft sentences illustrated in (2) or the difference of scope observed in (3).

(2) a. It is <u>when</u> **he was twenty** that *Fred went to Brazil*.

    b. #It is even though he really wanted to come that Fred stayed home.

(3) a. He did not come because he was hungry: he came because he was thirsty.

    b. #He did not come even though he still had work to do: he came even though he was tired.

In addition to SubConjs, we are interested in *attitude verbs* and *reporting verbs* (AVs) – verbs

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[1] Following the conventions of the PDTB (Prasad et al., 2007), we refer to the two arguments of DRs as Arg_1 and Arg_2 and use italics and bold face respectively to indicate the spans of text for each argument.

[2] There exist more complex markers constituting an open class, referred to as "AltLex" – "alternative lexicalization" (Prasad et al., 2010).

like *say* or *believe*, which describe an action or a state but also report the stance of an agent towards a given semantic proposition – and attributing prepositional phrases (APPs; e.g. *according to*). These have particular interactions with DCs in general and SubConjs in particular. Some of these phenomena could probably be correctly analysed with a purely semantic treatment of *at-issueness* inspired from (Potts, 2005) and (Scheffler, 2013). However, we think a proper treatment of the syntactic aspects as well requires a different formalism. The goal of this work is to model these various lexical elements in a Synchronous Tree Adjoining Grammar (STAG, (Shieber and Schabes, 1990)). Current models so far (see (Nesson and Shieber, 2006), or (Danlos, 2009) which focuses specifically on discourse analysis) do not incorporate most of the properties mentioned in this paper.

The paper is organised as follows. Section 2 presents relevant work related to DCs, AVs and some of their interactions. Section 3 exposes and summarises the properties we are aiming for with our model. Then, Section 4 describes our STAG proposition. Section 5 discusses this model and introduce a possible evolution.

2 Relevant Work

2.1 Non-Alignment of Syntactic and Discourse Arguments

According to a number of authors (see (Dinesh et al., 2005) for English and (Danlos, 2013) for French), in a sentence like (4a) the speaker intends to contrast her belief with the belief of Sabine; hence the inclusion of *Sabine thinks* in Arg_2. On the contrary, in (4b) the speaker does not intend to oppose her belief with the one of Sabine, but rather Fred's stay in Peru with his (alleged) absence of stay in Lima; hence the exclusion of *Sabine thinks* from the argument of the DR. In this last case, we observe that the (semantic/discourse) argument of the DR is included in but not equal to the propositional content of the (syntactic) argument of the DC.[3]

Such non-alignments of the syntactic and discourse arguments ("mismatches" in the following) often arise with *attitude verbs* and *reporting verbs* (AV): when an AV together with the clause it introduces is an argument of a DC, the AV may (4a)

or may not (4b) be included in the discourse argument of the corresponding DR. Following (Asher et al., 2006), we say the AV is *intentional* in the first case and *evidential* in the second. One can notice that an evidential AV is equivalent to the expression *according to Sabine*.

(4)   a. *Fred went to Peru* <u>although</u> **Sabine thinks he never left Europe**.

   b. *Fred went to Peru* <u>although</u> Sabine thinks **he has never been to Lima**.

It is interesting to note, as highlighted in (Hunter and Danlos, 2014), that contrarily to *although* not all DCs can be found with such mismatches. It is the case, for instance, of *because*, as illustrated in (5). (Hunter and Danlos, 2014), using the DR hierarchy of the PDTB, observes that a DC lexicalising a COMPARISON or an EXPANSION relation can often be found with a mismatch, whereas it seems impossible for a DC lexicalising a TEMPORAL or a CONTINGENCY relation.

(5)   a. *Fred could not come* <u>because</u> **he was not in town**.

   b. #Fred could not come because Sabine thinks he was not in town.

2.2 Two Types of Adverbial Clauses

An adverbial clause is a subordinate clause that functions as an adverb. It is the case of *after he ate* (temporal meaning) and *although he was starving* (concessive meaning) in (6).

(6)   a. *Fred left* <u>after</u> **he ate**.

   b. *Fred left* <u>although</u> **he was starving**.

Traditionally, adverbial clauses are considered a rather homogeneous syntactical category. But a particular distinction between two types of adverbial clauses is proposed by (Haegeman, 2004):

- on the one hand, the *central adverbial clauses* (CAC), which add an information (time, place, etc.) about the eventuality described in the matrix clause;

- on the other hand, the *peripheral adverbial clauses* (PAC), whose function is to structure the discourse (expressing a concession, providing background information, etc.).

