Gapping through TAG Derivation Trees*

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Abstract

This work provides a TAG account of gapping in English, based on a novel deletion-like operation that is referred to as *de-anchoring*. De-anchoring applies onto elementary trees, but it is licensed by the derivation tree in two ways. Firstly, de-anchored trees must be linked to the root of the derivation tree by a chain of adjunctions, and the sub-graph of de-anchored nodes in a derivation tree must satisfy certain internal constraints. Secondly, de-anchoring must be licensed by the presence of a homomorphic antecedent derivation tree.

1 Introduction

Existing TAG-accounts of gapping propose the contraction of nodes (Sarkar and Joshi, 1997) or adopt elementary trees with a gap that lack the verbal anchor (Babko-Malaya, 2006) or combine the gapped elementary tree with its antecedent site into a tree set within an MCTAG-account (Seddah, 2008). This work breaks new ground in that it uses *de-anchoring*, a deletion-like operation, for the modelling of gapping, which applies to elementary trees while being licensed by the derivation tree of licit TAG-derivations. De-anchoring removes the anchors of an elementary tree and can be seen to parallel PF-deletion in generative grammar (Hartmann, 2000; Merchant, 2001).

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Our work is inspired by recent ideas from (Osborne, 2008; Kobele, 2009). Working in minimalist grammar, (Kobele, 2009) states the following Derivational Identity Hypothesis (DIH): "If a syntactic object SO_1 is elided under identity with SO_2, then SO_1 and SO_2 have been derived in exactly the same way." A strict reading of the DIH then leads to the prediction that subtrees of the derivational structure can be a target of a deletion-like operation that yields gapped structures only if an isomorphic antecedent subtree of the derivation structure exists.

(Osborne, 2008), on the other side, transfers the notion of major constituent, that is seen as being central to the licensing of gapping (Hankamer, 1973; Neijt, 1979; Chao, 1987), from generative grammar to a dependency-based description of gapping. A major constituent is then "a constituent the head [i.e. the governor] of which is, but the root of which is not, a link in the predicate chain". The predicate chain is made of the verbal complex. Gapping then complies to the *Restriction on Internal Sharing* (RIS): "The gap of conjunct-internal sharing may not cut into a major constituent."

We combine these approaches by describing gapping in TAG as a de-anchoring operation restricted by the derivation tree.

The paper is structured as follows: In the next section, we introduce the operation of de-anchoring. Then, in Sections 3 and 4, we develop relevant constraints for de-anchoring, based on the derivation tree. Section 5 points out some potential problems of our approach while Section 6 discusses its relation to the aforementioned proposals. Finally, Section 7 briefly mentions some aspects of implementation.

2 The Idea of De-Anchoring

In our TAG derivation trees, the edge label S, followed by the Gorn address of the substitution node, indicates substitution, whereas A indicates adjunction, again followed by the Gorn address of the adjunction site.[1] As an example, Fig. 1 shows the derivation of (1-a).

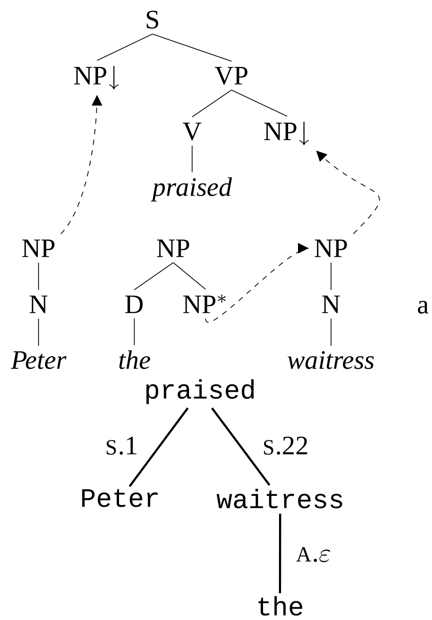

Figure 1: Derivation and derivation tree for "Peter praised the waitress".

(1) a. Peter praised the waitress.
 b. Adam praised Mary, and Peter ~~praised~~ the waitress.

