# Scope without Syntax: A Game Theoretic Approach

Luke M. Smith

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**Abstract**

Here I argue that the commonly (and uncommonly) known facts about the availability of quantifier scope interpretations fall out cleanly from communicative constraints which Speakers and Hearers tactically navigate to converge on the intended meaning of an utterance. This allows a relatively complete and motivated theory of quantifier scope ambiguity wholly without the need to resort to syntactic structure *per se* for the main data. I model this theory game theoretically, in a game where speakers receive a payoff for successful communication, and decrements to payoffs for the use of marked constructions. These assumptions are sufficient to account for classical scope ambiguity data, but also newly compiled data I present which argues that *word order rigidity*, across languages and constructions is the cause of scope ambiguity.

## Contents

# List of Figures



# 1 Need for a novel approach to scope

I've decided to add this section at the last minute. It will briefly overview some of the problems behind traditional generative attempts at modeling scope, chiefly:

- The marked unsystaticity of scope as an indicator of syntactic phenomena, i.e. that there still isn't a commonly accepted metric for what scope effects syntactic movements, etc. should have.
- The sensitivity of scope to linear order.
- The ubiquitous "Chomsky's Aphasia" in scope judgments and non-categorical judgments.

# 2 Assumptions

Before proceeding, I'll make some *a priori* assumptions about scope interpretations. We will see that much of the diversity of scope can be accounted for merely taking these as assumptions interacting with each other.

1. Speakers and listeners prefer for quantifiers to be in "surface scope" order.
2. "Transformations" classically named (e.g. passives) are "costly" or "dispreferred" in some sense.
3. "Scrambling" in languages which exhibit it, is not similarly costly.

Before explaning the model, it's at least worth justifying all three of these on functional grounds.

### 2.1 Preference for Surface Scope

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### 2.2 Transformations are "marked"

A longstanding assumption of transformational grammar was that those utterances which are "transformed" are in some ways, more marked or at least are derived from simplex expressions.

(1) a. Caesar crossed the Rubicon.
b. It was Caesar who crossed the Rubicon.
c. The Rubicon was crossed by Caesar.

That is, while all sentences in (1) share a semantically equivalent kernel, (1a) is in someway more basic than the cleft (1b) or the passive (1c). Earlier ideas in Generative Grammar assumed that this was because (1b) and (1c) were literally derived from (1a), thus leading to the psycholinguistic thesis of the Derivational Theory of Complexity, hypothesizing that the latter two sentences were marked as they are later formations of the first.

Theories such as this have fallen out of favor in mainstream Generative Grammar, but regardless, data from acquisition does indeed show that sentences such as (1b) and (1c) are acquired and employed at a distinctly later stage of language development. For our purposes, we could say something as simple as (**??**) and (1c) simply contain more morphemes or words than (1a). We should be clear that the particular nature of the cost of "transformations" isn't important for us, only the general assumption that they are marked or dispreferrable.

### 2.3 Scrambling is not costly

This may fall out for free depending on one's account of the costliness of transformations. For example, if we say that the passive is generally disprefered because it consists in adding additional morphemes and words to a clause, we implicitly say that scrambled sentences, since they require no additional morphology or periphrasis, are not similarly costly.

## 3 Basic English Data and Passives

With the background established, we can move to address data and spelling out this model. First note some rudimentary scope facts in English represented below:

(2) a. Every man saw a girl. $(\forall > \exists; \exists > \forall)$

b. Everyone speaks two languages. $(\forall > 2;\ 2 > \forall)$

(3) a. A girl was seen by every man. $(\exists > \forall;\ *\forall > \exists)$

b. Two languages are spoken by everyone. $(2 > \forall;\ *\forall > 2)$

Generally, unmarked active "kernel" sentences like (2a) and (2b) demonstrate fairly robust scope ambiguity. Thus, (2a) can mean either that there is one particular girl that every man saw $(\exists > \forall)$ or that each man saw a (potentially different) girl $(\forall > \exists)$.

In the "transformed" passive equivalents of the two sentences, however, syntactic ambiguity becomes unavailable and surface scope is typically the only sensible reading, as below.

(4) a. A man ate every watermelon. $(\exists > \forall;\ \forall > \exists)$

b. Every watermelon was eaten by a man. $(\forall > \exists;\ ??\exists > \forall)$

(5) a. Everyone loves someone. $(\forall > \exists;\ \exists > \forall)$

b. Someone is loved by everyone. $(\exists > \forall;\ ??\forall > \exists)$

Thus (3a) is only true if there was only one girl in question, while (3b) is only true if all of the people speak the same two particular languages. We see that this scopal alternation generally holds across most active/passive sentence pairs.[1]

It should be said that while (4b) and (5b) are labeled as requiring surface scope, there are indeed situations where the inverse readings are possible or required. While when some traditional accounts of scope categorically rule these sentences out, for me, what is important is that the inverse passive readings are simply *highly dispreferred*. As our analysis will show, there is nothing formally syntactic that makes these sentences essentially bad, but merely the results of the game theoretic analysis. The important fact here is merely that English passives, without other context strongly imply only surface scope.