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[3] Another argument for this distinction is that *Sabine thinks* can be felicitously removed from (4b) while it cannot from (4a).

In (7), *while he was a student* specifies the date, and *if it is sunny* expresses a necessary condition, of the event in their respective matrix clause; they both are CACs. In (8), *while Sabine has never left Europe* expresses a fact contrasting with, and *if it is sunny* justifies the interrogation in, their respective matrix clause; they both are PACs.

(7) a. *Fred went to Brazil* <u>while</u> **he was a student**.

    b. <u>If</u> **it is sunny**, *I'll go outside*.

(8) a. *Fred has been to Brazil* <u>whereas</u> **Sabine has never left Europe**.

    b. <u>If</u> **it is sunny**, *why aren't you playing outside?*

Several phenomena are studied in (Haegeman, 2004) – coordination, ellipsis, ambiguity, or phenomena related to scope, prosody, typography, etc. –, tending to show a greater integration of CACs into their matrix clause than PACs. Two of these phenomena are of particular interest for this work:

- "Main clause negation may scope over central adverbial clauses, but peripheral adverbial clauses cannot fall within the scope of a negative operator in an associated clause";

- "in addition to tense, other adverbial operators may also have scope over central adverbial clauses but they do not scope over peripheral adverbial clauses".

These two phenomena are illustrated in (9) – for negation – and (10) – for adverbs. These examples each present a pair of sentences with parallel construction: the first contains a CAC and the second a PAC. In line with (Haegeman, 2004)'s observation, the negation scopes over the whole sentence in (9a) while it only scopes over the matrix clause in (9b). Similarly, the adverb scopes over the whole sentence in (10a) while it only scopes over the matrix clause in (10b).

(9) a. *Fred did*n't *go to Brazil* <u>because</u> **he wanted to learn Portuguese** (but for another reason).

    b. *Fred has not been to Brazil* <u>whereas</u> **Sabine travels there often**.

(10) a. *Fred* often *wake up in the middle of the night* <u>because</u> **he is scared**.

    b. *Fred often takes the bus* <u>while</u> **Sabine prefers walking**.

It should also be noted that a CAC cannot contain an epistemic modal if it is *speaker-oriented* (as in (11a) but not in (11c) where *may* is mainly "John-oriented"), while a PAC can (see 11b). Expressed with the terms of (Hunter and Danlos, 2014): the syntactic and discourse arguments of a conjunction must be aligned in the case of a CAC, while there can be a mismatch with PACs.

(11) a. #Mary accepted the invitation without hesitation after John may have accepted it. [from (Haegeman, 2004)]

    b. *The ferry will be fairly cheap,* <u>while/whereas</u> **the plane** may/will probably **be too expensive**. [from (Haegeman, 2004)]

    c. *John is worried* <u>because</u> **he may be ill**.

In this paper, a SubConj introducing a CAC is called a *CConj* and a SubConj introducing a PAC is called a *PConj*. It is important to keep in mind that, as illustrated in (7b) and (8b), a same SubConj, depending on its meaning, can alternatively introduce a CAC or a PAC.

3   Desired Properties of the Model

Before exposing our STAG model, we list in this section the properties that we want to include. First, we want our model to be able to account for the possibilities (with PConjs) and impossibilities (with CConjs) of syntax-discourse mismatch presented in section 2.1. Then, as explained in section 2.2, the model should allow V-modifiers of a matrix clause – such as a negation or an adverb – to scope over a CAC but not over a PAC. Finally, two other interesting properties are presented in the following section, related to the scope of AVs and the meaning of attributing prepositional phrases (*according to NP*, *in NP's opinion*).

3.1   Scope of AVs

The scope ambiguity for V-modifiers described in (Haegeman, 2004) seems to also apply to some S-modifiers such as AVs. A sentence of the form *Sabine thinks A because B* can either mean that it is because of B that Sabine thinks A (narrow scope) or that Sabine thinks that A, that B and

the A-because-of-B relation (wide scope).[4] This generalises well to other CConjs, however things seem different for PConjs.

