Restricting Inverse Scope in Synchronous Tree-Adjoining Grammar

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Abstract

This paper provides an account for inverse scope restrictions with nominal quantifiers using synchronous tree adjoining grammar. It aims to provide an alternative account to Beghelli & Stowell's (1997) work on similar data.

1 Introduction

Recent work in the study of the syntax-semantics interface [Nesson and Shieber, 2006, 2007, 2008] using synchronous tree-adjoining grammars (STAGs) has attempted to cover a broad range of empirical issues with respect to scopal interactions (control verbs, relative clauses, inverse linking). The majority of this work has attempted to relax the locality restrictions enough to be able to derive possible interpretations while remaining as restricted as possible.

These analyses however are unable to account for asymmetries in the scopal interaction of nominal quantifiers (see §2). This paper aims to explain these asymmetries through two novel mechanisms: (1) Operations on an elementary tree must proceed in the opposite order of the prominence ordering of the nodes on the tree (to be explained in §3). (2) Different classes of quantifiers, represented as multi-component sets, differ in their derivation procedure, where some classes must combine simultaneously in an elementary tree while other classes' scopal tree is able to adjoin later in the derivation.

This paper gives an alternative analysis to Beghelli and Stowell's (henceforth B&S) (1997) analysis of quantifier scope in English. In particular this paper examines the restriction on inverse scope readings in English when the object quantifier is a count quantifier as compared to the the ability to have inverse scope readings when the quantifier is a universal quantifier. Additionally, these same restrictions will be shown to hold in the double object constructions in English.

This paper will then extend this analysis to quantifier scope puzzles in Mandarin Chinese and Hungarian. Quantifier scope in both Mandarin and Hungarian is said to correspond to the hierarchical positions of the nominal quantifiers, allowing no scopal ambiguities. Yet it has been observed that there are certain constructions in both languages where there are scopal ambiguities. Mandarin "passive" sentences and Hungarian sentences where both quantifiers follow the verb are known to allow inverse scope readings as well as surface scope readings. Previous analyses of these phenomena in conjunction with the constraints proposed in this paper derive the ambiguity in these constructions while keeping the other constructions unambiguous in their scope readings.

The organization of the paper will be as follows: §2 will describe the restrictions on inverse scope reading in English sentences with two nominal quantifiers. §3 will explain the derivational constraints utilized for the English analysis. §4 will show how these constraints derive the right scope readings in the examples described in §2. §5 will describe and analyze the Mandarin and Hungarian extensions to the analysis. §6 will conclude the paper, offering some further areas for exploration.

2 Data

2.1 English Nominal Quantifiers

As discussed in Beghelli and Stowell [1997], certain classes of nominal quantifiers are able to scope over quantificational subjects when in object position, while other classes may not. This is exemplified in (1) and (2).

(1) Every student read 2 papers. ($\forall > 2$, $2 > \forall$)

(2) Every student read more than 2 papers.
($\forall > 2+$, $2+ \not> \forall$)

The examples in (1) and (2) show that quantifiers like *2* (called group-denoting quantifier phrases (GQPs) by B&S) can take wide scope while in object position while quantifiers like *m*ore than 2 (called count quantifier phrases (CQPs) by B&S) cannot. Universal quantifiers (DQPs) also pattern with GQPs by being able to scope over the denotation of the subject NP, as shown in (3).

(3) 2 students read every book. ($\forall > 2$, $2 > \forall$)

2.2 English Double Object Construction

Double object constructions in English also seem to follow the same pattern where DQPs seem to be able to take scope over other quantifiers when in a hierarchically lower position, while CQPs are unable to (as in (4)[1]. The pattern of scope rigidity versus scope ambiguity is exhibited in both double object and prepositional dative constructions in (4) and (5).

(4) a. John assigned more than 2 students every paper on the syllabus. ($\forall >$ 2+, 2+ $> \forall$)

b. John assigned every student more than 2 papers on the syllabus. ($\forall >$ 2+)

(5) a. John assigned more than 2 papers on the syllabus to every student. ($\forall >$ 2+, 2+ $> \forall$)

b. John assigned every paper on the syllabus to more than 2 students. ($\forall >$ 2+)

[1] Some speakers consider this construction to be unambiguous. An analysis of this dialectal difference is outside the scope of this paper and awaits future work.