We write derivation trees as graphs $\langle V, E, r\rangle$ where V is the set of *vertices* or *nodes*, $E \subset V \times V$ the set of *edges* and there is a *labeling function* l that assigns a label $l(v)$ to each node $v \in V$ and a label $l(e)$ to each edge $e \in E$. $r \in V$ is the *root node*, i.e., the node with in-degree 0. E^* represents the reflexive transitive closure of E, i.e., the dominance relation in the tree.

We say that an elementary tree γ is *de-anchored* if the terminals of γ are deleted (i.e., replaced with a label ε), while the other parts of γ are retained, thus preserving, e.g., case marking and semantics. An example is the gapping correlate of (1-a) in (1-b) and its derivation tree in Fig. 2, in which the root node is de-anchored, indicated by crossing out the node label.

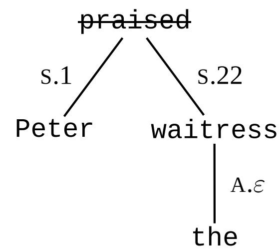

Figure 2: Derivation tree for "Peter ~~praised~~ the waitress".

Interesting questions are now, what kind of elementary trees can be de-anchored ("internal conditions on de-anchoring"), and what types of configurations allow for de-anchoring ("external conditions on de-anchoring"). We will formulate both types of conditions depending on the TAG derivation tree.

3 Internal Conditions on De-Anchoring

Based on Fig. 2, a preliminary formulation of the internal condition would be that only root nodes of derivation trees can be de-anchored while complete subtrees of the root node are major constituents. This explains the unavailability of (2).

(2) *Adam praised Mary and Peter ~~praised the~~ waitress.

However, there are cases where not only the root is part of the gap. Examples are (3) and (4).

(3) a. John gives Mary a book and Peter ~~gives Mary~~ a disk.
 b. John gives Mary a book and ~~John gives~~ Peter a disk.

(4) a. John is fond of Mary and Mary ~~is fond~~ of Sue.
 b. John is a reader in linguistics and Mary ~~is a reader~~ in philosophy.

In (3), in addition to the deleted verb, one of its substituted arguments is deleted as well. The derivation trees for the parts containing the gaps are shown in Fig. 3. This suggests that, if an element is de-anchored, each of its S-daughters can be de-anchored as well.

[1]The Gorn address of the root node is ε while the Gorn address of the ith daughter of a node with Gorn address p is $p \cdot i$.

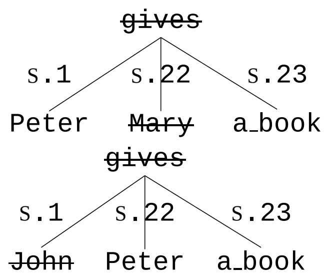

Figure 3: Derivation trees for (3).

In (4) , the deleted part includes a copula and a predicate. In XTAG (XTAG Research Group, 2001), copula as in (4) receive a small clause analysis. We adapt this idea, differing from the XTAG-analysis, however, in treating prepositions not as co-anchors of the predicate (see Fig. 4). In this analysis the predicate *fond* is the root of the derivation tree, and it dominates the copula verb.

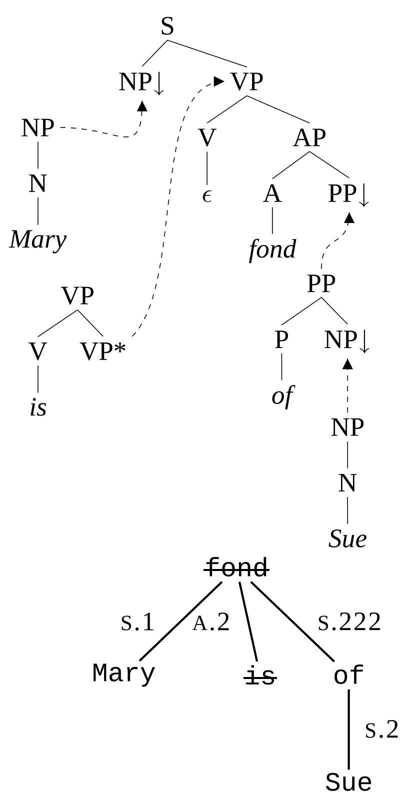

Figure 4: Derivation for "Mary ~~is fond~~ of Sue".