There has been a lot of discussion since Frege (Frege, 1948) about the semantics of a PConj such as *although*. Like a *presupposition*, the concessive meaning of *although* can project through *presupposition holes* (negation, epistemic modals, etc.), but it also projects through *presupposition plugs* such as AVs. Indeed, *although* is often cited as a *conventional implicature* trigger since (Grice, 1975), which are characterised in (Potts, 2005) with 4 properties: *noncancellability*, *not at-issueness*, *scopelessness* and *speaker-orientedness*. From these properties one can explain many of the observation in (Haegeman, 2004).[5]

It is also interesting to remark that there is a strong interpretation bias associated with PConjs like *although*: for instance, out of context, (12a) seems intuitively to imply that Fred was actually sick. Yet, saying that the Arg_2 of a *Concession* is never at-issue (i.e. that it cannot be targeted by any operator, like the concessive part of the meaning) would be taking shortcuts. Indeed, (12a) can be felicitously followed by (12b) even though it negates Arg_2. So in such a case, *he was sick* is under the semantic scope of *Sabine thinks*. That is why we believe such an utterance is ambiguous: the Arg_2 may (wide scope) or may not (narrow scope) be under the semantic scope of the AV; the latter being a default reading. Note that we do not relate this difference to a matter of centrality vs. peripherality; in both cases the lexicalised relation is the same speaker-oriented *Concession* and is not at-issue.

(12) a. Sabine thinks *Fred came to work* although **he was sick**.

    b. But she is wrong, he had recovered several days ago.

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[4]We are here implicitly dealing with the causal *because*, which introduces a CAC, whereas there also exists a pragmatic *because* as in *It has rained because the ground is wet*. Such pragmatic DCs are particular in many ways and even though we believe they introduce PACs, we won't consider them in detail here.

[5]One reviewer points out that *although* can be embedded under negation as in *Fred didn't leave ALTHOUGH Lucy arrived, but because of it*. We think that in such a case, the subordinate clause behaves as a central one and that *although* can be satisfactorily modelled with an ambiguity between PConj and CConj.

    c. Although **he was sick**, Sabine thinks *Fred came to work*.

Although we lack space to support this claim, we believe that those properties about at-issueness, speaker-orientedness and scope ambiguity are shared among PConjs. Even if PConjs are strongly biased towards the narrow scope reading, we still want our model to be able to handle both interpretations. Furthermore, the difference between them is not only a semantic one; only when the AV has narrow scope can the adverbial clause be anteposed (with no shift in meaning) as in (12c) – this applies to PConjs and CConjs equally.

3.2 Attributing Prepositional Phrases

In the context of this paper, we can consider that an evidential AV such as *Sabine thinks* is semantically equivalent to an attributing prepositional phrases (APP) such as *according to Sabine* (13a). It might then come as a surprise that APPs can felicitously be found with CConjs (13b), which otherwise do not accept evidential AVs. In fact, the situation is not symmetrical; with a CConj, the APP does not scope only over Arg_2 but also over the DR lexicalised by the CConj. (13b) is indeed semantically equivalent to (13c). We want our model to predict the correct semantics for sentences including an APP. Note that APPs are adverbials, and thus can also appear in clause-medial position (13d).[6]

(13) a. *Fred could not come* even though, according to Sabine, **he was really looking forward to it**.

    b. *Fred could not come* because, according to Sabine, **he was not in town**.

    c. Fred could not come and, according to Sabine, it is because he was not in town.

    d. *Fred could not come* even though **he was**, according to Sabine, **really looking forward to it**.

4 Our Proposition in STAG

We now turn to STAG and propose new structures for AVs and SubConjs, in addition to a slight vari-

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[6]We are aware that not all APPs are equivalent in terms of acceptability. In particular, some of our examples are more natural if *in X's opinion* is substituted for *according to X*. For the sake of simplicity, however, we have chosen to only use this latter expression.

ation of traditional phrase structures. These modifications reflect the properties described in the previous sections.

