The Syntactic Algebra of Adjuncts

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This paper gives a theory-neutral account of the Adjunct Island Constraint. I show that the island status of adjuncts is a consequence of two properties that set them apart from arguments: optionality and independence. Adjuncts can be omitted without affecting grammaticality as in (1), and if an utterance may contain adjunct *a* or adjunct *b*, then it may also contain both *a* and *b*, which is exemplified in (2).

(1) a. Obviously I will ace this exam.
    b. I will ace this exam.

(2) a. Obviously I will ace this exam.
    b. I will easily ace this exam.
    c. Obviously I will easily ace this exam.

Optionality and independence give rise to certain grammaticality inferences that mirror the entailment patterns of the logical connector *and*. For instance, just like $t = 0$ implies $t \,\&\, a = 0$ for propositions, the ungrammaticality of tree t entails that the result of adding adjunct a to t is also ungrammatical. Intuitively, these grammaticality entailments render adjuncts semi-permeable with respect to constraints — dependencies can "scope out" of adjuncts and thus restrict the shape of the rest of the tree, but not the other way round. In combination with standard assumptions about the feature-driven nature of Move, semi-permeability derives the Adjunct Island Constraint while still allowing for parasitic gaps.

The paper is laid out as follows. Section 1 introduces the theory-neutral notion of Adjuncts, which is defined purely in terms of optionality and independence without requiring reference to how Adjuncts are implemented in the grammar. Section 2 then explores the grammaticality inferences that hold for grammars with Adjuncts, which are subsequently invoked in Sec. 3 to derive the Adjunct Island Constraint. I close with a discussion of adjuncts that do not exhibit island effects in Sec. 4. In particular, I argue that these adjuncts behave like arguments semantically and thus might not be included in the class of Adjuncts.

1 A Theory-Neutral View of Adjuncts

In contrast to arguments, which every major syntactic theory handles via subcategorization frames or some technical variation thereof, adjuncts have no unified analysis in the literature. In some accounts adjuncts are just functional projections (Cinque 1999) or heads that belong to the same category as their complement (cf. Dowty 2003). Chomsky (1995) and Hornstein & Nunes (2008) posit that adjunction differs from standard Merge in the label that is projected. Stepanov (2001), on the other hand, sees the major difference between the two in their derivational timing, equating adjunction with Late Merge. Hunter (2012) favors a mixture between the two where adjuncts enter the derivational workspace at the same time as in Chomsky's model but aren't immediately operated on. Yet another view is offered by Frey & Gärtner (2002), who argue that adjunction involves asymmetric feature checking. So even within Minimalism there seems to be no consensus as to how adjuncts should be characterized on a technical level.

Despite these disagreements on matters of implementation, the surface properties of adjuncts are hardly controversial, in particular optionality and independence. For this reason I completely abstract away from the underlying mechanism for adjunction in this paper and instead focus on the properties said mechanism must capture. Once those are made sufficiently explicit, we can reason about the grammar in a principled manner without having to worry about the specifics of the formal machinery.

The goal is to characterize adjuncts as subtrees that are both optional and independent. This requires the notational means to factor a tree into at least two subtrees, as well as precise definitions of optionality and independence that are stated in terms of this factorization. First, a *footed tree* is a tree such that exactly one leaf is labeled by the special symbol $\Box$ (see Fig. 1). For s a tree and t a footed tree, the *(tree) substitution of t in s at n*, written $s +_n t$, is the result of inserting t in s at node n such that $\Box$ in t is replaced by the subtree rooted in n. A simple example is given in Fig. 2.