# 4 Model

Additionally, it's important to be clear about the game theoretics of communication. Resolving scope ambiguities like that in (2) is a kind of coordination game with imperfect information. That is, two interlocutors must converge on the same interpretation of a sentence which has been decided by circumstance; the Speaker knows the required interpretation and in speaking attempts to signal it to the Hearer. Both players "win" if the Speaker is succesful in leading the Hearer to the correct interpretation. If the speaker intends for a universal quantifier, such as *every*, to scope over an existential one, such as *some*, he ideally must word his sentence in such a way to communicate this.

To be more specific, we can say this is a kind of 3-player coordination game (where the sequence is indicated in Figure 1). Player 0, who we can term **Nature** dictates what the needed scope interpretation should be, that is, whether,

[1] Some exceptions will be discussed later.

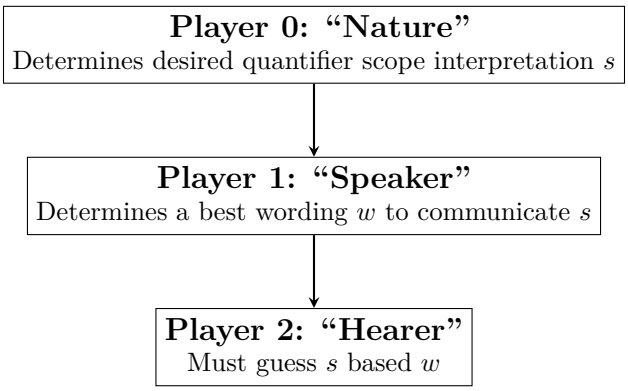


Figure 1: The sequence of player choices

based on circumstances, a subject quantifier must scope over an object quantifier, or *vice versa* or any other combination of quantificational elements. [2] We can think of the choice of Player 0, Nature, as a random or given element of the model. Player 1, **the Speaker**, knows what the needed scope given by Nature is, and has to encode a linguistic message to communicate it to Player 2: **the Hearer** who is ignorant of it (illustrated in Figure 2). In each language, the Speaker might have different strategies usable to communicate this message, depending on the structure of a language. [3]

If the Hearer's interpreted scope and the scope selected by Nature match, both human players get a payoff (represented as $c$ for ***c****ommunication*), while if they do not match, there has been a miscommunication and this there is no payoff. Similarly, we can formalize our assumptions in the Section 2. If transformations, specifically passives, are costly or dispreferred in some way, we can model them as saying that they reduce the payoff to the speaker to some degree (designated by $-p$). Similarly, instances of free word order and so-called "scrambling" do *not* reduce any payoff. Lastly, surface scope should be universally preferred, so in situations where a speaker and hearer settle on an *inverse* scope reading of a sentence, their payoffs are reduced by some degree (symbolized by $-i$).

We should also assume that $c > (p + i)$, meaning that it is always preferable for the two interlocutors to understand each other even if transformations and inverse scope may dig into that payoff. Also, $p$ and $i$ are not necessarily larger or smaller than one another, and may vary from situation to situation, meaning that in some situations, it may be preferable for a speaker to vie for inverse

[2] We will only be including subject and object quantification for sake of simplicity to outline some general principles.

[3] Thus, our intent here is not to argue how or why a given sentence in a language is grammatical or acceptable, but why Speakers choose to use a given sentence to communicate a particular scope reading.

| Abrv. | Strategy name |
|---|---|
| A | **A**ctive Voice (Speaker) |
| P | **P**assive Voice (Speaker) |
| S | Interpret **S**urface scope (Hearer) |
| I | Interpret **I**nverse scope (Hearer) |
| $Sub > Obj$ | Demand the subject scope over the object (Nature) |
| $Obj > Sub$ | Demand the object scope over the subject (Nature) |

scope rather than performing a transformation, while in others, it opposite may be true.

The particulars of an instantiation of the game are based in the structure of whatever language is being spoken. For any given language, there will be a different set of syntactically valid utterances that the Speaker can use to signal to the Hearer what the intended scope is. Given the constraints posited above, we will assume that surface scope is the ideal, but different languages differ in their abilities to use different transformations or scrambling.