4.1 AVs and APPs

AVs – as other bridge verbs – are usually modelled in TAG as anchors of auxiliary trees that adjoin on the S-node of the clause they introduce (Joshi, 1987). Auxiliary trees for these verbs are motivated by long distance extractions as in *He is the man Paul believes [...] Ringo said Yoko loves*, where *NP believes/said* is similar to *according to NP* (see Fig. 1 for a model of APPs). However this equivalence seems unwarranted for intentional AVs: such a verb describes the state or action (of believing, of saying, etc.) that is the argument of the DR, the introduced clause being a central element of this eventuality but not the eventuality in itself. Intentional AVs, contrarily to evidential ones, do not appear as semantic modifier of the clause they introduce.
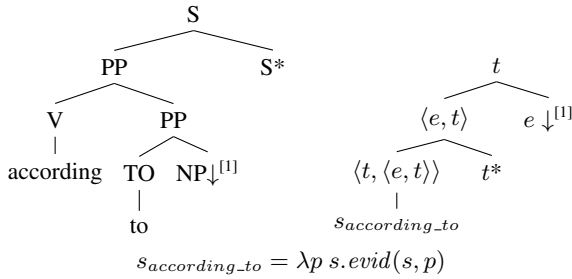
Figure 1: APP: $\beta_{\text{according to}}$ (the commas are omitted for readability)

Therefore, to take into account the two evidential and intentional uses of AVs, we propose an initial TAG pair (Fig. 2) in addition to the auxiliary one traditionally used (Fig. 3). In our model their semantics is also slightly different: evidential AVs use predicates – marked here without apostrophe unlike intentional predicates – that are "erased" when in a peripheral DR. This is achieved by introducing rewriting rules of the form:

$$Contrast(p, think(a, q)) \rightarrow Contrast(p, q)$$

Conversely, unnatural mismatches can be avoided by discarding any analysis displaying an evidential AV predicate as argument of a central DR:

$$Explanation(p, think(a, q)) \rightarrow \bot$$

Thanks to these rules, our model will be able to get the correct semantics and to account for the possibilities and impossibilities of mismatch.
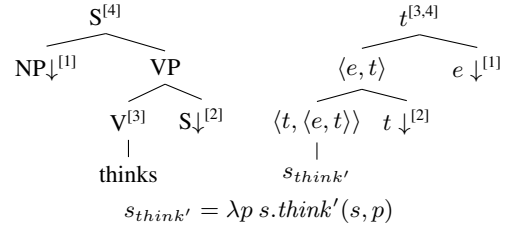
$$s_{think'} = \lambda p\, s.think'(s, p)$$

Figure 2: Intentional AV: α_{think}
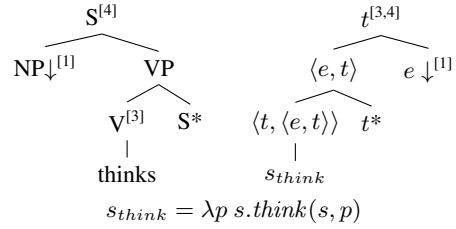
$$s_{think} = \lambda p\, s.think(s, p)$$

Figure 3: Evidential AV: β_{think}

4.2 Subordinate Conjunctions

In the same vein, the difference in syntax and semantics between CACs and PACs can be explained with different structures for CConjs and PConjs as in Fig. 4 and Fig. 5.[7] The syntax of all SubConjs is usually modelled homogeneously, be it with an auxiliary tree as in TAG (XTAG Research Group, 2001) or with an initial one as in D-LTAG (Webber, 2004), but this is not the case in our proposition. Because we model PConjs with a substitution node even for the left argument instead of the adjunction node of CConjs, we can assure that any modifier of the left argument (such as a negation) is only local and cannot scope over the whole $\text{Arg}_1 \wedge \text{Arg}_2 \wedge R(\text{Arg}_1, \text{Arg}_2)$ proposition, while this is possible with CConjs.

Also note that the link [3] for CConjs allows APPs such as *according to Sabine* in (13b) to scope over both the Arg_2 and the DR. With PConjs, the APP must adjoin on the right argument, which *a priori* would also be possible with CConjs but is in fact excluded by the semantic rule for evidentials within a central DR (an APP is considered as evidential). Not all S-modifiers should be allowed to adjoin on [3], in particular no AVs; a feature should then be used to restrict link [3] to natural adjunctions only.