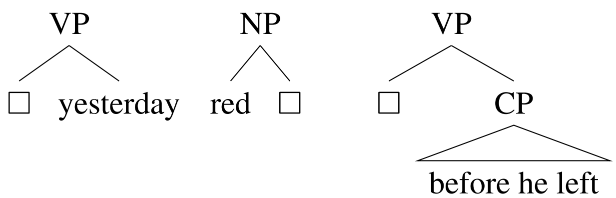


Figure 1: Footed trees for some adjuncts

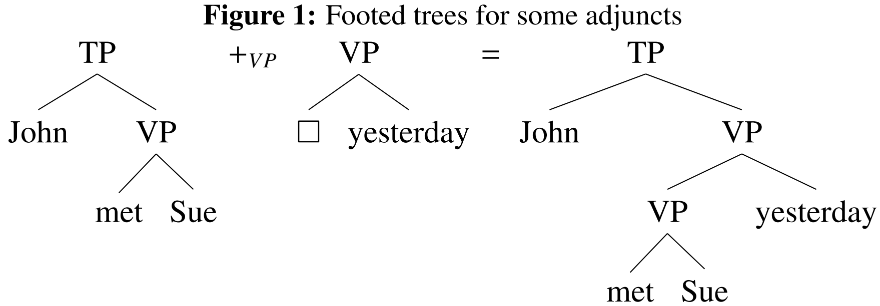


Figure 2: Inserting a VP-adjunct

Note that tree substitution is just used as a descriptive device here and as such is completely independent from the operations of the grammar. Some formalisms like TAG (Joshi *et al.* 1975; Joshi & Schabes 1997) may treat adjunction as tree substitution, but I make no such assumption. The crucial thing is that tree substitution allows us to home in on the adjuncts in a tree while keeping fixed the *argument spine*, i.e. the part of the tree that consists only of heads and arguments and does not contain any adjuncts. For instance, let s, t, and t' be the trees above for *John met Sue*, *yesterday*, and *before he left*, respectively. Then $s +_{VP} t$ and $s +_{VP} t'$ succinctly express the fact that *John met Sue yesterday* and *John met Sue before he left* are both built from the same argument spine and differ only in their adjuncts.

The substitution notation makes it very easy to define optionality and independence:

Optionality Given a grammar G, a footed tree t is optional with respect to G iff it holds for every tree that is generated by G and of the form $s +_n t$ that s is also generated by G.

Independence Given a grammar G, the footed trees t and t' are independent iff it holds that whenever G generates both $s +_m t$ and $s +_n t'$ for some choice of s, m, and n, it also generates $(s +_m t) +_n t'$.

Optionality as defined above is a very strict notion — a footed tree must be optional in every tree that it occurs in. Hence optional arguments do not qualify, because their optionality is dependent on the head they are selected by. For example, *pasta* can be omitted in (3) but not in (4).

(3) a. John is eating pasta.
    b. John is eating.

(4) a. Pasta is delicious.
    b. * Is delicious.

Independence is a minor generalization of iterability. The latter obtains if $t = t'$ and m and n are close to each other (depending on how node addresses are assigned and computed after each substitution step, one may even stipulate that $m = n$). The fact that t and t' may be identical also allows us to call a single footed tree independent even though that is strictly speaking a property of pairs of trees.

Now everything is in place to define adjuncts — or rather, *Adjuncts*, which is how I will refer to the formal object in order to distinguish it from the empirical one.

Adjunct A phrase marker is an Adjunct iff it is an optional, independent footed tree (*modulo* the leaf node labeled $\square$).

2 Properties of Grammars with Adjuncts

Treating Adjuncts as optional, independent footed trees does not amount to much more than a technical rephrasing of easily observed empirical properties of adjuncts. Yet surprisingly this is enough to generate some profound insights into grammars with Adjuncts, or more accurately, the languages they generate. Since we completely abstract away from how Adjuncts are implemented in syntax, all we can say about grammars with Adjuncts is that they have some mechanism that applies to certain phrase markers and makes them optional and independent. This mechanism might be one of the options mentioned at the beginning of the previous section, or it might be something completely new and unheard of. The only thing that matters for our purposes is that optionality and independence are captured in some way. If this is the case, then the language generated by the grammar is not just a flat, unstructured set of trees. Instead, the trees are related to each other in specific ways that give rise to certain grammaticality entailments: the (un)grammaticality of some tree implies the (un)grammaticality of certain other trees. In this section I explore the nature of these entailments, which are later shown to derive the Adjunct Island Effect.

