

# Is Syntactic Binding Rational?

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## Abstract

Recent results show that both TAG and Minimalist grammars can be enriched with rational constraints without increasing their strong generative capacity, where a constraint is rational iff it can be computed by a bottom-up tree automaton. This raises the question which aspects of syntax can be adequately formalized using only such constraints. One of hardest phenomena commonly studied by syntacticians is binding theory. In this paper, we give a high-level implementation of (the syntactic parts of) binding theory in terms of rational constraints, and we argue that this implementation is sufficiently powerful for natural language. This conclusion is backed up by data drawn from English, German, and American Sign Language.

## 1 Introduction

Finite-state methods and tools are ubiquitous in computational linguistics due to their ease of use, attractive closure properties, and efficient runtime behavior. At the level of trees, they are represented by *rational constraints*. A constraint is called rational iff it defines a regular tree language iff it can be computed by a bottom-up tree automaton iff it is definable in monadic second-order logic with predicates for immediate dominance and linear precedence (Gécseg and Steinby, 1997).

Recently it was demonstrated that rational constraints can be added to TAG as well as Minimalist grammars (MGs; Stabler, 2011) without increasing their strong generative capacity (Rogers, 2003; Mönnich, 2006; Graf, 2011; Kobele, 2011). At least in the case of MGs it is also known that

rational constraints are the most powerful class of constraints for which this result holds. Therefore any aspect of syntax that cannot be expressed in terms of rational constraints requires a proper extension of the framework. Quick surveys in Graf (2011) and Kobele (2011) suggest that rational constraints are powerful enough for a rich variety of modifications and embellishment put forward in the syntactic literature. One problematic area, however, is binding theory, which is sometimes claimed to be NP-complete (Ristad, 1993) and thus firmly outside the realm of finite-state computability. In this paper we give a high-level implementation of (syntactic) binding theory in terms of rational constraints; we also argue that this implementation is sufficiently powerful for natural language and discuss potential counterexamples from several languages, foremost English and American Sign Language (ASL).

**Organization.** The paper is laid out as follows. In Sec. 2 we discuss the limitations of rational theories of binding and what they nonetheless need to be capable of accounting for. The major stumbling block turns out to be the disjoint reference requirement on pronouns. We give a finite-state implementation in Sec. 3 that successfully captures this condition as long as there is an upper bound on the number of antecedents needed for all the pronouns in a specific domain. Sec. 4 demonstrates that this assumption is empirically feasible.

## 2 Object Domain

Binding theory is a very active research area, with proposals ranging from the purely syntactic to the purely discourse-driven and covering almost every shade in between. Thus it isn't particularly surprising that there is no consensus as to what

exactly a theory of binding needs to account for. In this section we delineate the scope of a rational theory of binding and highlight the main empirical issue such an approach faces. We will see that there are parts of binding theory that provably cannot be recast as rational constraints, but also that those aren't the aspects formal grammar formalisms like TAG or MGs should be concerned with.

A distinction is often made in the linguistic literature between syntactic binding and discourse binding (Reinhart, 1983; Kiparsky, 2002; Reuland, 2011). Syntactic binding regulates the distribution of pronominals on a structural level and thus is sensitive to c-command and locality effects.<sup>1</sup> Discourse binding, on the other hand, is agnostic about structure and cares mostly about the compatibility of certain readings with an established common ground and various pragmatic considerations. For example, *John* cannot syntactically bind *him* in *John likes him* due to a locality constraint, but discourse binding might be possible nonetheless if the sentence is a facetious reply to the statement that nobody likes John. The conditions on discourse binding are rather ephemeral (see Heim, 1998 for further examples) and must be evaluated with respect to highly detailed models of the context of utterance. Thus it should come as no surprise that we consider discourse binding beyond the reach of rational constraints and focus only on syntactic binding.