In order to account for (4) and (3), we revise our internal condition as follows: The gap constitutes a single A-branch in the derivation tree. An A-branch is a path of nodes connected by A-edges. Furthermore, if a node in the derivation tree is de-anchored, its S-daughters can be de-anchored as well.

The gap may also contain a chain of control verbs, as has been noted already in (Ross, 1970), exemplified in (5).

(5) I want to try to begin to write a novel, and

a. Mary ~~wants to try to begin to write~~ a play.
b. Mary ~~wants to try to begin~~ to write a play.
c. Mary ~~wants to try~~ to begin to write a play.
d. Mary ~~wants~~ to try to begin to write a play.

XTAG adopts an analysis of control verbs that adjoins the control verb at the embedded infinitive and that uses an empty category PRO that substitutes into the subject NP slot. Such infinitives allow only PRO as subjects; this constraint is achieved via corresponding features on the substitution node. The elementary trees are shown in Fig. 5.

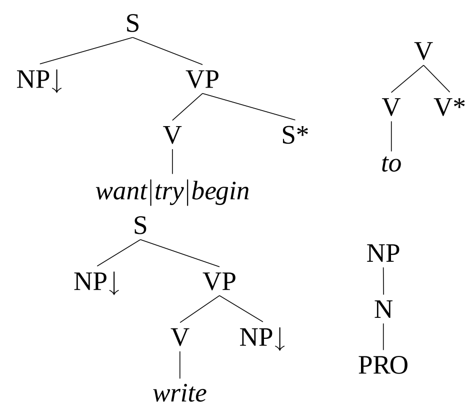

Figure 5: Elementary trees for control verbs in the spirit of XTAG.

The derivation tree for (5-a) is shown in Fig. 6. Three observations are striking: (i) the remnants *Mary* and *a play* are complements of different verbs; (ii) the gaps are variable in size; (iii) the gaps constitute A-subtrees rather than just A-branches.

The first observation contradicts the here proposed conception of major constituency, since the first remnant *Mary* is not an immediate daughter of the root. Instead, it is the immediate S-daughter of a node on a A-subtree.

The second observation suggests that a partial de-anchoring of the A-subtree is possible: the maximal gap in (5-a) corresponds to the A-branch, which is de-anchorable from the edge towards and including the root, as the other gap options in (5-b)-(5-d) show.

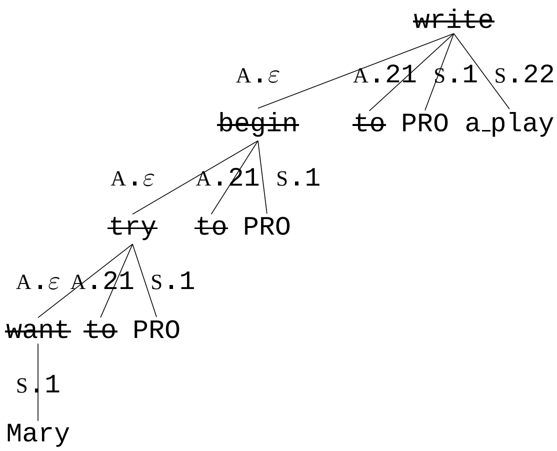

Figure 6: Derivation for (5-a).

Finally, we learn from the third observation that we have to either disallow the infinitive marker *to* to adjoin to the verbal stem and rather give it a lexical analysis, or we have to allow the de-anchoring of sister nodes, hence of A-subtrees of the derivation tree. When the mother is not de-anchored, however, it moreover holds that only the node adjoining highest can be de-anchored. This captures the unavailability of a sole de-anchoring of the infinitive marker:

(6) *…and I want ~~to~~ try to begin to write a novel.

In order to formulate our internal condition, we need the following notions: Given a derivation tree $\delta = \langle V, E, r \rangle$, we call the sub-graph γ of de-anchored nodes a *gap*. Given a node $v \in V$ with A-daughters $v_1, \dots, v_k$, we call $\langle v, v_i \rangle$ a maximally high adjunction if its label is A.p and all edges $\langle v, v_j \rangle$, $j \neq i$, $1 \leq j \leq k$, are labeled A.pq with $q \neq \varepsilon$.