Our tree substitution notation already establishes a certain dependency between trees, in the sense that if u can be represented as $s +_n t$, then u is more closely related to s than a tree for which no such decomposition is available. In order to make this idea fully explicit, suppose that we have a grammar G with Adjuncts $a_1, a_2, \ldots$, the set of which is denoted by A (this set may be infinite). Then u is an *Adjunct extension* of s with respect to A iff there are Adjuncts $a_1, \ldots, a_k$ in A and nodes $n_1, \ldots, n_k$ such that $u = s +_{n_1} a_1 +_{n_2} \cdots +_{n_k} a_k$ ($k \geq 0$). That is to say, an Adjunct extension of s in grammar G is a tree that can be obtained from s by inserting zero or more Adjuncts of G (so every tree is an Adjunct extension of itself). I write this relation as $s <_A u$. Several examples are given below:

(5) a. Obviously I will ace this exam $<_A$ Obviously I will easily ace this exam
b. I will ace this exam $<_A$ Obviously I will easily ace this exam
c. Obviously I will ace this exam $\not<_A$ I will easily ace this exam
d. I will ace this exam $\not<_A$ I will easily ace this test
e. exam will this I ace $<_A$ easily exam will this I ace

In (5a) *Obviously I will easily ace this exam* can be obtained from *Obviously I will ace this exam* by inserting the Adjunct *easily*, so the latter is an Adjunct extension of the former. But *Obviously I will easily ace this exam* is also an adjunct extension of *I will ace this exam*; this time one has to insert both *easily* and *obviously*. However, *Obviously I will ace this exam* is not an Adjunct extension of *I will easily ace this exam*, because neither can be obtained from the other without removing an Adjunct. Nonetheless both are Adjunct extensions of the same tree, and they both have *Obviously I will easily ace this exam* as one of their Adjunct extensions. In (5d) we see that a tree can never be an Adjunct extension of a tree that has a different argument spine. Finally, (5e) shows that the Adjunct extension relation also extends to trees that might be deemed ungrammatical by the grammar: *exam will this I ace* is an Adjunct extension of *easily exam will this I ace* given the set of Adjuncts in English even though neither tree is generated by the grammar for English.

The Adjunct extension relation puts some structure on top of the language generated by a grammar G with set A of adjuncts. It is easy to see that $s <_A t$ and $t <_A u$ jointly imply $s <_A u$, so the relation is transitive. Reflexivity is also satisfied because we treat every tree as an Adjunct extension of itself. Finally, $s <_A t$ and $t <_A s$ necessarily imply $s = t$ — s can be obtained from t without removing any Adjuncts only if all Adjuncts of s are Adjuncts of t, and similarly the other way round, so s and t must have the same Adjuncts and the same argument spine, wherefore they are identical. The Adjunct extension relation thus is a weak partial order and can be pictorially represented via Hasse diagrams as in Fig. 3.

Suppose that $T(G, A)$ is the set of all trees over the alphabet/lexicon of G (including ungrammatical trees) ordered by the collection A of Adjuncts of G. I call $T(G, A)$ the *Adjunct algebra induced by G*. We can think of $T(G, A)$ as one big Hasse diagram. Some nodes in the diagram correspond to trees that are generated

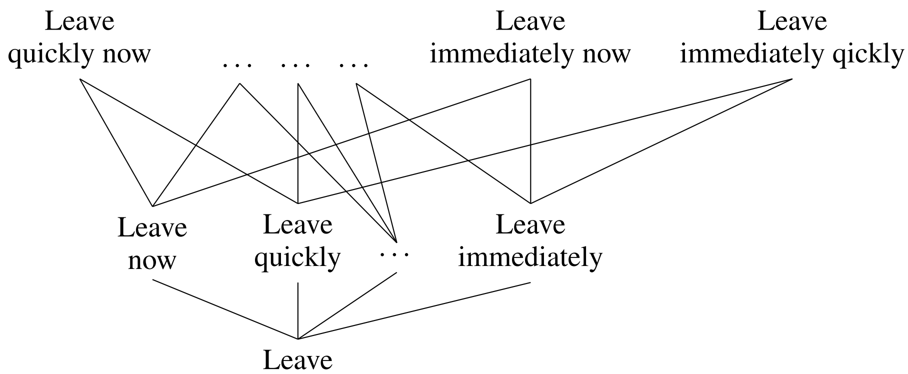


Figure 3: A Hasse diagram for Adjunct extension relation

by G, others do not. The intriguing part is that optionality and independence allow us to make certain inferences as to which trees are generated by G.