The decision to ignore any kind of non-syntactic binding is also motivated by the formal results of Ristad (1993). Ristad gives a proof that canonical binding theory is NP-complete, which entails that it cannot be captured by finite-state devices. But his proof relies on configurations where arguably no syntactic binding is involved, such as weak crossover, ellipsis and Principle C effects, all of which are assumed to be (at least partially) regulated by semantics nowadays.

Syntactic binding is still a fuzzy concept, though: does it regulate the availability of specific readings *modulo* discourse considerations, or merely determine the syntactic distribution of pronominals? The former implies the latter, but not the other way round — verifying that a particular reading is available is not the same thing as ensuring that a given sentence is grammatical

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<sup>1</sup>We use *pronominal* as a catch-all term to refer to anaphors and reflexives as well as pronouns.

under some interpretation. Seeing how both TAG and MGs are primarily formal models of syntax, we opt for the latter interpretation. A rational theory of binding determines for any given sentence whether it has some grammatical reading, while the computation of available readings is relegated to a dedicated semantic apparatus (Bonato, 2005; Kobele, 2006).

This decision is further corroborated by an observation by Rogers (1998). Rogers implements Principles A and B of the canonical binding theory (Chomsky, 1981) in terms of rational constraints and proves that any rational binding theory must be index-free. In the absence of indices one can only guarantee that a suitable antecedent exists for any given pronominal, but not which specific constituent in the tree serves this role (unless there is exactly one).

**Index-Free** A rational binding theory does not evaluate specific indexations. It only ensures that some grammatical assignment of indices exists.

This condition is at odds with common practice among linguists, where sentences are analyzed with respect to specific readings.

At least for English, though, the distinction is irrelevant if one is interested only in regulating the distribution of pronominals rather than their interpretation. First of all, Index-Free is inconsequential for anaphora such as *himself*, whose distribution is regulated by Principle A. Principle A requires for every anaphor to be syntactically bound within its binding domain, but crucially, two anaphors contained in the same binding domain may share an antecedent. Therefore we do not need to know whether two anaphors have the same referent, and indices — whose sole purpose is to denote referents — are redundant.

This leaves us with the case of pronouns. According to the standard binding theory, a pronoun must not be coreferent with any material in the same binding domain. Hence a sentence like *John told Mary that he likes him* is ungrammatical if both pronouns are supposed to be bound by *John*. However, pronouns can always get an interpretation from discourse; the pronouns in the example sentence might refer to male individuals distinct from John. Pronouns do not need a syntactic antecedent at all, and hence they have the same distribution as normal DPs. This means that Princi-

ple B can be ignored and Index-Free is once again irrelevant.

One might be tempted to conclude, then, that Rogers’s rational binding theory is empirically adequate despite the mandatory absence of indices and consider the issue solved. But the arguments above do not hold in full generality. English has a rather impoverished inventory of pronominals, and the bifurcation into anaphors and pronouns is too simple from a cross-linguistic perspective. Kiparsky (2002; 2012) proposes to stratify pronominals depending on the maximum size of their binding domain and whether there are configurations in which they must be disjoint in reference from other DPs. Pronominals with such a disjointness requirement are *obviative* or, equivalently, *show obviation*. Kiparsky’s system gives rise to ten distinct types, eight of which are attested empirically (see Tab. 1).

Our previous argument that Index-Free is unproblematic for anaphors because they need not be disjoint in reference carries over to all pronominals that lack obviation effects. Likewise, indices aren’t required for any pronominals that do not need a syntactic antecedent, for the reasons we just discussed. This still leaves us with two attested subclasses, though: I) long-distance reflexives such as Swedish *sig* that need an antecedent which belongs to the same finite clause but is not a coargument, and II) pronouns like Marathi *aapaṅ* that cannot receive a referent from context or discourse. In neither case can the problem of determining the correct distribution be separated from obviation, so that Rogers’s implementation is insufficient in its current form.

What is needed, then, is a strategy for dealing with obviation effects that can be implemented with rational constraints. In combination with suitable modifications of the definition of binding domain in Rogers (1998), this would be enough to cover all instances of syntactic binding identified by Kiparsky (the first three columns in Tab. 1).