3 Restricting Inverse Scope

3.1 Inverse Scope in STAG

Common to many STAG analyses is the use of *m*ultiple adjunction [Schabes and Shieber, 1994] to get inverse scope. With multiple adjunction, the scopal part of all QPs are able to adjoin at the same node in the course of the derivation. A further convention states that the later combined tree adjoins above the earlier combined tree. Inverse scope is derived because either quantifier is able to adjoin first. This type of analysis runs into problems accounting for the data in §2 because the only restriction on scopal parts of two clausemate quantifiers is that they both appear within the semantic tree associated with the verb of which they are both arguments. As a result, it fails to distinguish among different classes of quantifiers and also between the scopal possibilities when the quantifiers are in subject and object position.

3.2 Beghelli & Stowell

B&S obtain the differences in scope possibilities (developed within the minimalist framework) by positing a series of functional projections above VP. They argue that different sets of quantifiers have different features that need to be checked and this leads to movement at LF where the QPs move to a functional projection that satisfies some feature. They categorize quantifier phrases into five groups: Interrogative QPs, Negative QPs, Group-denoting QPs, Distributive QPs, and Count QPs. Each group is denoted by a shared semantic feature: WhQPs introduce questions, NQPs negate, GQPs denote groups (and plural individuals), DQPs distribute over sets and are universally quantified, and CQPs count individuals with a certain property. The different scope possibilities are constrained by the positions each class of quantifier can move to. The different functional projects (hierarchically ordered) with the associated QP class that moves to the specifier position of the functional projection are in (6).

(6) RefP(GQP) $>$ CP(WhQP) $>$ AgrSP(CQP) $>$ DistP(DQP) $>$ ShareP(GQP) $>$ NegP(NQP) $>$ AgrOP(CQP)

B&S's solution to why CQPs can't scope over the subject quantifier while in object position is that a CQP in object position is only able to move to the specifier of AgrOP while GQPs and DQPs move to a position higher in the structure. The c-command relationship then determines the scope relation.

Although this style of analysis may be available in a STAG, this paper aims to provide an alternative account. An alternative account is preferable because (a) this type of analysis seems to go against the spirit of STAG where syntactic and semantic elements combine synchronously; and (b) it is worth while to see if this approach can be simplified within STAG. Complexities that arise in the B&S analysis include the notion that quantifiers must be ambiguous as to their feature specifications, and that a large number of functional projections are necessary for any verbal tree. For instance they analyze 'every' as a DQP or a GQP, this would entail three different possible landing spots for 'every' and thus three different lexical items.

3.3 Current Proposal

Our proposed analysis assumes a synchronous derivation [Shieber and Schabes, 1990], multi-component trees (MCTAG) [Joshi, 1987], and multiple adjunction. Also following the literature on multiple adjunction, I will assume that the tree that is adjoined later in the derivation scopes over the previously adjoined structure [Schabes and Shieber, 1994].

The analysis aims to capture the intuition that the derivation of the sentence reflects the sentence structure and that a different structure stems at least partially from a different derivation. For the present data this assumes that there is a structural difference between the two different scope readings. In the present analysis this will manifest itself in the semantic trees.

3.4 Hierarchy in Derivation Order

Traditionally, TAGs do not specify the order of derivation among the substitution and adjoining operations that target a given elementary tree. One way in which to limit the inverse scope possibilities is to restrict the ordering of such operations in the following fashion: The order of operations on an elementary tree must proceed in the opposite order of the asymmetrical c-command (ACC) and irreflexive dominance (DOM) ordering of the nodes of the tree. More formally we define a relation PROM in (7) and then impose the following restriction in (8).