Optionality Closure If $s <_A t$ and G generates t, then G generates s.

Independence Closure If $u <_A s$ and $u <_A t$ and G generates both s and t, then G generates the smallest tree that is an Adjunct extension of s and t.

Neither entailment is particularly surprising. If t is an Adjunct extension of s, then removing those Adjuncts preserves grammaticality due to the optionality of Adjuncts. Similarly, if s and t share the same argument spine and only differ in the Adjuncts they contain, then by independence of Adjuncts the grammar generates the "fusion" of s and t, i.e. the tree that can be obtained from s by inserting all Adjuncts of t that are not already part of s (or the other way round). The respective entailments are also depicted in Fig. 4 and 5.[1]

As indicated in Fig. 4, optionality closure ensures that grammaticality is downward entailing, in the sense that if t is grammatical, so is every tree that it is an Adjunct extension of. But it also enforces indirectly that ungrammaticality is upward entailing: if t is ungrammatical, then it cannot be salvaged by adding an Adjunct a, because then the grammaticality of $t +_n a$ would imply that t is grammatical, contradicting our initial assumption.

It is important to keep in mind that the comparisons between trees and their Adjunct extensions are just a strategy for us to determine which trees are grammatical, the grammar itself does not have to be aware of the Adjunct extension relation or any of the inferences that build on it — instead, the patterns simply emerge from the standard, tree-local mechanisms as long as the grammar has an implementation of Adjuncts that captures their optionality and independence.

In sum, Adjuncts give rise to the following entailment patterns over $T(G, A)$:

[1] Optionality Closure and Independence Closure are actually reflections of a more general property. For every grammar G, the Adjunct algebra induced by G is a (usually) infinite collection of lattices (things are actually slightly more complicated: the carrier of each lattice is a set of equivalence classes of trees such that trees s and t belong to the same equivalence class iff they are both minimal adjunct extensions of u and v). The language generated by G, in turn, is a union of ideals over these lattices. Recall that ideals are lower, directed sets ($x \in L$ implies $y \in L$ for every $y \leq x$, and for all $x, y \in L$ there is some z such that $x \leq z$ and $y \leq z$). These two conditions correspond exactly to optionality and independence.

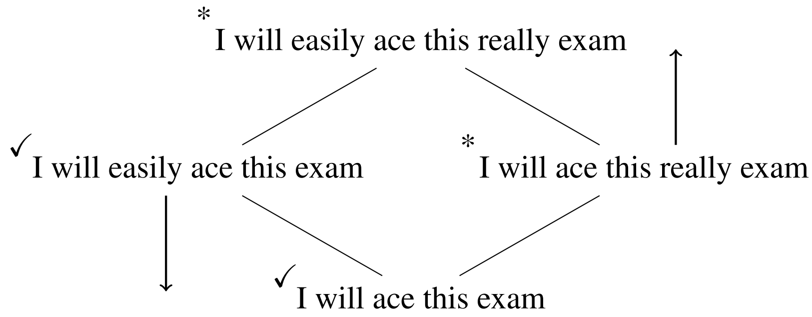


Figure 4: Grammaticality Entailments of Optionality

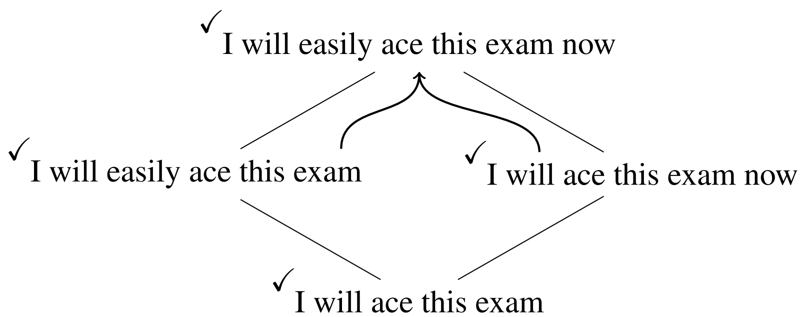


Figure 5: Grammaticality Entailments of Independence

1. Grammaticality is downward entailing.
2. Ungrammaticality is upward entailing.
3. Grammaticality is preserved under "fusion" of Adjunct extensions.