Note that this is relevant even if one is only interested in English. While unrestricted *him* can appear in the same positions as standard DPs (i.e. R-expressions), the distributions of discourse bound *him* and syntactically bound *him* are incomparable (more on that in Sec. 4). At the same time, unrestricted *him* is mostly restricted to deictic uses, which are comparatively rare. Since *him* is actually bound in most instances and the type

of binding gives rise to different distributions, an efficient mechanism for syntactic binding is essential under more realistic conditions where not every pronoun can be assumed to introduce a new referent.

In sum, the basic duty of binding theory from the perspective of formal grammars is to regulate the distribution of various pronominal forms (where, depending on the ultimate goals, one might want to distinguish between homophonous pronouns that belong to distinct classes). More ambitious goals, such as computing specific meanings or incorporating conditions imposed by discourse, are beyond the reach of rational constraints and best left to additional machinery. This does not mean that the task at hand is trivial, though. Since rational constraints cannot keep track of indexations, it is unclear how the requirements of obviative pronouns are to be handled. The next section offers a simple solution to this issue.

### 3 Computing Obviation

As just discussed, the only challenge to a rational binding theory is posed by pronominals that both need a syntactic antecedent and show obviation effects. Other pronominals either do not involve syntactic binding or are easily reigned in by extending the size of the binding domain in Rogers’s (1998) definition of Principle A. For the problematic subclass of pronominals — be it Swedish *sig*, Marathi *aapaṅ*, or syntactically bound pronouns in English — there are two constraints to be taken care of: I) every pronoun has an antecedent, and II) no two pronouns that must be disjoint in reference have the same antecedent.

Suppose that we have some well-defined notion of *obviation domain* such that every pronominal belongs to at least one obviation domain and only pronominals belonging to the same one can (but need not) be required to be disjoint in reference. In addition, there is some procedure  $A$  such that for each pronominal  $p$  in tree  $t$ ,  $A(p, t)$  is the set of viable antecedents of  $p$  in  $t$ . In the case of canonical binding theory, the two would be supplied by the definition of binding domains on the one hand and c-command on the other. Then I) and II) can be verified as follows.

Given a tree  $t$  and sequence  $P := \langle p_1, \dots, p_{i-1} \diamond p_i, \dots, p_n \rangle$  of pronominals in  $t$ ,  $n \geq 0$ , the *debt* of  $P$  is

	Size of Binding Domain				
	Subject Domain	Finite Clause	Sentence	Discourse	Unrestricted
<b>No Obviation</b>	English <i>himself</i>	Russian <i>sebjja</i>	Icelandic <i>sig</i>	Turkish <i>kendisi</i>	—
<b>Obviation</b>	—	Swedish <i>sig</i>	Marathi <i>aapaṅ</i>	Greek <i>o idhios</i>	English <i>him</i>

Table 1: Cross-linguistic classification of pronominals according to Kiparsky (2002; 2012)

- 0 if  $i - 1 = n$ ,
- $0 + \text{debt}(\langle p_1, \dots, p_i \diamond p_{i+1}, \dots, p_n \rangle)$  if there is some  $p_j$ ,  $j < i$ , such that  $p_j$  and  $p_i$  need not be disjoint in reference in  $t$ ,
- $1 + \text{debt}(\langle p_1, \dots, p_i \diamond p_{i+1}, \dots, p_n \rangle)$  otherwise.

Assume  $t$  contains obviation domains  $O_1, \dots, O_n$ ,  $n \geq 1$ , and let  $\text{pro}(O_i)$  be the set of pronominals contained by  $O_i$ ,  $1 \leq i \leq n$ . Furthermore, let  $\phi$  be some arbitrary procedure for totally ordering any given set  $P \subseteq \text{pro}(O_i)$ ,  $\text{debt}(P) := \text{debt}(\langle \diamond \rangle \cdot \phi(P))$ , and  $A(P, t) := |\bigcup_{p \in P} A(p, t)|$ . Then conditions I) and II) above are satisfied in  $t$  iff for every  $1 \leq i \leq n$  and  $P \subseteq \text{pro}(O_i)$ ,  $A(P, t) \geq \text{debt}(P)$ .