(7) $\text{PROM}_{def} = \{(x,y) | (x,y) \in \text{DOM}_{irr} \cup \text{ACC}\}$

(8) PROMINENCE RESTRICTION ON DERIVATION (PROD)
If node a in syntactic tree T is targeted (by substitution or adjoining) prior to node b in T, then (a,b) must not be in PROM

This constraint ensures that a hierarchically lower node is targeted before a higher one. The dominance relation applies in sentences like (9) where the adverb that adjoins to S scopes over the adverb that scope over VP.

(9) a. Intentionally, John knocked twice.

b. Twice, John knocked intentionally

The c-command relation applies in the cases of nominal quantifiers discussed in §2. Since the subject of a transitive sentence c-commands its object, the object quantifier must combine into the elementary tree first in the derivation. Since the combination of the syntactic and semantic trees is synchronous, this restriction does not allow scope ambiguity in these cases.

3.5 Relaxing Derivation Order

Different applications of MCTAG have assumed that the properties of all instances of multicomponent adjoining in a grammar behave in a uniform fashion, whether restricted to being tree-local, set-local, or non-local. In particular MCTAG [Joshi, 1987] assumes that all members of a tree set combine with a target tree simultaneously and VTAG [Rambow, 1994, Nesson and Shieber, 2008] assumes that that there is no simultaneity constraint on members of a tree set. I propose instead that a tree set can specify derivational restrictions on its use during a derivation. In particular, I will consider two possibilities for a given set, which interact with my proposal concerning derivational order:

1. Simultaneous combination (SC): the integration of the trees within a tree-set must take a single point in a derivation.

2. Delayed combination (DC): the integration of the trees within a tree-set may take place at different points during the derivation.

Only the variable-trees must be derived following the hierarchical order (as in vector-TAG [Rambow, 1994, Nesson and Shieber, 2008]). I argue that the different classes of quantifiers differ along the SC/DC dimension. Specifically, the tree-set of CQPs is SC, while the other QP classes are DC. For present purposes, it will suffice for me to assume that all quantifier trees are constrained to adjoin in a tree-local fashion. Note that non-local derivation in combination with SC will be equivalent to non-local MC-TAG and is NP-hard to parse[Rambow and Satta, 1992, Champollion, 2007].[2]

3.6 English Nominal Quantifiers

With these preliminaries in place, we can now turn to the analysis of the scopal asymmetries in (1) and (2). Since the object QP in (1) is DC, two possible derivations are available (using the trees in Figure 1). In the first of these, the object quantifier *2 papers* is combined first, following the PROMINENCE RESTRICTION ON DERIVATION order. On the semantic side, this means that the variable tree must be substituted into the *read* tree. At this point, the scopal component is also free to adjoin to the t* root of the *read* tree. If it does this, the subsequent integration of the subject quantifier *every student* will result in the scope of the universal being outside of the numeral (as in figure 1). In the other derivation, the DC property of the universal quantifier tree is exploited. The scope portion of the numeral quantifier is not adjoined immediately. Instead, the derivation proceeds through the integration of the subject quantifier, including its scope, and then the scope of the object quantifier is finally adjoined. This yields wide scope for the object quantifier (as in figure 1).

For example (2), in which the object quantifier, in virtue of being a CQP, is SC, only the first of these derivations is possible: the scope of *more than 2 books* must adjoin to t* at the point that the variable is substituted, resulting in obligatory narrow scope for the object quantifier.

Note that when CQPs are in subject position, they nonetheless show scope ambiguity with respect to object quantifiers, as in (10).

(10) More than 2 students read every book.
 $(2+ > \forall)$

This possibility is predicted by the current analysis: the flexibility of the object quantifier to adjoin at t* either before or after the subject quantifier will permit the generation of either scope, even in the face of a SC requirement on the subject quantifier.

The double object construction described in §2 also can be explained using the c-command constraint and delayed combination. Adopting the Larsonion VP-shell analysis [Larson, 1988] as in figure 2, the node that is targeted by the goal object c-commands the node that is targeted by the theme object. Theme object quantifiers that have the DC property are able to take scope over the theme object quantifier, while ones that have the SC property are unable to. The prepositional dative case works analogously, where only when the lower goal object has the DC property does inverse scope take place.