Gaps must satisfy the following **Internal Condition on De-Anchoring**:

1. γ must be a tree $\gamma = \langle V_g, E_g, r_g \rangle$ with $V_g \subset V, E_g \subset E$;

2. there must be an A-branch (possibly empty) from the root of δ to the root of γ such that all edges on this path are maximally high adjunctions;

3. for every node $v_g \in V_g$, it holds that all A-daughters of v_g in δ are also part of γ. I.e., for all $v_g \in V_g$ and all $v \in V$, if $\langle v_g, v \rangle \in E$ and $l(\langle v_g, v \rangle) =$ A.p for some Gorn address p, then $v \in V_g$;

4. for every node $v_g \in V_g$, it holds that an S-daughter v_s of v_g in δ can be part of γ; if so, all nodes dominated by v_s in δ must also be part of γ. I.e., for all $v_g \in V_g$ and all $v \in V$ such that $\langle v_g, v \rangle \in E$ and $l(\langle v_g, v \rangle) =$ S.p for some Gorn address p, if $v \in V_g$, then it holds for all v' with $\langle v, v' \rangle \in E^*$ that $v' \in V_g$.

It follows that in our model **major constituents** correspond to S-daughters of nodes of the A-subtree below the root node. It is not permitted to delete only parts of them. This use, however, is not extensionally congruent with Osborne's use of the term, since he also applies it to modifiers.

4 External Conditions on De-Anchoring

Gapping is further constrained by a certain parallelism of the ellipsis site and the antecedent site. We assume here that an antecedent derivation tree represents the first conjunct of a coordinative construction whose second conjunct includes the ellipsis. We call this aspect the *external conditions* on de-anchoring, and we will be mainly dealing with homomorphism properties of the derivation trees of the ellipsis site and the antecedent site. A strict formulation of the external condition would be that de-anchored nodes must have a corresponding node in the antecedent derivation tree, such that both have (i) an identical position in their derivation trees (i.e. an identical path to the respective root nodes) and (ii) an identical node label, given that the node label always identifies an elementary tree unambiguously.

This is however too restrictive: Gapping is known to allow number mismatch between elided material and its antecedent, see (7) and also (5) above.

(7) I am flying to Europe, and you ~~are flying~~ to Asia. (Osborne, 2008)

We hence need complex node labels that help to abstract away from number information, as is depicted in Fig. 7. Then, instead of requiring the identity of the entire feature structure, we require only the identity of specific features. In particular, we require the LEMMA feature to be identical for the two nodes while the ANCHOR and NUM features can be different.

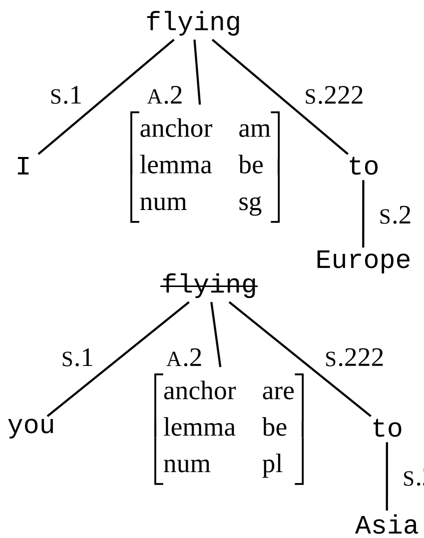

Figure 7: Derivation trees of the first and second conjunct of (7) with complex nodes.

Furthermore, dissimilarities of other properties of ellipsis and antecedent could be permissible, though not as easily as number mismatch. For example, the gapped verb could be differing from the antecedent verb wrt. word order, such as in (8), and subcategorization properties, as shown in (9).

(8) ?This guy she likes, and Mary ~~likes~~ Peter.

(9) a. ?Peter was looking for the Olympic games and Mary ~~was looking~~ after the children.
b. ?Peter ate and Mary ~~ate~~ a whole chicken.