*Proof.* Suppose  $A(P, t) \geq \text{debt}(P)$  for every  $P \subseteq \text{pro}(O_i)$ . Then in particular  $A(\{p\}, t) \geq \text{debt}(\{p\})$  for every  $p \in \text{pro}(O_i)$ , implying I). As for II), let  $\Omega$  be the smallest set containing all obviative  $p \in \text{pro}(O_i)$ . By assumption  $A(P, t) \geq \text{debt}(P)$  for all  $P \subseteq \Omega$ , too, which entails that for any arbitrary choice of  $p_1, \dots, p_n \in \Omega$ ,  $n \geq 2$ , there are at least  $n$  available antecedents. It follows immediately that no two  $p_i, p_j \in \Omega$  need to share an antecedent.

In the other direction, we prove the contrapositive:  $A(P, t) < \text{debt}(P)$  for some  $P \subseteq \text{pro}(O_i)$  implies violation of I) or II). If there is some  $p$  such that  $\text{debt}(\{p\}) = 1 > 0 = A(\{p\}, t)$ , then I) does not hold. Now let  $\Omega$  be defined as before. It is easy to see that II) is necessarily violated if for some  $P \subseteq \Omega$ ,  $A(P, t) < \text{debt}(P)$ .  $\square$

Intuitively, our condition states that for every collection of mutually obviative pronominals, there are enough antecedents such that no two pronominals need to share a referent. It is crucial that we consider every subset of a given obviation domain, for otherwise a pronominal with many available antecedents could pay off debt induced by other pronominals. For example, if  $A(p_1, t) =$

2 and  $A(p_2, t) = 0$ , then  $A(\{p_1, p_2\}, t) = 2 = \text{debt}(\{p_1, p_2\})$  yet  $p_2$  has no viable antecedents at all and thus cannot be bound.

Let us quickly work through an example. Consider the clause *that he wants him to entertain him*. According to standard linguistic assumptions, it consists of two overlapping obviation domains,  $O_1 := \text{that he wants him}$  and  $O_2 := \text{him to entertain him}$ . Each obviation domain has a debt of 2, and each pronoun needs at least one possible antecedent. Any masculine singular DP that c-commands the entire clause is a viable antecedent for the pronouns. Hence we correctly predict (1b) but not (1a) to be grammatical if all pronouns are meant to be syntactically bound.

- (1) a. \* John said that he wants him to entertain him.
- b. John told Bill that he wants him to entertain him.

Note that almost all morphological requirements on the antecedent (gender, animacy, etc.) can be encoded as part of the procedure  $A$  if one considers them relevant to syntax. The major exception is number, which also needs to be taken into account in the definition of the debt function. At first sight this seems rather trivial: instead of a single debt value, the function now returns a pair encoding the minimum required number of singular and plural antecedents. However, a plural pronominal can be bound by two singular DPs, so every time one is encountered there is a choice of either increasing the singular antecedent threshold by 2 or the plural antecedent threshold by 1. Rather than a pair of values, then, we actually need to keep track of a set of such constantly updated pairs, and the cardinality of said set doubles with every new plural pronominal. Singular and plural antecedents must be counted separately, too, and for every obviation domain  $O$  and  $P \subseteq O$  there must be some pair  $d := \langle sg, pl \rangle \in \text{debt}(P)$  such that  $sg$  and  $pl$  do not exceed the number of singular and plural antecedents, respectively.

Things might be even more involved, because at least some sentences seem to marginally allow for a singular pronoun to partially overlap in reference with a plural pronominal, even in cases where the former should be obviative.

- (2) John<sub>i</sub> and Peter<sub>j</sub> agreed that they<sub>i+j</sub> like him<sub>i</sub>.