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[7]The presence of the SBAR-node for CConjs is necessary because of the possibility of cleft sentences (*It is because A that B*), which shows that there exists such a constituent. No cleft sentences are observed with PConjs.
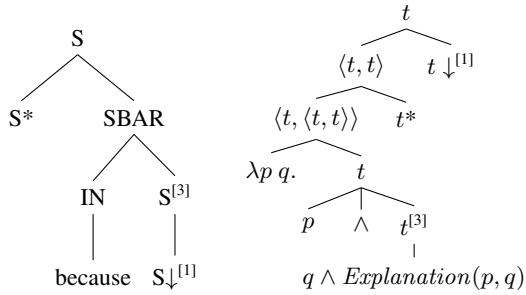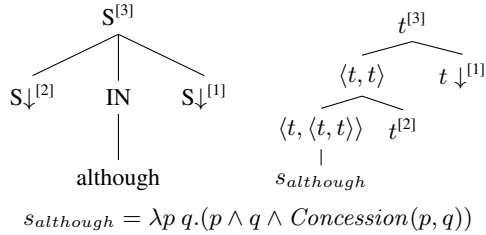
Figure 4: CConj: β_{because}

$$s_{although} = \lambda p\, q.(p \wedge q \wedge Concession(p,q))$$

Figure 5: PConj: α_{although}

Figure 6: A sentence structure; link [2] is restricted to AVs and APPs, other S-modifiers adjoin at [3].

Figure 7: The derivation trees for ¬*A CONJ B* with a CConj (left) or a PConj (right). Because in α_A links [1] and [3] are at the same semantic node, the left tree is a scope neutral representation yielding one syntactic tree but two semantic ones depending on the order of the adjunctions.

4.3 Sentence Structures

Following (Nesson and Shieber, 2006), we consider that sentence structures have two different adjunction sites in their semantic tree for V-modifiers (such as negation and adverbs) and S-modifiers (such as AVs). Because multiple adjunctions on the same node are allowed and are used to represent various scope ambiguities, doing so avoids (unnatural) interpretations of a V-modifier scoping over a S-modifier. However, CConjs are sentence modifiers like AVs but, as seen in the previous sections, they do present scope ambiguity when confronted with verbal modifiers such as negation. This is why, as illustrated in Fig. 6, we consider adding to sentence structures another adjunction site on the S-node (link [3]) whose semantic counterpart is at the same node as verbal modifiers' one. We can use features to restrict the other S-site (link [2]) to AVs and APPs, and conversely to force them to adjoin there.

Fig. 7 shows the derivations trees obtained from the adjunction of a negation (or any verbal modifier) on the matrix clause of a SubConj. Our model correctly predicts that the negation can have local *or* global scope in the case of a CConj, but only local scope in the case of a PConj.
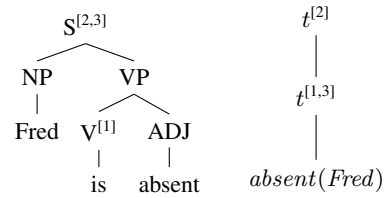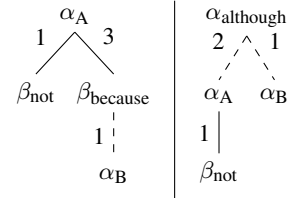
5 Discussion

5.1 Standard STAG

Tab. 1 shows the derivation trees for sentences of the form *A CONJ Sabine thinks B* as in (4). We lack space to display all the derived trees corresponding to this configuration, however Fig. 8 shows the trees obtained with a PConj and an evidential AV (top-right possibility in Tab. 1). The syntactic trees do not depend on the use (intentional or evidential) of the AV, whereas the semantic trees do, but only in the substitution of the evidential s_{think} term for the intentional $s_{think'}$ one. This slight difference, in addition to the semantic rules stated earlier, accounts for the correct semantic of these various interpretations and the exclusion of analyses where an evidential AV is an argument of a CConj. Remains for PConjs, however, an ambiguity that only the semantics of the various elements involved can solve.

Tab. 2 shows the derivation trees for sentences of the form *Sabine thinks A CONJ B*, that is with the AV in sentence-initial position as in (12a). In this configuration, *A CONJ B* may be an S-constituent introduced by the AV; the latter is not then part of the arguments of the relation lexicalised by CONJ and is called here "external". Note that in this case and without context, the in-

Table 1: Derivation trees for sentences of the form *A CONJ Sabine thinks B*.

	Intentional AV	Evidential AV
PConj:	$\alpha_{although}$ 2 / \ 1 α_A $\alpha_{Sabine\,thinks}$ 2 α_B	$\alpha_{although}$ 2 / \ 1 α_A α_B 2 $\beta_{Sabine\,thinks}$
CConj:	α_A 3 $\beta_{because}$ 1 $\alpha_{Sabine\,thinks}$ 2 α_B	

Figure 8: Result of the analyse of *A although Sabine thinks B* with an evidential AV.