These kinds of mismatch would also be handled in terms of partial identity of complex node labels in the derivation tree.

On the other side, certain properties of the nodes in question must be identical, most prominently their position within the derivation tree: In (10), the antecedent verb *ordered* is embedded in a fronted adverbial clause, whereas the elided correspondent is the matrix verb and hence in the root position of the second conjunct.

(10) *Since Peter ordered a beer, the waitress instantly reached for the fridge and
Mary ~~ordered~~ a whole chicken.

Likewise, we claim that mismatches of voice and tense are not acceptable (see (11)).

(11) a. *Peter was informed by the young police officer, and the older one ~~was informing~~ Mary.
b.?*Peter had to clean the floor last week, and Mary ~~has to clean~~ the kitchen this week

The **External Condition on De-Anchoring** is then as follows: A derivation tree δ containing a gap $\gamma = \langle V_g, E_g\rangle$ is licensed if the following holds: There are two subtree $\delta_1 = \langle V_1, E_1, r_1\rangle$, $\delta_2 = \langle V_2, E_2, r_2\rangle$ of δ such that δ represents the conjunction of δ_1 and δ_2, γ is a subtree of δ_2 and there is a homomorphism $h : V_g \rightarrow V_1$ such that:

1. Identity of paths to root nodes: for all $v \in V_g$: There are $v_1^{(2)}, \ldots, v_k^{(2)} \in V_2$ for some $k \geq 1$ with $v_1^{(2)} = r_2$, $v_k^{(2)} = v$ and $\langle v_i^{(2)}, v_{i+1}^{(2)}\rangle \in E_2$ and $l(\langle v_i^{(2)}, v_{i+1}^{(2)}\rangle) = l_i$ for $1 \leq i < k$ iff there are $v_1^{(1)}, \ldots, v_k^{(1)} \in V_1$ with $v_1^{(1)} = r_1$, $v_k^{(1)} = h(v)$ and $\langle v_i^{(1)}, v_{i+1}^{(1)}\rangle \in E_1$ and $l(\langle v_i^{(1)}, v_{i+1}^{(1)}\rangle) = l_i$ for $1 \leq i < k$.
2. Identity of specific features: for all $v \in V_g$: Certain feature values are identical for v and $h(v)$ in δ. These include at least LEMMA, TENSE and VOICE.

5 Problems

The internal condition on de-anchoring correctly allows for the de-anchoring of S-nodes, accounting for examples such as (12).

(12) John gave a book to Mary and
a. Peter ~~gave a book~~ to Sue.
b. Peter ~~gave~~ a report ~~to Mary~~.

This, however, is too permissive. It needs to be carefully constrained, in order to rule out instances of bare argument ellipsis such as in (13), which are traditionally judged ungrammatical (see, e.g., (Jackendoff, 1971, (27-a)), (Johnson, 2004, p.3)).

(13) *John gave a book to Mary and
Peter ~~gave a book to Mary~~.

Interestingly enough, Osborne's proposal is also too permissive in this respect, and this also holds for the proposals of, e.g., (Neijt, 1979) and (Hartmann, 2000, p.144).

The internal condition, moreover, turns out to be too restrictive when it comes to adverbial remnants. Consider the gapping instance in (14) and its derivation tree in Fig. 8.[2]

(14) Mary always finishes her homework, but
Peter ~~finishes~~ ~~his homework~~ only sometimes.

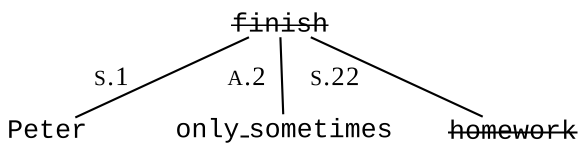

Figure 8: Derivation tree of (14).

We must observe that the adverb remains overt while its dominating A-node is de-anchored. This contradicts the internal condition according to which A-daughters of de-anchored nodes must be de-anchored as well. A solution could be to enable the optionality of the de-anchoring of adverbs. This would make it necessary to have access to a distinctive feature of adverbs and verbs in the process of de-anchoring, e.g., by having access to the feature structure used for implementing the external condition below. The distinction could be a distinction between *modifier auxiliary trees* (adverbs, adjectives, etc.) and *predicative auxiliary trees* (verbs selecting for a sentential complement). This distinction already has been used in (Schabes and Shieber, 1994).