Unfortunately the binding properties of plural pronominals (let alone dual) still aren't particularly well understood, so we have to leave it to future research for now.

Even when the complications introduced by plural are taken into account, though, the procedure proposed here can be computed by rational constraints iff the following holds.

**Rational Base** Obviation domains, mandatory disjointness in reference, and possible antecedents can be determined by rational constraints.

**Limited Obviation** There is some finite upper bound  $k$  on the range of *debt*.

The relevance of Rational Base is obvious in both directions. The necessity of Limited Obviation follows immediately from the fact that rational constraints are computable by bottom-up tree automata, which by virtue of being finite-state can only count up to some fixed threshold  $k$ . In the right-to-left direction, it suffices to observe that both the debt function and the cardinality comparison  $A(P, t) \geq \text{debt}(P)$  can easily be stated in monadic second-order logic — definability in which is equivalent to being rational — if Limited Obviation holds together with Rational Base.

To our knowledge, Rational Base is satisfied for all theories of binding commonly entertained in the literature (cf. Rogers's implementation). Whether Limited Obviation is tenable is an empirical question. Is there an upper bound on the number of required antecedents per obviation domain?

## 4 Empirical Evaluation

In this section we investigate a range of data drawn primarily from English in an attempt to elicit a counterexample to Limited Obviation. Since Limited Obviation can be falsified only by instances of syntactic binding, we assume

that pronouns are indeed syntactically bound unless there is evidence to the contrary. We also make heavy use of quantified DPs, which aren't as amenable to discourse binding as their non-quantified counterparts. In particular, DPs quantified by *no* are viable antecedents for syntactic binding, but not for discourse binding, as it evidenced by the paradigm in (3).

- (3) a. Every player was given a card. He was delighted.  
 b. \*No player was given a card. He was upset.  
 c. Every/No player was upset that he wasn't given a card.

Discourse binding is the only option in (3a) and (3b) (besides introducing an entirely new referent), whereas (3c) also allows for syntactic binding. A *no*-quantified DP is a licit antecedent in the latter example, but not the former.

Besides the restriction to syntactic binding, it is also clear from our definitions that Limited Obviation is trivially satisfied for every obviation domain that may only contain a bounded number of pronouns. So if there exists a counterexample to Limited Obviation in natural language, it must involve an obviation domain without such a bound. The literature on binding contains not a single mention of a language where obviation domains are larger than a single CP (keep in mind that we only consider pronominals here; there are of course instances of obviation domains extending beyond several CPs, but those involve R-expressions such as proper names). There are three ways of accommodating an unbounded number of pronouns inside a single CP: adjunction, TP/VP/DP-recursion, and coordination. Let's consider one after another.

### 4.1 Adjuncts

In English, pronouns inside adjuncts usually do not show obviation effects. Native speakers of English agree that the sentence below has a reading in which the pronoun is bound by the quantified DP.

- (4) Every/No/Some woman put the box down in front of her.

Even speakers that prefer a reflexive instead of the pronoun still consider this sentence grammatical under the intended reading.

In cases where obviation occurs, pronouns contained by distinct adjuncts do not obviate each other, so debt is increased by at most one point, irrespective of the number of adjuncts.

- (5) a. \* Every/No/Some priest sacrificed a goat for him/in honor of him.  
 b. Every/No/Some Egyptian goddess asked of some priest that he sacrifice a goat for her in honor of her.

In (5a), the pronoun must introduce a new referent or be at least discourse-bound. Otherwise it would be locally bound by the *priest*-DP, and this reading is not available. In the perfectly acceptable (5b), on the other hand, the same adjuncts are clause mates and each one contains a pronoun that is bound by the quantified subject of the next higher clause. Note that in the minimally different (6) below, the pronouns inside the adjunct must still be disjoint in reference from the embedded subject. Consequently, they can be bound by *priest* iff *he* is bound by *god* (this reading, albeit odd, is indeed available).

- (6) Every/No/Some Egyptian god asked of some priest that he sacrifice a goat for him in honor of him.