3 Deriving the Adjunct Island Constraint

Now that we have a solid understanding of the inference patterns that Adjuncts give rise to, we are finally in a position to derive the Adjunct Island Constraint. More precisely, I show that Adjuncts are necessarily islands if movement involves the satisfaction of some dependency on the target site. Under a Minimalist conception of Move, for instance, that would be encoded by the presence of a feature at the target site that must be checked.

3.1 Adjunct Island Constraint

Consider the ungrammatical *which book did John fall asleep before reading t*. It arguably involves wh-movement of the DP *which book* out of the adjunct into Spec,CP. This movement is commonly assumed to be mediated by wh-features such that the both *which book* and the C-head carry a wh-feature that must be checked via Spec-Head agreement. This analysis is shown in the top tree in Fig. 6 on the following page. Certain details such as head movement of *did* are ignored for the sake of clarity. Also note that nothing hinges on the usage of a multi-dominance interpretation of Move.

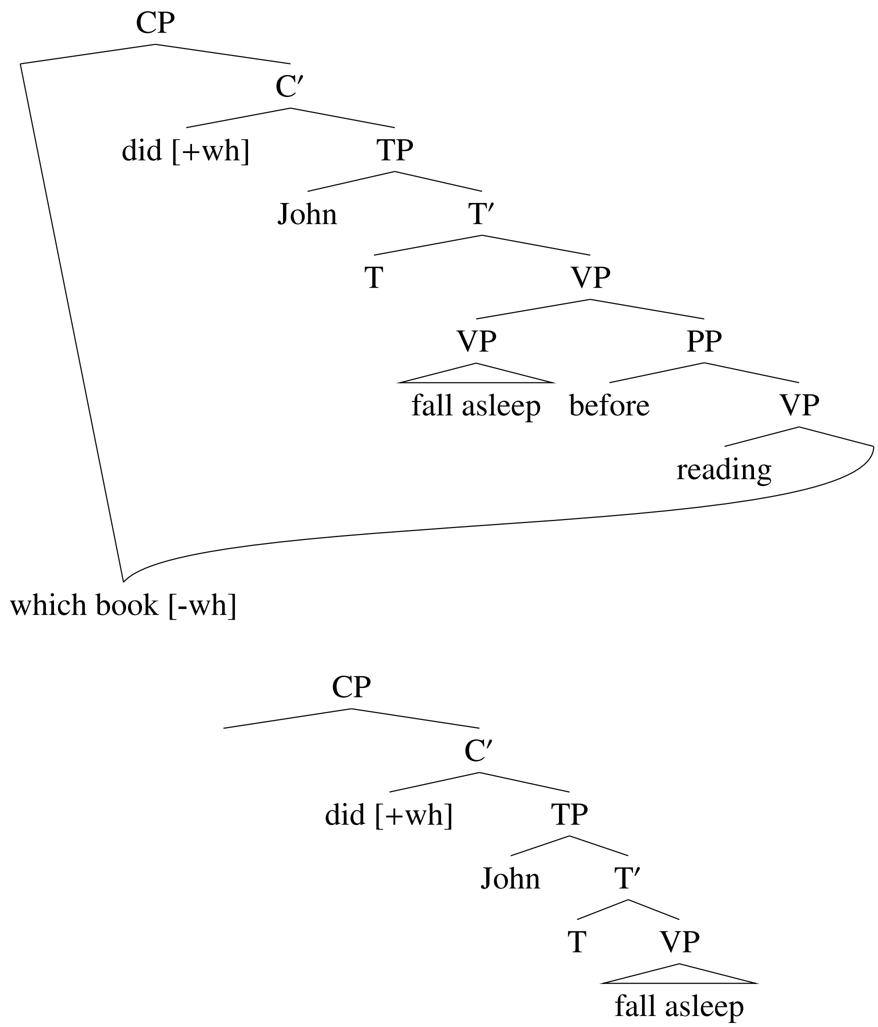


Figure 6: Adjunct Island Constraint: the ungrammaticality of the bottom tree necessarily entails the ungrammaticality of its Adjunct extension