A further example of an adverb that is not de-anchored is (15). The derivation tree is shown in Fig. 9.

(15) Mary is always fond of cheese cake, but
Peter ~~is~~ only sometimes ~~fond of cheese cake~~.

Here, the adverb remains overt while not only its dominating A-node but also its dominated A-node are de-anchored. Hence, the A-branch is de-anchored with a hole. This clearly contradicts the internal condition on de-anchoring. Making use of concepts such as sister adjunction, one

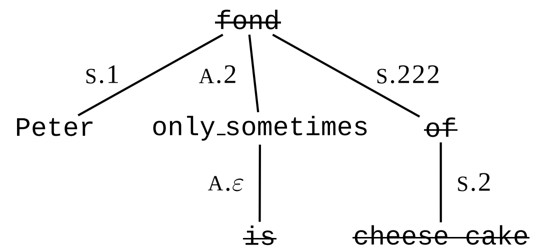

Figure 9: Derivation tree of (15).

could rearrange the derivation tree such that `is` and `only_sometimes` are siblings, directly dominated by `fond`. This would reduce the example to an example of the type of (14).

Finally, the internal condition on de-anchoring proves too permissive in cases, where the A-tree does not correspond to a small clause or a control chain, but rather to , e.g., a bridge verb construction. Consider the derivation tree in Fig. 10 resulting from the XTAG analysis for (16):

(16) Larry thinks Sue is nice.

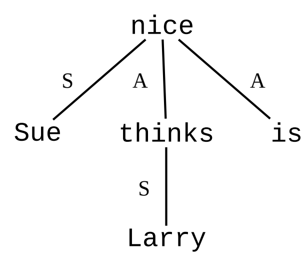

Figure 10: Derivation trees for “Larry thinks Sue is nice”.

Since both the bridging verb *thinks* and the embedded finite auxiliary verb *is* directly adjoin to the small clause anchored by *nice*, the derivation tree contains exactly two A-branches. Taken the internal condition for granted, the acceptability of the following gaps is predicted:

(17) Larry thinks Sue is nice and
a. *Sue ~~thinks~~ Larry is funny.
b. *Sue ~~thinks~~ Larry ~~is nice~~.

(17-a) and (17-b) are claimed to be unacceptable (see, e.g., (Sag, 1976, p.198)), (Johnson, 2004, p.18), (Osborne, 2008, (106))).[3] The internal con-

[2]Note that the alternative gapping instance “Peter ~~always finishes~~ ~~his homework~~ only sometimes” is not ruled out by the syntax.

[3](17-a) can be improved by adding a that-complementizer, i.e. “Larry thinks that Sue is nice and Sue ~~thinks~~ that Larry is

dition might thus be too permissive.

One could argue that the verb *thinks* in (16) is no bridge verb, but receives an analysis, where the clausal complement is substituted into the elementary tree of *thinks*. Gapping into the clausal complement would thus be blocked since a de-anchoring of *nice* would also require a de-anchoring of the entire complement clause. This move, however, would explain only such simple cases. Where the bridge verb analysis with adjunction is inevitable, it would still predict the availability of the following, highly awkward gapping instance:

(18) ?*Who does Mary think Bill likes and
who ~~does~~ Sue ~~think~~ Joe ~~likes~~.

Note however that the available literature on gapped bridge verb constructions seems to be very slim. Furthermore, the dependency analysis in (Osborne, 2008) can correctly predict the unacceptability of (17-b) only by the cost of stipulating two separate predicate chains. The syntactic characterization of those predicate chains and their separation is again obscure.