Taken together the data corroborates our initial claim: pronouns inside adjuncts usually aren't obviative, but when they are the obviation effect does not extend to adjuncts contained in the same clause. This guarantees that debt is increased by only one point no matter how many adjuncts are present.

A similar pattern emerges in German, where some speakers treat pronouns inside PP-adjuncts as obviative yet pronouns contained by distinct PPs do not obviate each other.

- (7) a. \* Jeder/Kein/Irgendein Student hat  
 every/no/some student has  
 für ihn/neben ihm  
 for him.ACC/next to him.DAT  
 einen Spickzettel versteckt.  
 a book hidden  
 'Every/no/some student hid a cheat sheet for himself/next to himself.'  
 b. Jeder/Kein/Irgendein Student hat  
 every/no/some student has  
 seine Schwester gebeten, dass sie  
 his sister asked that she

für ihn neben ihm einen  
 for him next to him a  
 Spickzettel versteckt.  
 cheat sheet hides  
 'Every/no/some student asked his sister to hide a cheat sheet next to him for him.'

## 4.2 TP-Recursion

Nested TPs do not endanger the empirical adequacy of Limited Obviation. This is witnessed by the paradigm in (8).

- (8) a. \* Every/No/Some patient said [<sub>CP</sub> that [<sub>TP</sub> he wants [<sub>TP</sub> him to be sedated ]]].  
 b. \* Every/No/Some patient said that he wants him to sedate him.  
 c. Every/No/Some patient told some doctor that he wants him to sedate him.  
 d. Every/No/Some patient told some doctor that he incorrectly believes him to want him to sedate him.

The ungrammaticality (8a) shows that the ECM subject must be disjoint from the subject of the embedded clause, so obviation domains span at least an entire TP and may partially overlap. At the same time it is clear that the embedded subject pronoun can be bound by the matrix subject, indicating that obviation domains do not extend beyond CPs. Comparing (8b) to (8c), we see that the overlap in nested TPs is limited to Spec,TP, since two antecedents are enough for three pronouns, which implies that the embedded subject and the object of the ECM clause can have the same referent. This conclusion is further corroborated by (8d), in which two antecedents are sufficient to satisfy the binding requirements of four pronouns. It follows, then, that the debt of  $n$  nested TPs,  $n \geq 1$ , is determined by the maximum of the debts of the individual TPs. As long as the debt of individual TPs is finitely bounded, so is the debt of nested TPs.

## 4.3 VP-Recursion

It is commonly assumed that English does not allow for VPs to be nested without an intervening TP. To the degree that one is willing to entertain

VP-recursion as a possible analysis for some constructions in English, it seems to behave exactly like TP-recursion.

- (9) a. \*Every/No/Some patient said that he made him operate on him.  
 b. Every/No/Some doctor told some patient that he made him watch him operate on him.

#### 4.4 DP-Recursion

The absence of obviation effects with pronouns inside DPs in English is a well-established fact.

- (10) Every/No/Some politician liked the (photographer's) picture of him.  
 (11) Every/No/Some politician enjoyed the (consultant's) presentation to him.

It is a contentious issue whether the observed behavior is due to DPs establishing new obviation domains or pronouns losing their obviative properties in these configurations. For our purposes, though, the underlying cause of this pattern is irrelevant as long as it carries over to nested DPs, which is indeed the case.

- (12) Every/No/Some post-modern artist must paint at least one [picture of [him and a picture of him]].  
 (13) Every/No/Some facetious client wanted to see a [presentation of [a presentation to him] to him].

The first sentence has a grammatical reading in which every post-modern artist *a* must paint a picture that depicts both *a* and some other picture of *a*. In order for this reading to be licensed the two pronouns inside the DP need to be coreferent, wherefore they do not obviate each other. One could wonder whether this might be due to the presence of a conjunction, but this objection does not apply to (13), which has an analogous reading. Some speakers dislike both sentences, but their judgment is independent of a specific interpretation and thus has no bearing on determining obviation requirements. We conclude that nested DPs do not give rise to unbounded debt.