4 Extending the Analysis

The behavior of nominal quantifiers in various other languages differs from the English case described above. Both Mandarin and Hungarian are purported to have their scope ordering match surface structure very closely. "Active" Mandarin sentences and Hungarian sentences where both quantifiers are in the pre-verbal field only have surface scope readings. This corresponds with all the quantifiers in both languages having the SC feature. Yet there are constructions in both languages where scope ambiguity does arise. This section aims to show how the constraints in this analysis are able to account for the varying scopal behavior in these languages without DC.

4.1 Data

4.1.1 Mandarin Chinese Passives

Aoun and Li [1993] observes that there is a distinction in the scope possibilities between (11) and (12). In (11), the subject QP must scope over the object QP. This contrasts with the sentence in (12) where the inverse scope reading is possible. Traditionally (11) has been categorized as an active sentence and (12) as the passive with BEI being alter-

[2] Thanks to an anonymous reviewer for pointing this out.

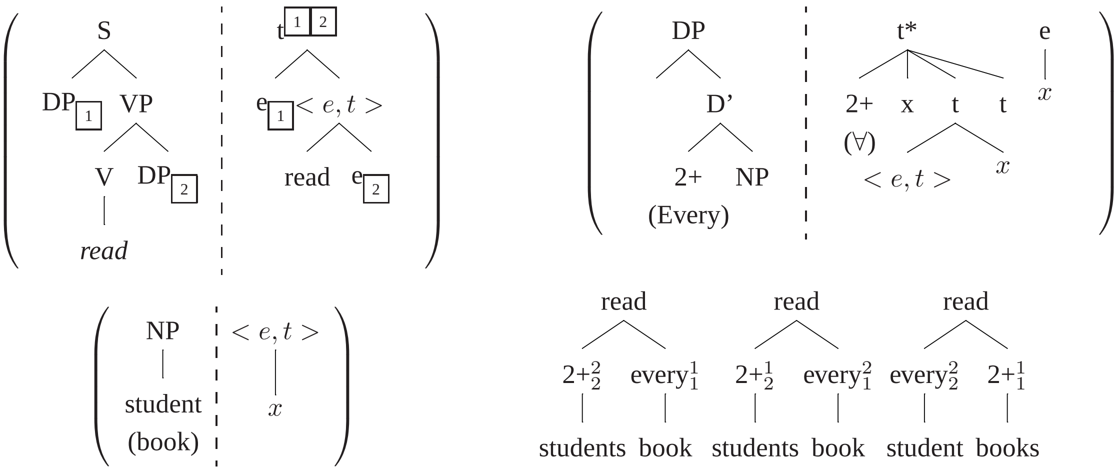

Figure 1: This figure shows elementary trees for the verb, quantifiers, and NPs. Derivation trees for examples (2) and (3) are provided: the leftmost and middle derivation trees show the two ordering options when a DQP is in object position and the rightmost one shows the one option when a CQP is in object position. The subscripted numbering represents the order of syntactic derivation the superscripted numbering represents the order of semantic derivation of the scopal-trees with delayed combination.