## 4.1 The Game Theoretic Core

Regardless, given our constraints above, we can derive these facts of the difference between actives and passives from the interaction of strategic interpretation on the part of the two interlocutors. Assume the three player game above (of Nature, a Speaker and a Hearer), dealing with the kernel sentence in (5a) "Everyone loves someone," depicted in the decision tree in Figure **??**.

First, the Nature player determines whether the intended scope of the utterance should be where the universal quantifier takes wide scope ($\forall > \exists$, or $Sub > Obj$) or where the existential does ($\exists > \forall$, or $Obj > Sub$). Then the Speaker, aware of Nature's choice, takes his turn choosing either to word the sentence as the active "Everyone loves someone" or the passive "Someone is loved by everyone". Lastly, the Hearer, unaware of Nature's original decision, chooses whether to interpret the sentences with surface scope or inverse scope.

To repeat, if the Hearer guesses the correct scope as defined by Nature, both the Speaker and Hearer receive a payoff of $c$. If the players fail to engineer this, both will receive no payoff. Additionally, because a passive transformation is "costly," the payoff of the Speaker will be deducted by $p$ whenever he chooses to produce a passive. Lastly, if the dispreferred inverse scope has to be employed, both speakers will have a penalty of $i$.

Since this decision tree involves three players with substantive choices, it helps to narrow down the decision to find Nash Equilibria or optimal strategies. Let's put ourselves in the position of the Hearer. The Hearer is the one dealing with the informational asymmetry guessing the choice of Nature given the Speaker's utterance. Given the aforementioned decision tree in Figure 2, the Hearer can make two hypotheses about Nature, that it chose to demand that the subject $\forall$ scope over the object $\exists$, which is represented in Figure **??**, or that it demands that the object $\exists$ should scope over the subject $\forall$.

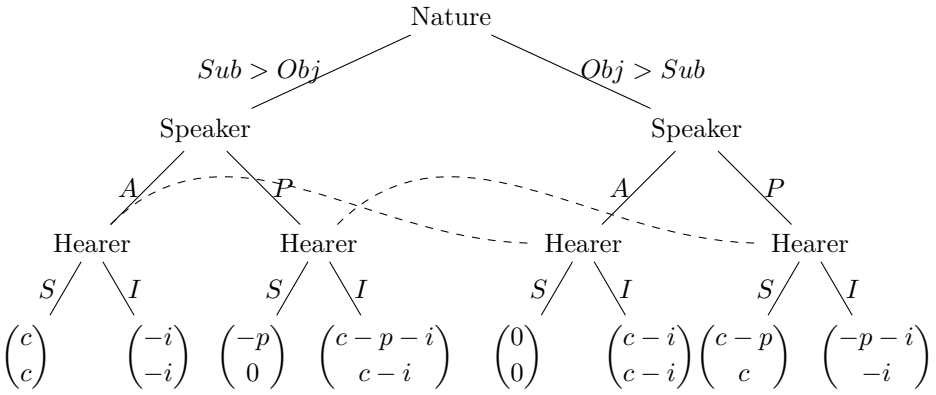


Figure 2: The extensive game in English

## Notes on the Game Tree

Each branch represents a player choice. Payoffs to the Speaker and the Hearer are at each terminal node, the Speaker's being on top and the Hearer's below.

The dotted lines represent the equivalence classes for the Hearer. That is, they unite the nodes that the Hearer can not distinguish. To be clear, if the Speaker chooses the "Active" strategy, the Hearer knows he must be on the nexus either first or third from left, but can't distinguish between the two since he is unaware of Nature's original choice.

Figure 3: A primer on extensive game theory notation as in Figure 2

## Game Theoretic Terms

**Imperfect information** – When at least one player is not perfectly aware of the actions of another. In our game, the Hearer is not aware of the decision of Nature, ergo this is a game with imperfect information.
**Incomplete information** – When at least one player is not aware of the payoffs for a player. Although this concept is frequently confused with imperfect information, we *do not* have a incomplete information game.
**Signalling** – When a player voluntarily undergoes a costs to communicate his tactics or strength. For example, a zebra, noticing a stalking lion may "irrationally" jump up and down in place instead of running to show his spriness and tell the lion he isn't an easy target.
**Nash Equilibrium** – A point in a game where no player can improve his position by changing strategies given what he knows. While Nash Equilibria are usually the McGuffin of game theoretic analysis, our game has no proper Nash Equilibrium (not assuming iteration). The concept is usually attributed to Nash (1950) (hence the name), but was originally formulated at least in Cournot (1838)'s theory of economic duopoly.
**Schelling Point** – Sometimes called a *Focal Point*. A point which is not a Nash Equilibrium, but due to some meta-game reasoning is a particularly marked. Originally formulated in Schelling (1960).
**Equivalence Classes** – In an Imperfect Information game (like this one) nodes in a decision tree that a player cannot distinguish due to his imperfect information.