Since all features are checked in the top tree, one would expect it to be grammatical. However, notice that the tree contains a VP-adjunct. Let us assume that this adjunct is treated as an Adjunct by the grammar. Then the tree under consideration is actually an Adjunct extension. The tree without the Adjunct, which is depicted at the bottom of Fig. 6, still contains a wh-feature on the C-head, but the removal of the Adjunct has also resulted in the removal of its subconstituent *which book*, which carried the other wh-feature. Consequently the wh-feature on the C-head is no longer checked, and the entire tree is ungrammatical. But recall that ungrammaticality is upward entailing, so all Adjunct extensions of this tree are also deemed ungrammatical by the grammar, including the structure for *which book did John fall asleep before reading*. From this perspective, the Adjunct Island Constraint is not a constraint at all, it is simply a consequence of how grammaticality is computed in a grammar with Adjuncts.

3.2 Parasitic Gaps

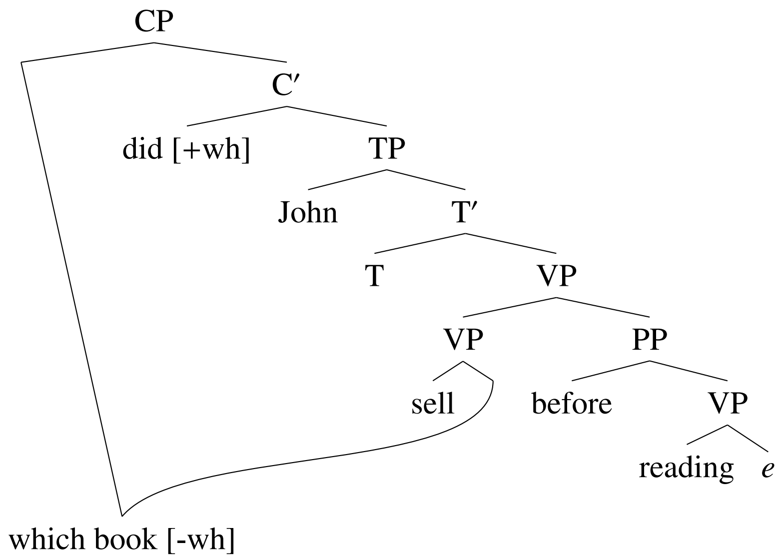
Even though extraction from Adjuncts is rendered impossible by their optionality, Adjuncts may still contain parasitic gaps, as in *which book did John sell t before reading e*. The crucial difference is that a parasitic gap must piggy-back on a moving phrase that originates within the argument spine, so removal of the Adjunct does not affect checking of the wh-feature. This is shown in Fig. 7 on the next page, where the tree at the bottom has no Adjuncts but is still well-formed (once again nothing depends on whether movement creates multi-dominance tree, nor does it matter if parasitic gaps are empty heads or traces created by sidewards movement). Since grammaticality is only downward entailing, nothing follows at this point — the tree with a parasitic gap may be well-formed, or it may be ungrammatical. Therefore extraction from Adjuncts is impossible in every grammar, whereas the status of parasitic gaps is subject to cross-linguistic variation.

That is not to say that Adjuncts put absolutely no restrictions on parasitic gaps. If independence is indeed a property of Adjuncts, then one would expect that no language puts a restriction on the number of parasitic gaps that can be licensed by a single mover. In other words, if (6a) and (6b) are grammatical, then by independence (6c) must be, too. This prediction is borne out.

(6) a. Which movie did John *t* throw in the trash after watching *e*?
b. Which movie did John whilst mocking *e* throw *t* in the trash?
c. Which movie did John whilst mocking *e* throw *t* in the trash after watching *e*?

3.3 Further Observations

The difference in status between movement and parasitic gaps is not an accident but rather due to the directionality of the dependencies involved. Parasitic gaps require the presence of certain material in the argument spine, *viz.* a mover that they can piggy-back on. However, nothing in the argument spine depends on the presence of a parasitic gap. Loosely speaking, one might say that the constraints regulating parasitic gaps originate within an adjunct and scope out of it. Movement, on the other