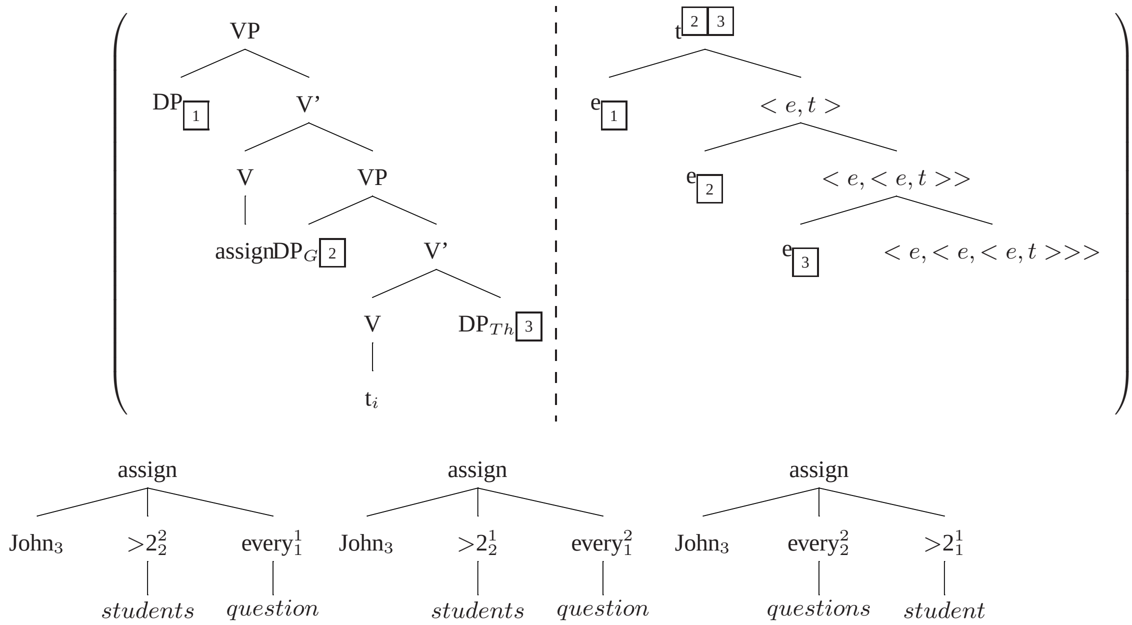

Figure 2: This figure shows elementary trees for the ditransitive verb *a*ssign; all other trees needed for this derivation are in figure 1. Derivation trees for (4) are provided: the leftmost and middle show the two ordering options when a DQP is in the lower object position and the one option when a CQP is in the lower object position. The subscripted numbering represents the order of syntactic derivation the superscripted numbering represents the order of semantic derivation of the scopal trees with delayed combination.

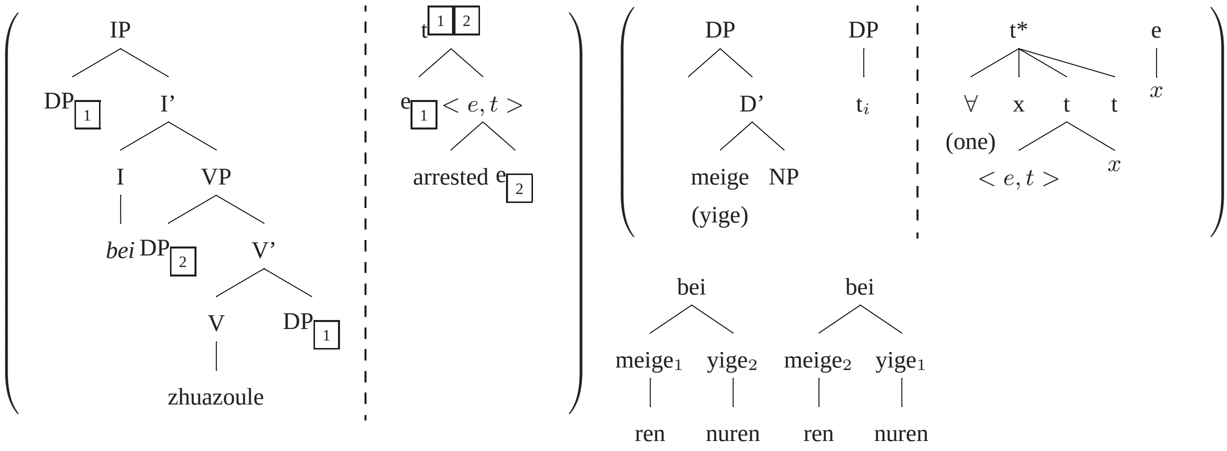

Figure 3: This figure shows (1) an elementary tree containing BEI and a main verb. It has three positions for DP substitutions. (2) A multi-component tree for *m*eige, and (3)derivation trees for the BEI sentence. The leftmost derivation tree has *meige* adjoin first making *yige* take wide scope. The rightmost derivation tree has *yige* adjoin first making *meige* take wide scope. The numbering on these trees represents the ordering on the derivation where either of the quantifiers is able to combine first. Not pictured are trees corresponding to the NPs and the other quantifier; these trees are identical to the trees for the same type lexical items in figure 1.