The key to the strategy is the cost of the passive $p$. Let's take the situation when Nature selects $\forall > \exists$. In that case, the hypothetical active form "Everybody loves someone" already has the correct surface scope order. While it is not immediately sure that the Hearer would determine that this active clause is indeed the required order, it costs the Speaker neither decrements of $p$ or $i$.

If the Speaker were to passivize the sentence to "Someone is loved by everybody", not only would he be incurring the loss of $p$ for the passive transformation, but if the Hearer did guess correctly that the sentences should have *inverse* scope in this reading, both players would additionally be losing $i$.

The Speaker therefore is in a position of two theoretically uncertain outcomes, one that can yield him $c$, while the other can yield him only $c - p - i$. All things considered, $c$ is preferrable, and therefore using the active sentence to express $\forall > \exists$ should be preferrable. While this is not a proper Nash Equilibrium, since we are dealing with a non-simultaenous game, this decision can act as a *signal* to the second player, the Hearer.

The Hearer, knowing that there is this Schelling Point for choosing the active sentence when given $\forall > \exists$ can therefore conclude by deduction that if the Speaker for some reason chooses to word his sentence in the passive, it is nearly certain that Nature meant *the other* alternative: $\exists > \forall$. Or put more generally in (6).

(6) *A speaker will not engage in a costly transformation which yields an*

*undesired scope order.*

Or to spell (6) out more specifically in our context, see (7).

(7) *The use of a costly reordering transformation,* ceteris paribus*, entails that the underlying object should take wide scope over the subject. Or put another way, scopal ambiguity dissappears in favor of surface scope after a costly transformation.*

To put it in more intuitive terms, if the subject does something costly like passivization to a sentence, *he is doing it for a reason*, specifically here to avoid the other loss of $i$. Passivizing only to also lose $i$ is not a good Schelling Point strategy. For this reason, in most pragmatic circumstances, passivized sentences appear as unambiguous, seeing that we conclude that they are motivated to avoid the cost of the inverse scope.

In the situation where Nature chooses $\exists > \forall$, the situation is less clear. This is because the Speaker has two possible winning payoffs: $c - i$ and $c - p$, neither of which is necessarily preferrable since we have not established whether $p > i$, nor do I think one is always larger than the other. In this situation, a Speaker could passivize and to avoid inverse scope order, or bite the bullet and take inverse scope without the passivization, both with uncertainty. The end result is that the active sentence "Everyone loves someone" does not clearly communicate whether Nature choose $\forall > \exists$ or $\exists > \forall$ since there is no obvious Schelling Point to rule out one of the strategies. Therfore, while the English passive is unambiguous due to the presence of a Schelling Point, the English active is not.

## 4.2 Scrambling

But how should scope ambiguities work where there are "costless" ways of reordering quantified nominals? Scrambling languages present ways of reordering nominals without a marked transformation. In our model, Speakers in languages like this, such as German, Persian, Korean and Japanese, have access to another strategy aside from producing an active or passive clause. They may also *scramble* the object such that it appears to the left of the subject.

First a theoretical note. The "scrambling" tendencies of each of these languages may be different: German "scrambling" is quite different syntactically than Korean's, etc. This is not so important to us here. We only need to know if there is a valid reordering strategy in a language which is not marked in the way that passives are. Why German or Perian or other languages vary with respect to syntactic flexibility is not germane for us here, only the *effects* of these traits on scopal possibilities.

### 4.2.1 Scope in Scrambling Languages

First the empirical facts. German, a scrambling language shows a very different paradigm of scope availabilities than does English. Even in "kernel" sentences

like (8), surface scope is the only plausible interpretation. The same is true in the scrambled sentence (9), where the object has been scrambled left of the subject.

(8) dass eine Frau jeden liebt
that a woman everybody loves
"…that everyone loves a woman" (some > every; ??every > some)

(9) dass jeden eine Frau liebt
that everybody a woman loves
"…that everyone loves a woman" (every > some; ??some > every)

This universal surface scope is well mirrored in other languages. Karimi (2003) notes that one of the principle differences between scrambling languages and ones with inflexible word order like English is the lack of ambiguity. We can see similar patterns in Persian in (10).