#### 4.5 Coordination

Coordination exhibits a very peculiar pattern that to our knowledge has gone unnoticed in the empirical literature so far: coordination of syntacti-

cally bound pronouns is grammatical iff the coordinated pronouns are distinct.

- (14) a. Every/No/Some football player told every/no/some cheerleader that the coach wants to see him and her in the office.  
 b. \*Every/No/some football player told every/no/some masseur that the coach wants to see him and him in the office.

It is unclear what exactly the relevant notion of distinctness is. Several languages have distinct pronouns with identical morphological feature specifications that differ with respect to degrees of discourse salience, e.g. Latin *is*, *iste*, *ille*, and *dieser* and *jener* in German. Marcel den Dikken (p.c.) points out that a similar contrast exists in Dutch and that the Dutch analogue of (14b) seems well-formed if one coordinated pronoun is replaced by one of these alternate pronouns.

We are unsure whether the same holds true of German, but fascinating as this question might be, it is ultimately orthogonal to the issue at hand, *viz.* whether coordination can lead to unbounded debt. Latin, German, and Dutch still have only a finite inventory of distinct pronoun types, so unless arbitrarily many identical tokens of one of these types can be coordinated, we are still guaranteed a finite bound on debt even if the pronouns would all obviate each other.

#### 4.6 American Sign Language

Curiously, the analogue of (14b) is well-formed in ASL, so identical pronouns may indeed be coordinated.

- (15) [all wrestler]<sub>i</sub> inform [someone swimmer]<sub>j</sub> that *pro*<sub>i</sub> and *pro*<sub>j</sub> will ride-in-vehicle limo go-to dance  
 'Every wrestler told some swimmer that the two of them would ride in a limo to the dance.'

It is important to keep in mind, however, that ASL's binding mechanism differs in essential respects from that of English. Foremost, it has distinctively deictic flavor to it. Referential expressions are assigned distinct *loci* in front of the speaker, and a pronoun is realized by pointing at a previously established locus. So in (15), the signer would first map *every wrestler* and *some*

*swimmer* to specific loci, which we indicate by the subscripts  $i$  and  $j$ , respectively. In order to refer back to them in the coordination, the signer simply points at the intended loci. That is to say,  $pro_i$  and  $pro_j$  in the sentence above represent only the act of retrieving referents from their loci via pointing, no discrete morphological forms beyond that are involved. Pronouns are pointers.

Considering the deictic nature of all pronouns in ASL, one might suspect that (15) involves discourse binding rather than syntactic binding. After all, (14b) is perfectly grammatical in English if the pronouns are used deictically by simultaneously pointing at two specific individuals. Moreover, binding in ASL lacks several properties of syntactic binding. Foremost, the denotational domain of a pronoun must be non-empty, meaning that a DP quantified by *no* is not a suitable antecedent.

- (16) a. [each politics person] <sub>$i$</sub>  tell-story  
 $pro_i$  want win  
 b. \* [no politics person] <sub>$i$</sub>  tell-story  $pro_i$   
 want win  
 ‘Every/No politician <sub>$i$</sub>  said he <sub>$i$</sub>  wants to win.’

As we saw at the beginning of this chapter, discourse binding across sentences in English is subject to a similar restriction, making it rather unlikely that these instances of binding in ASL are truly syntactic. Further evidence along these lines is presented by Schlenker (2011; 2012). Recent work of Rudnev and Kimmelman (2011) on Russian Sign Language also suggests that it is the norm for binding conditions in signed languages to differ from those of spoken languages, rather than the exception.

When these observations are added to our own, it seems that neither English nor ASL furnish a decisive counterexample to Limited Obviation. Consequently, a rational theory of binding seems empirically feasible.