Generated formula:
$$p \wedge think(Sabine, q) \wedge Concession(p, q)$$

tentional or evidential status of the AV is undetermined; we have chosen to use the traditional β_{thinks} pair. As before, this configuration presents ambiguities that can only be resolved with the help of the semantics of the particular DR.

Fig. 9 shows the two syntactic trees obtained in this configuration with the PConj *although*, depending on the role of the AV (on the top: intentional or evidential; at the bottom: external). Note that our model analyses the evidential case with a syntax-discourse mismatch on Arg_1. Indeed, in the top tree *Sabine thinks A* is the syntactic argument of *although*, whereas if the AV is evidential, only the propositional content of *A* constitutes the Arg_1 of *Concession*. This analysis is supported by the possibility of anteposition of the subordi-

nate clause in intentional and evidential cases illustrated in (12c): the anteposition of *although B* appears natural from the top tree and not from the bottom one.

Figure 9: Syntactic derived trees for sentences of the form *Sabine thinks A although B*. Note that with *although* (a PConj), the tree at the bottom corresponds to a less likely reading that must be forced by the context.

Finally, Fig. 10 shows the analyses for *A CONJ, according to Sabine, B*. Note how the additional link [3] in CConjs lead to a correct interpretation of (13b) where the APP scopes over both the DR and its Arg_2 as stated in section 3.2.

Figure 10: The derivation trees for *A CONJ, according to Sabine, B* with a CConj (left) or a PConj (right).

5.2 Towards Multi-Component TAG

We have proposed the link [3] in CConj (see Fig. 4) in order to handle modifiers such as APPs that are inserted between a CConj and the rest of the introduced clause while scoping over the DR and the Arg_2. However, we previously mentioned that such modifiers can also be found

	Intentional AV	Evidential AV	External AV
PConj:	$\alpha_{although}$ — 2 $\alpha_{Sabine\ thinks}$, 1 α_B; $\alpha_{Sabine\ thinks}$ — 2 α_A	$\alpha_{although}$ — 2 α_A, 1 α_B; α_A — 2 $\beta_{Sabine\ thinks}$	$\alpha_{although}$ — 3 $\beta_{Sabine\ thinks}$, 1 α_B; 2 α_A
CConj:	$\alpha_{Sabine\ thinks}$ — 2 α_A, 3 $\beta_{because}$; $\beta_{because}$ — 1 α_B		α_A — 2 $\beta_{Sabine\ thinks}$, 3 $\beta_{because}$; $\beta_{because}$ — 1 α_B

Table 2: Derivation trees for sentences of the form *Sabine thinks A CONJ B.*

in middle position with the same meaning as illustrated in (13d). This clearly poses a problem for our current approach, because an APP in middle position must adjoin on the right argument and thus cannot scope over the DR itself. It seems we can overcome this problem with the help of Multi-Component Tree Adjoining Grammars (MCTAG) in a fashion similar to what is done for noun phrases in (Nesson and Shieber, 2007). We won't give here a fully detailed MCTAG proposition, but rather sketch the main aspects of it.

Our idea is that when an S-constituent is the syntactic argument (be it left or right) of a Sub-Conj, its modifiers can have a local scope (i.e. within this constituent), or, in the case of a CConj, also a wider scope (which depends on whether the S-constituent is on the left or right of the CConj). These scope phenomena could be dealt with homogeneously by considering a two-component structure for the S-constituents as shown in Fig. 11. One component provides the content of the sentence while the other one – a vestigial (S*, t*) one – would serve the purpose of "pluging in" the correct node of the SubConj's semantic tree for subsequent adjunctions. Links [1,2] in Fig. 11 are for local scope and links [3,4] for (possibly) wider scope. Because of this multi-component structure, we probably don't need an adjunction site for the left argument of CConjs anymore, as they can be modelled with two substitution sites as shown in Fig. 12.