(10) a. Yek dāneshju hame ketāb-i xānd.
a student all book-IND read
"A student read every book." (∃ > ∀; *∀ > ∃)

b. Hame ketāb-i yek dāneshju xānd.
all book-IND a student read
"A student read every book." (∀ > ∃; *∃ > ∀)

#### 4.2.2 An Account of Scramblible Scope

In our game theoretic framework, we can say that the *Scramble* strategy, which consists of moving the object left of the subject, achieves the linear order of passivization without the cost of $p$ to the Speaker. Because of this, *Scramble* in a scrambling language is always preferable to the dominated strategy *Passive* for the Speaker.

Thus if we disregard the possibility of passivization as dispreferred as a scope technique, once again, both human players have two possible choices. Once again, we can again simplify the decision tree into two two-dimensional grids given the two different possible choices of the Nature player. We should see that there is no straight-forward dominant strategy for either player, but a very obvious signalling opportunity arises in the meta-game, or a Schelling Point.

Specifically, independent of the Speaker and Nature's choices, the Hearer will want to avoid choosing the *Inverse* strategy. The Speaker realizes this and can strategically select his strategy based on what will require the Hearer to *not* select the *Inverse* strategy. This acts as a signal to the Hearer.

In the meta-game, the Speaker acts so that both players can be applicable for the highest possible payoff of $c$. And a Hearer totally blind to the Speaker's actions should have a bias to the *Surface* scope interpretation strategy.

If the Hearer or Speaker violate this meta-strategy, they would be subject to a decrease in expected returns over time, independent of the other players

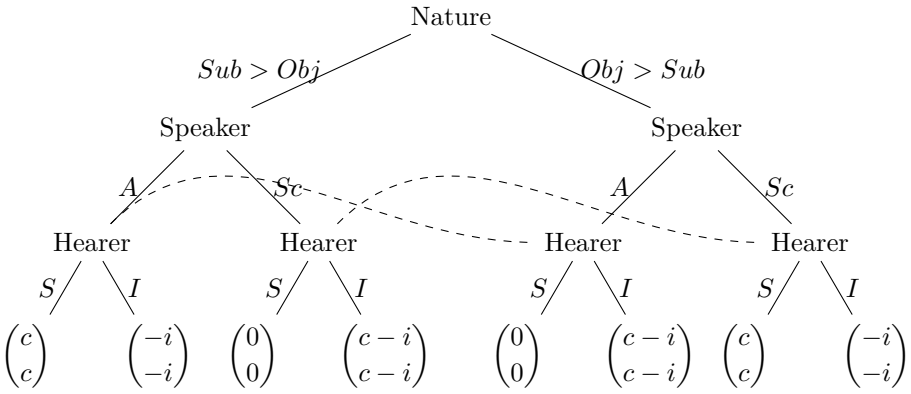


Figure 4: The extensive game in a scrambling language

| | $Sub, S$ | $Sub, I$ | $Obj, S$ | $Obj, I$ |
|---|---|---|---|---|
| Active | $c$ | $-i$ | $0$ | $c-i$ |
| ~~Passive~~ | $-p$ | $c-p-i$ | $c-p$ | $-p-i$ |
| Scramble | $0$ | $c-i$ | $c$ | $-i$ |

For every pair of decisions made by other speakers, each payoff for the Speaker is greater if he chooses *Scramble* than if he chooses *Passive*, due to the $-p$ penalty.

Figure 5: *Scramble* dominates *Passive* as a strategy for Speaker

actions. Therefore in a language with the free movement of nominals, we should predict that Hearers should *only* try to interpret sentences in surface order in normal situations, and that speakers should scramble or not depending on which produces a sentence which gives the correct scope interpretations with a surface scope reading.

All in all, the free availability of a costless movement makes avoiding $-i$ the only possible constraint, meaning that all of the choices the Speaker makes should be assumed to avoid $-i$. This simply means that surface scope, as the empirical judgments have shown, should be preferred at all times in scrambling languages.

## 4.3 The Generalization

We can sum up the generalization of this game theoretic analysis of both English-like and scrambling languages below in (11).

(11) **Wherever there is free and costless word order, scope ambiguities need not arise, but where word order is inflexible, scope ambiguities occur.**

This generalization simply falls out from the analysis we have outlined, and we can widen the scope and look at other kids of scope ambiguities to see similar effects.

Before that, just a restatement of the intuitions in intuitive terms. Hearers assume that sentences with free word-order are always surface scope because, due to the free word-order, the speaker could've put the words in another ideal surface scope reading if such reading had been intended. On the other hand, in English-like languages, costly transformations are unambiguous because hearers assume that speakers would not have engaged in costly transformations unless they intended the sentence to be in a special surface scope order.

*But* ambiguity arises in English-like languages when a sentence like "Everyone loves someone" is produced. This is because hearers can say, "Ah, that may just be the desired reading in surface scope, *or* perhaps it is a suboptimal order, and the speaker didn't want to undergo a costly transformation".