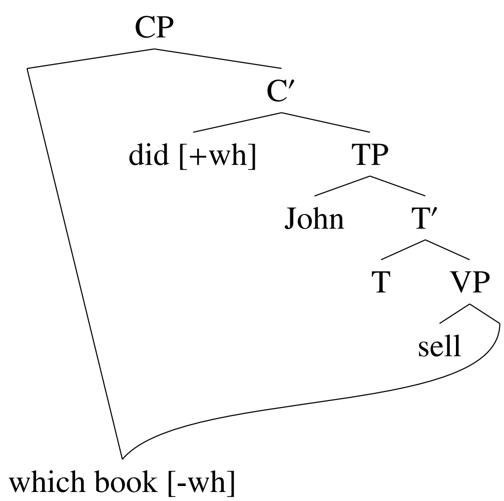


Figure 7: Parasitic Gaps: as the bottom tree is grammatical, nothing follows for its Adjunct extension

hand, enforces two dependencies: not only does the moving phrase inside the adjunct need a matching wh-feature in the argument spine, but the head carrying said feature is also dependent on the moving phrase. So the head with the wh-feature creates a dependency that has to scope into the Adjunct, and that is what leads to the ungrammaticality inference via optionality. The split between movement and parasitic gaps thus is just a specific instance of a more general principle, the *semi-permeability of Adjuncts*: constraints from within an Adjunct may reach out of it, but constraints from outside an Adjunct cannot reach into it.

The notion of semi-permeability is hard to pin down formally, mostly because many constraints on Adjuncts can be replaced with equivalent constraints on the argument spine. Still, the intuitive notion of semi-permeability immediately brings to light other configurations that just like parasitic gaps are compatible with the optionality of Adjuncts.

First, even though extraction from Adjuncts is blocked, displacement of the entire Adjunct is still possible if the dependency is not mediated by movement. Consider the sentence *how did John meet Mary t*, where the VP-adjunct *how* supposedly moves to Spec,CP. If actual movement is involved, then this sentence will be blocked for exactly the reasons already discussed in Sec. 3.1. However, an alternative analysis is that *how* adjoins directly to Spec,CP. In this case, no movement takes place, so the sentence is not ruled out *a priori*. Of course we do not want to allow Adjuncts to adjoin at arbitrary positions in the tree, so suppose that the set of adjunction sites is limited such that the node being adjoined to must contain a node that the Adjunct could adjoin to. For the example under discussion, *how* would be allowed to adjoin to Spec,CP because it is a VP-adjunct and the CP contains a VP. Admittedly, many more technical details must be specified before this account has even a remote chance of being empirically tenable, but this is not the point here. What matters is that there is some analysis that models certain instances of displacement without movement. Is this analysis compatible with optionality? Yes and no. If the entire adjunct is base-merged at a different position, then the requirement that there be a suitable adjunction site somewhere deeper down the tree is a constraint on the argument spine and thus not at odds with optionality. Consequently, this kind of displacement should be grammatical in at least some languages. Crucially, though, using base-merger to emulate extraction from within an Adjunct is still blocked because that would require constraining the shape of the Adjunct, which is impossible because of semi-permeability.

It is tempting to extend this kind of approach to instances where extraction from an adjunct is grammatical as long as movement leaves behind a resumptive pronoun. Such constructions are common in Lebanese Arabic, for example (Aoun *et al.* 2001:575):

(7) ha-l-muttahame tfeeʒaʔto lamma/laʔanno ʕrəfto ʔənno hiyye nhabasit.
this-the-suspect.SgFem surprised.2 when/because know.2 that she imprisoned.3SgFem
'This suspect, you were surprised when/because you knew that she was imprisoned.'

The grammaticality of extraction in this case is expected under the proviso that it is not brought about by Move but rather by base-merger of the extracted phrase at the target site, followed by binding of the resumptive pronoun. Due to the directionality of binding dependencies — the pronoun must be bound, but no R-expression needs a pronoun that it can bind — semi-permeability would not be an issue, then. This step, however, has to be taken with great care. For one thing, the analysis must be severely restricted so that one cannot model arbitrary instances of movement as base-merger coupled with binding of an empty element. At the same time it is far from obvious how optionality should be evaluated with respect to the base-merged phrase. If it its base-merger is treated as CP-adjunction, then a sentence like (7) would be an Adjunct extension of two sentences containing the Adjuncts *this suspect* and *because you knew that she was imprisoned*, respectively.