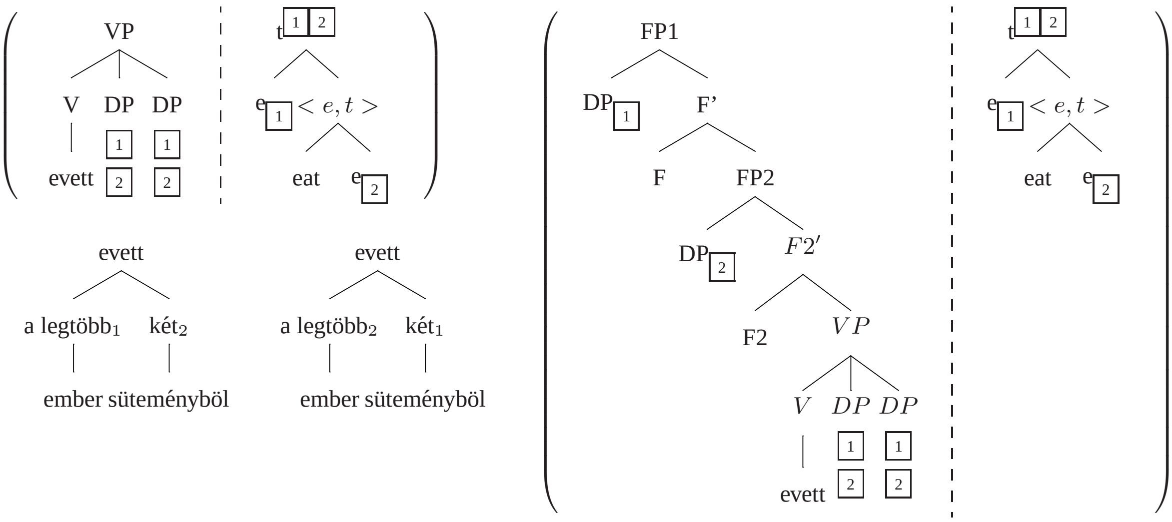

Figure 4: This figure shows (1) an elementary tree for the verb *e*vett with a flat structure for the arguments. (2) an elementary tree for *e*vett where there are functional projections above VP where multi-component QP sets combine both in the FP and under VP, and (3)derivation trees for the sentence. The leftmost tree is for the sentences (13) or (14). The rightmost derivation tree is for example (13) and is only available when the tree with functional projections is the verbal tree. Not pictured are trees corresponding to the NPs and the quantifiers; these trees are identical to the trees for the same type lexical items in figures 1 and 3.

natively a passive marker or preposition-like lexical item.

(11) Meigeren dou xihuan yige nuren
everyone all like one woman
'Everyone loves a woman' ($\forall > 1$)

(12) Meige ren dou bei yige nuren zhuazou le
every man all BEI one woman arrested
'Everyone was arrested by a woman
($\forall > 1, 1 > \forall$)

4.1.2 Hungarian Scope

In Hungarian, transitive sentences with two quantifiers can be in a number of different word orders. When both quantifiers precede the verb the scope ordering is strict and no inverse scope reading is possible, as in (13). When both quantifiers are unstressed and follow the verb inverse scope readings are possible, as in (14).

(13) tegnap a legtöbb ember két
yesterday the most person two
süteményből evett
cakes-from ate
'Yesterday most people ate from two cakes'
(most $>$ 2)

(14) tegnap evett a legtöbb ember
yesterday ate the most person
két süteményből
two cakes-from
'Yesterday most people ate from two cakes'
(most $>$ 2, 2 $>$ most)

4.2 Extending the Analysis

The syntactic trees chosen for the Mandarin and Hungarian data in figures 3 and 4 are chosen based on previous analyses of this data. Aoun and Li [1993] argue that the trace allows either scope reading because each quantifier c-commands the other. Kiss [2002] argues that the structure of Hungarian has a hierarchical preverbal field and a flat structure in the VP field. Ambiguous scope is available when the quantifiers are in the VP field because neither c-commands the other, yet while they are above VP there is surface scope because one quantifier will c-command the other. Both of these analyses base their analysis off of the idea that c-command relations derive scope relations [May, 1977].