Now our initial assumptions have accounted for much variation between different languages, but there is scopal differences *inside* of languages between different constructions that is worth outlining and accounting for in this novel way.

## 4.4 Intra- vs. Inter-language variation

In the Generative Program, part of the common idea of quantifier scope differences between languages has been that there are parametric differences between languages that not only cause syntactic differences, but also these scopal differences.

One language, due to a scopal paramter, may have ubiquitous ambiguity due to some parameter setting affecting "Logical Form", one might have the reverse.

I'll argue that this conception is untenable, not just because of the better account we can get from this type of game theoretic and pragmatic model, but also because there are many examples of "local rigidity" which, in the same way that English syntactic rigidity produces ambiguity, produce ambiguity only in particular constructions in languages. Quantifier scope availability, therefore, *cannot* be a language parameter setting, and must be grounded in the very specific context of a construction, as I will show our theory here is.

### 4.4.1 Flexibility of Negation

We can take the generalization in (11) and compare it to the flexibility or rigidity of non-nominal quantificational elements as well.

English expresses sentential negation in the element *not*. As a descriptive generalization, *not* may occur only after a modal or another auxiliary. In normal discoursive situations, it may not occur after main verbs or before a modal. Many attempts have been made to describe and justify the specifics of these facts. We will not address them here, but assume the empirical facts as given syntactic constraints and proceed.

On to the scopal facts. Notice first that an English sentence with one modal and one negation produce ambiguity.

(12) Billy can not go. ($\neg >$ can; can $> \neg$)

(12) is ambiguous. Negation can take wide scope (which is inverse) such that Billy is *unable* to go, or the modal can take wide (surface) scope, where Billy is able *not* to go, if he so pleases.

In keeping with our assumptions, we can say that ambiguity arises because the following order in (13) is syntactically invalid for other reasons in English.

(13) * Billy not can go.

Since (13) is syntactically ill-formed, we cannot, by normal syntactic means force negation to linearly scope over the modal, thus its parallel sentence (12) can be assumed to be a suboptimal enunciation of the meaning of an intended (13). If we imagine a hypothetical "negation scrambling" language where the equivalent of (13) is available, (12) should be unambiguously *can* $> \neg$.

Now that is the situation of modal and negation scope with one non-main verb. However as inferred previously, where there are multiple auxiliaries, *not* may freely occur after any one. Syntactic flexibility should reduce or eliminate the possibility of ambiguity. This is the case as below.

(14) Billy could not have gone before we arrived.

(15) Billy could have not gone before we arrived.

Notice as there is flexibility of negation position with non-modal auxiliaries in English, neither (14) nor (15) are ambiguous. In (14), we express the fact that Billy was unable to go before our arrival. In (15), we express the possibility

Billy was able to *not* go, but in a world where Billy did go, (15) may still be true.

Thus even in a single language our generalization holds. Syntactic rigidity allows for ambiguity, while free flexibility creates situations where ambiguity is ruled out due to the assumption that speakers have that surface scope is universally preferred.

This is not just true from language to language or construction to construction, but in English, even when specifically addressing negation, *any* higly local syntactic rigidity causes ambiguity and *any* highly local syntactic flexibility disambiguates.

And as expected, languages that can syntactically bear negation before all modals/verbs, such as Chinese do not create the ambiguity in the rigid English example (Ernst 1998).

(16) Shujuan keyi bu gen Guorong tiao wu.
S. may not with G. dance
"Shujuan may not dance with Guorong." (may > not; *not > may)

(17) Shujuan bu keyi gen Guorong tiao wu.
S. not may with Guorong dance
"Shujuan may not dance with Guorong." (not > may; *may > not)

The Persian situation is particularly interesting. In most situations, while noun scrambling is mostly free, scrambling of the verb and its negation is more marked. This manifests in that inverse scope is very possible in positions involving a negation interfacing with another quantifier.

(18) Yek dāneshju ān ketāb-rā na-xānd.
one student that book-ACC not-read
"A student didn't read that book."

As we would predict, (18) is ambiguous. It can mean either a certain student didn't read the book ($\exists > \neg$) or that *not one* student read it ($\neg > \exists$). This ambiguity arises because the movement of the verb is more marked.

In other situations, particularly in movement verbs, the Persian main verb becomes more flexible. SVO order, where the negation is still a pre-verbal clitic, is common with some movement verbs, and as expected, the ambiguity evaporates in (19) and (20).