6 Related Work

Previous TAG-accounts of gapping consider only a very limited set of data. Furthermore, complex gaps such as (4) and (5) pose a serious challenge for those accounts that model the ellipsis-antecedent relations syntactically, such as (Sarkar and Joshi, 1997) and (Seddah, 2008). In the simple cases of gapping, (Sarkar and Joshi, 1997) let the preterminal nodes contract such that anchoring (i.e. lexicalization) happens at the same time as substitution and adjunction during the parse. When gaps are complex, however, not yet anchored derived trees have to be contracted instead of not yet anchored elementary trees. In other words, contraction would then also operate on non-immediate daughters of the conjunctor in the derivation tree. Unfortunately, Sarkar and Joshi do not elaborate on the details of this powerful extension, in particular on how to constrain it.

(Seddah, 2008) also analyzes simple cases of gapping. In his approach, he combines the elementary trees of the antecedent verb and the elided verb into a single tree set. The resulting MCTAG is constrained to be tree-local. To process complex gaps in this vein, however, requires more expressive power: since, e.g., the control verbs and their elided counterpart adjoin into different trees from different elementary trees belonging to the same tree set, we need at least set-locality. This illustrates the so far unnoticed complication due to complex gaps.

It remains to say that the semantic account in (Babko-Malaya, 2006) is not affected in this respect.

Even though we share with (Kobele, 2009) the interest in derivational structures along the Derivational Identity Hypothesis (DIH), his account (within the minimalist grammar framework) differs considerably from ours. The main reason for this contrast is the fundamentally differing nature of the respective derivational structures. In minimalist grammar, the non-terminal nodes of the derivation tree indicate combinatorial operations, i.e., merge and move. Most importantly, the predicate-argument relation is opaque, which also follows from the fact that minimalist grammar does not dispose of an extended domain of locality. Since the DIH suggests that only common subderivations are subject to deletion, Kobele's account seems to run into difficulties when applied even to simple cases of gapping. In fact, Kobele does not flesh out a theory of gapping in his paper. He is more concerned with voice mismatches in sluicing constructions, where his account is particularly fruitful.

Compared to (Kobele, 2009), our account bears more similarity to the theory of gapping in terms of dependency structures as presented in (Osborne, 2008). This follows from the fact that TAG-derivation trees and dependency structures share crucial commonalities, even though complementation in some cases (e.g. with control verbs) receives an inverted dominance relation. Hence, the empirical predictions for gapping should overlap for the most part, if not completely. Crucial differences, however, can be found in the technical specification: while Osborne remains vague about the syntactic nature of a "predicate chain", which constitutes a gap, and refers to its semantic contribution instead, we propose an intrinsically syntactic delimitation of gaps based on A-subtrees. Osborne's proposal, furthermore, does not account for the variability of gaps within control chains. This is maybe

funny". (c.f. (Sag, 1976, p.198)),(Osborne, 2008, (5)) due to the fact that Osborne aims at rephrasing major constituency in terms of dependency, and control chains are considered not to involve major constituents. Finally, our account includes an explication of the antecedent-ellipsis relation in terms of a homomorphism on derivation trees, which Osborne's proposal lacks completely.

The problems of our account concerning the role of adverbs reflect the ambivalence of adjunction with respect to complementation and modification. This work would, thus, benefit from a convergence with dependency representations in this regard.

7 Implementation Issues

As we have seen when formulating the external condition, de-anchoring is licensed only if we can find a homomorphic antecedent node in the derivation tree of the first conjunct. This could be exploited for parsing. The idea is to allow some kind of *multiple use under de-anchoring* for selected elementary trees. Whenever a de-anchored tree is used during parsing, we check the internal and external conditions for de-anchoring on the part of the derivation tree that is already available.

8 Conclusion

This paper has provided an account of gapping in English within LTAG. We have exploited the fact that LTAG provides an extended domain of locality and, besides the derived trees, generates also derivation trees that abstract away from details of the constituency structure and that are close to dependency trees. We claim that LTAG derivation trees are an appropriate structure for restricting the availability of gapping constructions.

In our approach, gapping is achieved via an operation of de-anchoring that deletes lexical anchors from elementary trees. Inspired by recent research on gapping and relations to the derivation structure in the context of minimalist grammar, we have formulated a list of licensing conditions on the derivation tree that allow for de-anchoring within gapping constructions. Even though there are cases that remain problematic, our approach covers a large part of the gapping phenomena discussed in the literature.

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