With such a model, sentences with a CAC containing a clause-initial APP like (13b) could be analysed as in Fig. 13. The derivation tree for sentences with clause-medial APP would be almost identical: the APP would adjoin on the link [3] of α_B instead of the link [4].
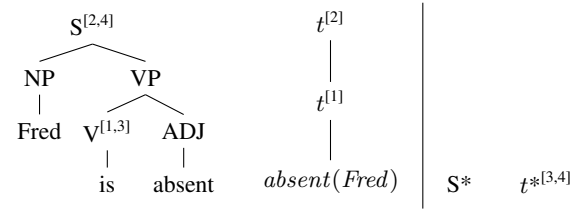

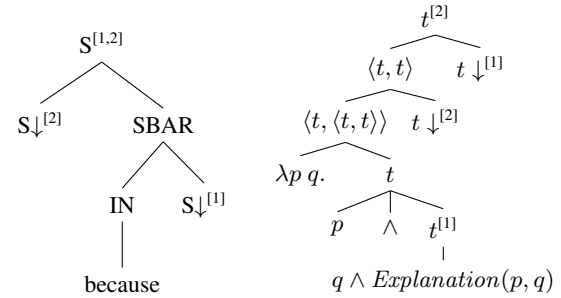Figure 11: A sketch of MCTAG structure for S-constituents.

Figure 12: A sketch of MCTAG structure for CConjs.

6 Conclusion

We have first recalled the notion of syntax-discourse mismatch and related it to the two intentional and evidential uses of AVs. Then, we have presented the distinction made in (Haegeman, 2004) between central and peripheral adverbial clauses. Additional syntactic and semantic phenomena were mentioned, which have motivated our STAG model. This model is enriched with new structures for AVs and SubConjs that reflect the distinctions and properties previously highlighted.

Yet, it is still too constrained regarding the relatively free position of attributing prepositional phrases. This lead us to consider the Multi-
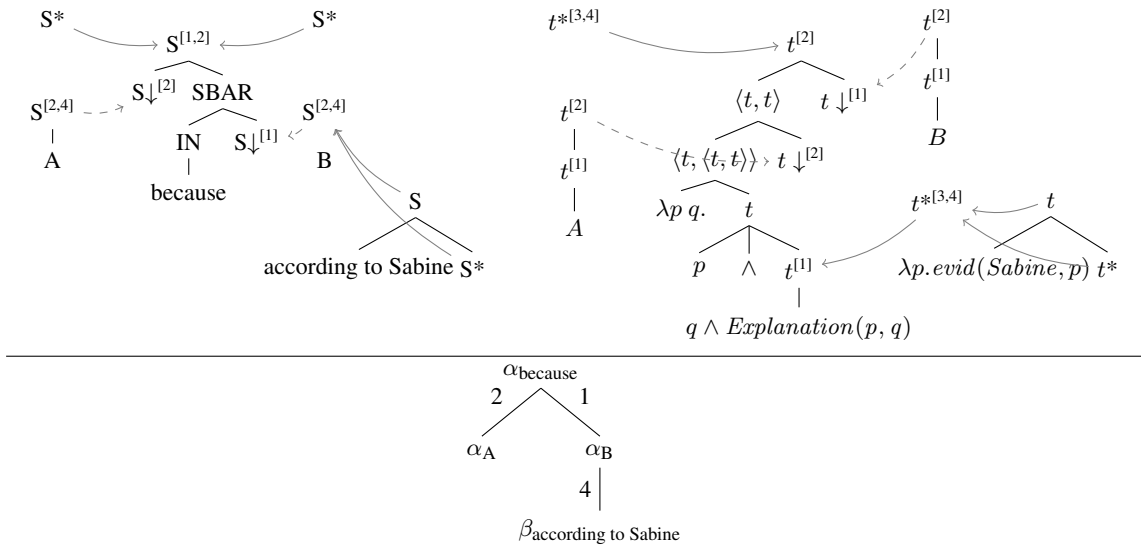
Figure 13: MCTAG analysis of sentences with a CAC containing a clause-initial APP like (13a).

Component TAG formalism, which we believe is more suitable for modelling fine-grained phenomena in discourse. Only a sketch of an MCTAG model is given here; we plan on developing these ideas in the future. Furthermore, projection properties not mentioned here will probably require us to refine our proposal, before extending our approach to the other categories of discourse connectives. Among them, adverbials are the most problematic; their ability to be integrated inside one of their argument has lead previous TAG-based accounts – namely D-LTAG (Webber, 2004) and D-STAG (Danlos, 2009) – to resort to a complex parsing process with an intermediate step. While more recent work has been successful in getting rid of this additional step in an elegant way (Danlos et al., 2016), it requires a substantial change in formalism (the use of *Abstract Categorial Grammars* (de Groote, 2001)). Further investigation with MCTAG may confirm whether such a change is necessary.