(19) Billy na-raft hame shahr-i.
B. not-went all city-IND
"Billy didn't go to every city." ($\neg > \forall$; *$\forall > \neg$)

(20) Billy be hame shahr-i na-raft.
B. to all city-IND not-went.
"Billy didn't go to any city." ($\forall > \neg$; *$\neg > \forall$)

### 4.4.2 Construction-specific Rigidity

Since my statement here is that scope ambiguity is merely the result of linear rigidity in syntax, not of some language-wide parameter, we should see the unambiguous surface scope of scrambling languages disappear in particular constructions where normally scramblible nominals are tied in position.

Chinese, usually a very stablely scrambling or discourse configurational language generally allows the low cost movement of nominals as illustrated in (21) (from Aoun and Li (1993)). These sentences, as we should expect are unambiguous and force surface scope. In (21a), everyone arrests different women, while in (21b), only one woman, who apparently is a prolific criminal, is arrested.

(21) a. Meigeren dou zhuazou yige nüren.
everyone all arrest a woman
"Everyone arrested a woman."

b. (You) yige nüren meigeren dou zhuazou.
(have) a woman everyone all arrest.
"A woman was arrested by everyone."

However Chinese *bei* pseudo-passives require a particular word order. The semantic object is promoted as the initial nominal, while the agent follows the preverbal co-verb "bei" as shown in (22a). As (22b) shows, however, the quasi-prepositional *bei* + *agent* constituent may not be fronted or topicalized.

(22) a. Meigeren dou bei yige nüren zhuazou.
everyone all PASS a woman arrest
"Everyone was arrested by a woman."

b. * Bei yige nüren meigeren dou zhuazou.
PASS a woman everyone all arrest

The scopal possibilities follow the predictions perfectly. Since flexible word order is unavailable, (22a) is ambiguous: there can either be one woman arresting everyone, or each person can be arrested by a different woman.

Interestingly enough, the scope possibilities in Chinese in normal clauses and the *bei* pseudo-passive are precisely the opposite of English, again this falls out from the fact that nominal movement is generally free in Chinese (meaning unambiguous sentences normally) and the additional fact that *bei* passives are not precisely equivalent to their active counterparts, but add additional meaning.[4]

On a philological note, it might be that languages with free word-order like Chinese probably use transformations less than rigid word-order languages like English specifically because they are unnecessary for scope. Those transformations they do use, like *bei* passives, may tend to have extra semantic value lest they be "worthless."

[4] *Bei* passives imply some kind of misfortune or negativity. Thus (22a) could be translated as "Everyone befell arresting by a woman" or something of the sort.

| Rigid Constructions | Flexible Constructions |
|---|---|
| English main clauses | Main clauses in scrambling languages |
| Persian negation | Chinese negation |
| Typical English negation | English negation around auxes |
| Chinese passives | English passives* |
| **All of these are ambiguous** | **All of these are non-ambiguous** |

Figure 6: Empirical generalizations: Rigidity → Ambiguity

# 5 Theoretical Issues Solved and Opened

## 5.1 The Gambit of Linear Order

It should be noted that the data of scope present an existential problem for the general interpretation of syntax from a "logical form" perspective. On one hand, the assumption has been that scope interpretations are read from quantificational elements which interface with the hierarchical structure of language. This structure (from the Chomskyan perspective) is construed as irrelevant to the linear order of a sentence, which is a later realization of the expression in phonological form.

But the overwhelming reality of scope as a feature of natural language is that it is manifestly and abundantly tied to linear order, nearly all of the data presented here, along with that in the literature testify to this.

I think a proper understand of scope would be that *all possible scope readings of all sentences are theoretically possible at all times.* In normal discoursive situations, however, most possible readings as pruned out as implausible, based on pragmatic circumstances or world-knowledge. This also would attest well the conundrum of every syntax class, where graduate students sit around long enough looking at sentences without context and start seeing *all* of the scopal readings after long enough. My analysis here has endeavored to show why some readings are *ruled out* in certain situations, although this is no be-all-end-all solution to scope, precisely because it is a pragmatic, and perhaps extralinguistic portion of language.

Such a framework would be able to maintain the statement that human language, at its syntactic core, should be independent of linear order, as the linear order effects are part of the pragmatic traits of language use and discourse.

## 5.2 Scope Interpretations are Not Licensed, but ***Pruned***

Again, I have not crafted a universal account of scope ambiguities, and have deliberately avoid some contradictory examples that I think explicable on other grounds. Take the sentence pair below.

(23) Every boy ate an apple.

(24) An apple was eaten by every boy.

(23) follows the generalizations we've sketched here in, that it is ambiguous ($\forall > \exists$, $\exists > \forall$). (24), as a passive, is unambiguous, but not in the way we've predicted here, but *only* inverse scope is allowed ($\forall > \exists$, $*\exists > \forall$), or at least, inverse scope is highly preferred.