## 5 Conclusion

We have shown that if one is content with a theory that can only verify the existence of some grammatical reading for a given phrase structure tree — rather than evaluating specific readings — the major challenge to a rational theory of binding is posed by pronouns that need a syntactic antecedent yet must not be coreferent with any other

material within the bounds of some locality domain. This problem can be tackled by a system that builds on obviation domains, antecedents, and the notion of debt, which represents the number of antecedents that must be present in order to satisfy all binding requirements. As long as the debt of obviation domains is finitely bounded, the proposed system is finite-state computable. No convincing counterexample to this assumption could be found in English or ASL. While it is difficult to estimate from the existing binding literature whether this result will carry over to other languages due to the scarcity of pertinent data, we are confident that potential counterexamples will also turn out not to be truly syntactic in nature.

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## References

- Roberto Bonato. 2005. Towards a computational treatment of binding theory. In *Logical Aspects of Computational Linguistics, 5th International Conference, LACL 2005, Bordeaux, France, April 28–30, 2005*.
- Noam Chomsky. 1981. *Lectures on Government and Binding: The Pisa Lectures*. Foris, Dordrecht.
- Thomas Graf. 2011. Closure properties of minimalist derivation tree languages. In Sylvain Pogodalla and Jean-Philippe Prost, editors, *LACL 2011*, volume 6736 of *Lecture Notes in Artificial Intelligence*, pages 96–111.
- Ferenc Gécseg and Magnus Steinby. 1997. Tree languages. In Gregorz Rozenberg and Arto Salomaa, editors, *Handbook of Formal Languages*, volume 3, pages 1–68. Springer, New York.
- Irene Heim. 1998. Anaphora and semantic interpretation: A reinterpretation of Reinhart’s approach. In Uli Sauerland and O. Percus, editors, *The Interpretive Tract*, volume 25 of *MIT Working Papers in Linguistics*, pages 205–246. MIT Press, Cambridge, Mass.
- Paul Kiparsky. 2002. Disjoint reference and the typology of pronouns. In Ingrid Kaufmann and Barbara Stiebels, editors, *More than Words*, volume 53 of *Studia Grammatica*, pages 179–226. Akademie Verlag, Berlin.



- Paul Kiparsky. 2012. Greek anaphora in cross-linguistic perspective. *Journal of Greek Linguistics*, 12:84–117.
- Gregory M. Kobele. 2006. *Generating Copies: An Investigation into Structural Identity in Language and Grammar*. Ph.D. thesis, UCLA.
- Gregory M. Kobele. 2011. Minimalist tree languages are closed under intersection with recognizable tree languages. In Sylvain Pogodalla and Jean-Philippe Prost, editors, *LAACL 2011*, volume 6736 of *Lecture Notes in Artificial Intelligence*, pages 129–144.
- Uwe Mönnich. 2006. Grammar morphisms. Ms. University of Tübingen.
- Tanya Reinhart. 1983. *Anaphora and Semantic Interpretation*. Croon-Helm, Chicago University Press.
- Eric Reuland. 2011. *Anaphora and Language Design*. MIT Press, Cambridge, Mass.
- Eric Sven Ristad. 1993. *The Language Complexity Game*. MIT Press, Cambridge, Mass.
- James Rogers. 1998. *A Descriptive Approach to Language-Theoretic Complexity*. CSLI, Stanford.
- James Rogers. 2003. Syntactic structures as multi-dimensional trees. *Research on Language and Computation*, 1(1):265–305.
- Pavel Rudnev and Vadim Kimmelman. 2011. Breaking the coreference rule: Reflexivity in Russian Sign Language. Submitted to *Semantics & Pragmatics*.
- Philippe Schlenker. 2011. Donkey anaphora: The view from sign language (ASL and LSF). To appear in *Linguistics & Philosophy*.
- Philippe Schlenker. 2012. Complement set anaphora and structural iconicity in ASL. To appear in *Snippets*.
- Edward P. Stabler. 2011. Computational perspectives on minimalism. In Cedric Boeckx, editor, *Oxford Handbook of Linguistic Minimalism*, pages 617–643. Oxford University Press, Oxford.