These cases force us to complicate the analysis given in §3. In both the Hungarian and Mandarin cases quantifiers are represented by MC-sets. As such, there are cases where a MC-set both commands and is c-commanded by some other tree (set). The current definition of PROM when utilized by PROD leads to paradox as two different nodes cannot be be targeted until the other one has been targeted. The definition of PROM needs to be refined by accounting for this configuration. To do this a new relation PROM' will be defined in (7).

(15) PROM'$_{def}$ = $\{$(x,y)$|$(x,y) $\in$ PROM, no z such that (1) (y,z) $\in$ PROM, (x,z) is targeted by a MC-set or (2) (z,x) $\in$ PROM, (z,y) is targeted by a MC-set.$\}$

The definition of PROM' eliminates from PROM pairs (a,b),(b,c) where a and b are targeted by different MC-sets (a,c) and (b); and (a,b) and (b,c) are in PROM. In these cases there is no possible ordering between the two sets based on their hierarchical position. PROM' then replaces PROM in the PROD.

The Mandarin data falls out from this revised PROD. First, the restriction against inverse scope in the "active" sentences can be explained if Mandarin quantifiers all obey simultaneous combination. The interaction of the quantifiers in the syntactic tree explains the scope ambiguity in the "passive" sentences. The higher surface quantifier is analyzed as a multi-component set. The lexical tree substitutes into the higher DP and the trace tree substitutes into the lower DP. In transformational terms the trace-tree occupies the base position and the lexical tree occupies the surface (moved-to) position. Between these two positions is the other quantifier. It is represented by a singleton tree set. The asymmetrical c-command relations between the three nodes that the quantifiers occupy are the following: The lexical-tree of the higher quantifier c-commands the lower quantifier and the lower quantifier c-commands the trace-tree. Since both quantifiers c-command each other they are not in PROM' and there is no restriction in their derivation because neither derivation order violates the PROD. This allows either quantifier to take wide scope during the derivation of the semantic tree. This produces the scope ambiguity, and does so without delayed combination. Thus, both the strict scope behaviour and ambiguous scope behaviour can be derived.

The Hungarian data also can be derived given the revised PROD. The ambiguous scope cases are derived because the nodes the quantifiers substitute into are not in a PROM relation with respect to one another. Thus either DP is able to combine first and on the semantic side either scopal tree is able to then adjoin first. The unambiguous case is derived because the highest DP node is in a PROM' relation with a DP under VP. Thus the tree-set that targets the DP under FP2 must combine first with the elementary tree. On the semantics side the scopal tree must attach before the scopal tree for the other quantifier. This produces the surface scope reading only.

5 Conclusions and Further Ideas

5.1 Summary

This paper has explored one method of restricting scope relations in S-TAG. The two mechanisms discussed in the paper have been shown to predict the correct scope possibilities in English sentences with subject and object quantifiers (and object quantifiers in the double object construction), in Mandarin Chinese "active" and "passive" constructions, and the different Hungarian configurations. The former utilized both the PROM constraint on derivation and delayed combination while the latter two utilized only a revised PROM constraint.

5.2 Further Work

Further work on this topic involves a more indepth look at the scopal possibilities in the English, Mandarin, and Hungarian. Notably a comparison to Szabolcsi [1997] for Hungarian would be advantageous. Further work on this analysis involves seeing how the constraints proposed in this paper interact with other scopal elements. For instance how does this paper's analysis affect the scopal possibilities between negative markers, questions, or intentional operators, and nominal quantifiers. Phenomena from other languages should also be explored: It might prove interesting to see what languages utilize DC and which don't and whether DC varies cross-linguistically in what lexical items possess it. Evidence for this type of analysis may be borne out of a coherent typology. Another avenue of exploration would be to seek out an alternative to the PROM' relation that is less complex and independently motivated.

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