References

N. Asher and A. Lascarides. 2003. *Logics of Conversation*. Cambridge University Press.

N. Asher, J. Hunter, P. Denis, and B. Reese. 2006. Evidentiality and intensionality: Two uses of reportative constructions in discourse. In *Workshop on Constraints in Discourse Structure*, Maynooth, Ireland.

L. Danlos, A. Maskharashvili, and S. Pogodalla. 2016. Interfacing Sentential and Discourse TAG-based Grammars. To appear in the proceedings of the 12th International Workshop on Tree Adjoining Grammars and Related FormalismsTAG+12 (TAG+12), Düsseldorf, Germany., June.

L. Danlos. 2009. D-STAG: a Formalism for Discourse Analysis based on SDRT and using Synchronous TAG. In P. de Groote, editor, *Proceedings of FG'09*. INRIA.

L. Danlos. 2013. Connecteurs de discours adverbiaux: Problèmes à l'interface syntaxe-sémantique. *Linguisticae Investigationes*, 36(2):261–275, December.

P. de Groote. 2001. Towards Abstract Categorial Grammars. In *Proceedings of the 39th Annual Meeting on Association for Computational Linguistics*, ACL '01, pages 252–259, Stroudsburg, PA, USA. ACL.

N. Dinesh, A. Lee, E. Miltsakaki, R. Prasad, A. Joshi, and B. Webber. 2005. Attribution and the (Non-)Alignment of Syntactic and Discourse Arguments of Connectives. In *Proceedings of the Workshop on Frontiers in Corpus Annotations II: Pie in the Sky*, pages 29–36, Ann Arbor, Michigan, June. ACL.

G. Frege. 1948. Sense and Reference. *The Philosophical Review*, 57(3):209–230.

H. Grice. 1975. Logic and conversation. In P. Cole and L. Jerry, editors, *Syntax and semantics 3: Speech acts*, pages 41–58. Academic Press, San Diego, CA.

L. Haegeman. 2004. The syntax of adverbial clauses and its consequences for topicalisation. In M. Coene, G. De Cuyper, and Y. D'Hulst, editors, *Current Studies in Comparative Romance Linguistics*, number 107 in APiL, pages 61–90. Antwerp University.

J. Hunter and L. Danlos. 2014. Because We Say So. In *Proceedings of the EACL 2014 Workshop*

on Computational Approaches to Causality in Language, CAtoCL, pages 1–9, Gothenburg, Sweden, April. ACL.

A. Joshi. 1987. An introduction to Tree Adjoining Grammars. *Mathematics of Language*, 1:87–115.

R. Nesson and S. Shieber. 2006. Simpler TAG semantics through synchronization. In *Proceedings of FG 2006*, pages 129–142, Malaga, Spain.

R. Nesson and S. Shieber. 2007. Extraction Phenomena in Synchronous TAG Syntax and Semantics. In *Proceedings of the NAACL-HLT 2007/AMTA Workshop on Syntax and Structure in Statistical Translation*, SSST '07, pages 9–16, Stroudsburg, PA, USA. ACL.

C. Potts. 2005. *The logic of conventional implicatures*. Oxford University Press Oxford.

R. Prasad, E. Miltsakaki, N. Dinesh, A. Lee, A. Joshi, L. Robaldo, and B. Webber. 2007. The Penn Discourse Treebank 2.0 Annotation Manual. *IRCS Technical Reports Series*, December.

R. Prasad, A. Joshi, and B. Webber. 2010. Realization of Discourse Relations by Other Means: Alternative Lexicalizations. In *Proceedings of the 23rd International Conference on Computational Linguistics*, pages 1023–1031, Beijing, China, August.

T. Scheffler. 2013. *Two-dimensional Semantics. Clausal Adjuncts and Complements*. De Gruyter Mouton, Berlin/Boston.

S. Shieber and Y. Schabes. 1990. Synchronous Tree-adjoining Grammars. In *Proceedings of the 13th Conference on Computational Linguistics - Volume 3*, COLING '90, pages 253–258, Stroudsburg, PA, USA. ACL.

B. Webber. 2004. D-LTAG: extending lexicalized TAG to discourse. *Cognitive Science*, 28(5):751–779, September.

XTAG Research Group. 2001. A Lexicalized Tree Adjoining Grammar for English. Technical Report IRCS-01-03, IRCS, University of Pennsylvania.