What rules out the surface scope interpretation of (24) is not the pragmatics of passivization *per se*, but the interface of general world knowledge with the inherent telicity of the verb *eat* with a count noun object. The predicate "ate an apple" implies that the subject totally consumed an apple, but if the universal quantifier is thought to scope over the existential "an apple," this would have to mean that every boy totally ate the same apple as every other boy, which is logically impossible.

This makes the otherwise disfavored $\forall > \exists$ interpretation the only logically consistent option. If we rejigger the sentence to remove the telicity, as in (25), we see that the expected scope possibilities return, even when the sentence is still somewhat strange by that interpretation.

(25) Some of an apple was eaten by every boy. ($\exists > \forall$, $\forall > \exists$)

Note *also* that if we imagine (24) in a discourse environment, we're most likely to think of constrastive focus or something else: "An apple was eaten by every boy, a banana by every woman, a pineapple by every man…"

I do *not* consider this a contradiction, but evidence in favor of the wider point. Scope ambiguities are trimmed away by pragmatic factors. In (24), it is world knowledge, in most of the other examples here, it's economy of derivation.

# 6 Towards a general, game theoretic theory of quantifier scope

Our empirical domain established here is quite robust in the data problems we've addressed here. Specifically, we can

## 6.1 Universal vs. existential quantifiers

There have been game theoretic accounts to address these problems, notably in Clark (2012). Clark models the difference between universal and existential scopes as being an abstract game between falsifier and verifier algorithms. The scopal differences between universal and existential quantifiers come about from how these two "players" procede to attempt to find a contradiction or vindication of the truth of a sentence in a Model Theoretic framework.

To editorialize baselessly, I'm suspcious of the use of game theory to describe abstract "actors" without there being a plausible

## 6.2 *some* vs. *a* vs. *one*; and other scope preferences

Another domain on which our current theory here is insolvent or at least agnostic is the generally acknowledged tendency for some quantifiers to prefer to take

higher or lower scope. Take the pair of sentences below.

(26) a. Every girl loves a man.
b. Every girl loves some man.

Either of these sentences can be interpreted as being ambiguous ($\forall > \exists$ or $\exists > \forall$), but (26b) with the quantifier *some* seems to predispose one to be somewhat closer to the $\exists > \forall$ interpretation, where every girl loves one particular man, say, Billy.

We can see a similar effect with universal quantifiers:

(27) a. Three postmen visited each house.
b. Three postmen visisted every house.

(27a) seems to prefer the ($\exists > 3$) interpretation where at every house there were three, possibly different postmen. (27a) prefers the reading ($3 > \exists$) where exactly three postment went to every single house.

While the account I have built here does quite well to predict the effects of transformations and scrambling on scope interpretations, as well as predicting typological facts, I do not think these narrow differences between the tendencies of particular quantifiers can be capturedin our current formalism.

However, an Evolutionary game theory account could do so quite well. In fact, an an evolutionary account could also answer the general question of why languages indeed do have "synonymous" quantifiers in the first place.

Specifically, given what we've modeled here, ambiguity is still a sizeable problem for communication's sake. To disambiguate sentences which maintain ambiguity, language systems gradually evolve a meta-game or, really *conventions* as to particular quantifiers having particular scope readings.

That is, in English, for example, *some* and *a* may both be existential quantifiers, as *every* and *each* are both universal quantifiers, but over time, Schelling Points arise where particular quantifiers are conventionalized as prefering wide or narrow scope. In English, it seems that both *some* and *each* tend to prefer wide scope while *a* and *every* prefer narrow scope.

### 6.3 Empirical extensions

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## 7 Closing

In closing, much of the confusion about scope can be alleviated by understanding that scope availabilities are determined by pragmatic factors and implicatures that can be modelled game theoretically. We've seen here that the facts about the scope availabilities of most languages fall out quite effortlessly from assumptions about the cost of transformations, the costlessness of scrambling and the wider syntactic capacities of a language.

I feel that much more work can be note to resolve questions in scope using pragmatic facts, particularly in the areas of telicity and world knowledge. Regardless, there seems to be decent circumstantial evidence to lend credence to the idea that scope is not a component of narrow syntax, but a set of extra-UG implicatures we make about language use.

Additionally, other factors of grammar, such as binding in the classical sense are in need of new life, once insurmountable problems were brought to traditional syntactic analyses of the data. It may be that these other factors, binding, negative polarity items and cross-over effects may actually be derivable on pragmatic grounds, and thus would eliminate such of the theoretical mess and greatly economize and minimize the core language faculty.

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