(8) a. This suspect, you were surprised.
    b. You were surprised when/because she was imprisoned.

Sentence (8b) should be grammatical as long as the pronoun does not need a syntactic antecedent. The status of (8a) is uncertain, though. Should it be considered syntactically ill-formed, or just infelicitous? If the former, then resumptive pronouns should never be able to salvage island violations. If the latter, then it is unclear why this strategy is only available with overt pronouns.

4 Open Problems

Resumptive pronouns are not the only challenge to the simple picture painted so far. There seems to be a wide array of adjuncts that are not islands. Subject *by*-phrases and instrumentals are not arguments and satisfy optionality. Nonetheless they do not block extraction.

(9) a. Mary was assaulted (by John) (with a hammer).
    b. Which man was Mary assaulted by *t*?
    c. What kind of weapon was Mary assaulted with *t*?

While the status of such phrases as adjuncts may be debatable, there are also clear-cut cases where an adjunct allows for extraction.

(10) Which car did John drive Mary crazy trying to fix *t*?

Intriguingly, though, it seems that even if those examples involve syntactic adjuncts, it is highly doubtful that they behave like adjuncts on a semantic level. In Davidsonian semantics (Davidson 1967; Pietroski 2005), adjuncts are analyzed as conjuncts consisting of a single predicate that applies to an even variable. For example, the sentence *John left immediately* would be assigned the LF $\lambda e.\mathbf{leave}(e)$ & $\text{Agent}(e, \mathbf{john})$ & $\mathbf{immediate}(e)$. Instrumentals and *by*-phrases are not adjuncts under this conception because they receive theta roles and thus are more tightly integrated into the denotation of the clause. Similarly, Truswell (2007) investigates non-island adjuncts like the one in (10) and concludes that these adjuncts denote an event e' that is related to the event e of the main clause through some relation R. In other words, the adjunct also adds the conjunct $R(e, e')$ to the LF and thus behaves more like an argument than an adjunct semantically. Perhaps, then, the class of Adjuncts contains only elements that are both syntactic and semantic adjuncts.

This is actually a rather natural perspective if we look at the grammaticality entailments of Adjuncts more closely. Recall that grammaticality is downward entailing, ungrammaticality is upward entailing, and grammaticality is also preserved under "fusion" of Adjunct extensions. This is remarkably close to the inference patterns of logical *and*. First, $a \ \& \ b = 1$ implies $a = 1$. Second, $a = 0$ implies $a \ \& \ b = 0$. Third, $a \ \& \ b = 1$ and $a \ \& \ c = 1$ jointly imply $a \ \& \ b \ \& \ c = 1$. So if semantic adjuncts are always interpreted as logical conjuncts, then the syntax and semantics of Adjuncts closely mirror each other at a more abstract level. One might even speculate that Adjuncts are handled by some operation in the grammar that is both structure-building and interpretative, and that the same algebraic properties thus apply both in syntax and semantics. If so, then it makes sense why syntactic adjuncts that are not semantic adjuncts behave differently from the prototypical adjuncts that Adjuncts are modeled after.

Conclusion

I introduced Adjuncts as a technical abstraction of adjuncts that is defined purely in terms of the surface properties optionality and independence. Grammars with Adjuncts exhibit certain grammaticality entailments, in particular that ungrammaticality is upward entailing. From this the Adjunct Island Constraint follows immediately as a mathematical theorem, under the assumption that I) adjuncts are Adjuncts, and II) Move is necessary to satisfy a dependency at the target site.

The first assumption needs to be refined for empirical reasons, as not all syntactic adjuncts exhibit island effects. At the same time, other constructions like coordination and relative clauses also exhibit optionality and independence to some degree, and they also constitute islands. Hopefully, a better understanding of Adjuncts — in particular regarding their semantics — will make it possible to exclude non-island adjuncts while also subsuming non-adjunct constructions that are islands.

Even such a refined definition, though, would still leave little room for parametric variation. If phrase can be extracted from in one language but not in another, then it makes little sense to treat it as an Adjunct in the former but not in the latter if it is still optional, independent, and interpreted conjunctively. However, there might be crosslinguistic variation with respect to whether certain features may remain unchecked. If so, then movement triggered by such features should not be subject to the island effects induced by Adjuncts.

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