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Abstract

Scope-taking is one of the most characteristic, distinctive, and ubiquitous phenomena in natural language. When an expression takes scope, it combines with surrounding material as its semantic argument. For instance, in *Amy gave everyone a book*, the semantic argument of *everyone* is an abstraction over the entire rest of the sentence, namely, $\lambda x.Amy\ gave\ x\ a\ book$, the property an individual has if Amy gave that individual a book. This ability to operate on surrounding context dramatically enriches (and complicates) the ways that meanings can be expressed. Although there are many formal theories of scope-taking, Quantifier Raising—often thought of as a covert (silent) version of overt syntactic movement—is by far the dominant approach. There are many constraints on the availability of scope taking that depend on the identity of the scope-taker as well as on its surrounding context.

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Significance statement

Scope taking is a distinctive and characteristic feature of natural language. An expression “takes scope” when it semantically combines with material that contains it. For instance, the sentence *Amy gave nothing to Bill* is true just in case there is no thing x such that Amy gave x to Bill. In other words, the expression *nothing* takes scope over the entire sentence that surrounds it. A vast amount of semantic explanation depends on scope taking, so theories of scope are basic and essential for describing natural language meaning.

1. Introduction

Scope-taking in natural language is ubiquitous, and at the same time almost impossible for an untrained native speaker to perceive. Yet it is a peculiar, and indeed, a spectacular strategy for enriching meaning, one that is both distinctive and highly characteristic of natural language.

Scope-taking happens when certain expressions combine semantically with material beyond their immediate syntactic environment.

- (1) Amy gave **nothing** to Bill. **nothing**(λx .Amy gave x to Bill)

For instance, in example 1, the quantifier *nothing* takes scope over the entire sentence, so that its semantic argument is a property that an entity has if Amy gave that entity to Bill.

Scope taking is not an obvious strategy for a language. In fact, many artificial languages, including formal logics and programming languages, get by without any scope-taking at all. Yet scope taking is pervasive in natural language, and plays an essential role in the interpretation of many construction types. Furthermore, it is ubiquitous across languages—I am not aware of any claim that there might be a natural language that has no scope-taking, with the exception of Everett (2005).

Scope, then, is a striking phenomenon that is highly characteristic of natural language. Its importance to the study of meaning cannot be exaggerated: it is foundational and indispensable.

2. Basics

The scope of an expression is what it combines with semantically, that is, its semantic argument.

I'll develop the discussion in the context of an extensional type system. Basic types will be e , the type of individuals, and t , the type of propositions. In addition, if α and β are types, then $\alpha \rightarrow \beta$ is also a type, the type of functions from objects of type α to objects of type β .

The most basic mode of semantic composition is Function Application. Function Application combines a function of type $\alpha \rightarrow \beta$ with an argument of type α to form an expression of type β , where the function and the argument can occur in either linear order.

- (2) Amy left. **left**(amy) Function Application
- (3) Amy gave **nothing** to Bill. **nothing**(λx .gave(x)(**to**(bill)))(amy) Taking scope

In example 3, the quantifier **nothing** (type $(e \rightarrow t) \rightarrow t$, abbreviated below as et, t) takes the entire rest of the sentence (type $e \rightarrow t$, abbreviated as et) as its semantic argument, so the scope of the quantifier is its entire surrounding clause. In order to model this subpart/container mode of semantic composition, an adequate theory of scope must find a way to package surrounding material—in this case, a sentence surrounding a DP position—as a semantic constituent.

The prototypical scope-taking expressions are generalized quantifiers such as *everyone*, *no one*, *every boy* or *no woman*. Besides DPs, the list of expression types that have been analysed as scope-taking include in-situ wh phrases, adverbs, adjectives, coordinating particles, comparatives, superlatives, focus particles, and more.

Scope is often conflated with quantification. And indeed, most scope-taking expressions have meanings that quantify over a set of entities. However, the correspondence between scope and quantification fails in both directions: there are scope analyses of expressions that are difficult to interpret as quantificational in the usual sense, such as proper names, coordination, sentence negation, and in-situ wh expressions; and there are quantificational expressions that typically or always take only surface-adjacent scope, such as tense and modal auxiliaries. So scope taking and quantification are conceptually independent; that said, scope-taking and quantification are closely intertwined.

2.1. Scope ambiguity

Ambiguity can arise from indeterminism about where exactly a scope taking expression takes scope.

- (4) Amy wants everyone to leave.

In example 4, the quantifier *everyone* either takes scope over just the embedded clause, in which case Amy has a single thought (roughly, a desire for solitude); or it takes scope over the entire clause, in which case Amy has many distinct thoughts, one for each relevant person. Under this interpretation, solitude is not her goal, except accidentally.

A second, related, kind of ambiguity involves priority among multiple scope taking elements.

- (5) Someone saw everyone.

In example 5, both *someone* and *everyone* take scope over the entire sentence. The different interpretations correspond to which quantifier takes priority over the other. If *someone* takes scope over *everyone* (the linear scoping), there is one person who saw everyone; if *everyone* takes scope over *someone* (the inverse scoping), there can be a different seeing agent for each person seen.

There is considerable work on the acquisition of scope alternations by children (Lidz (2018)).

2.2. Scope and Quantificational binding

Quantifiers are sometimes able to bind pronouns in their scope.

- (6) Every boy^{*i*}'s mother loves him_{*i*}.

In example 6, there is a prominent interpretation on which each boy x is loved by x 's mother. It is often assumed that the quantifier must not only take scope over the pronoun, but also c-command the pronoun in the surface syntax (Reinhart (1983), Büring (2005)). However, there are many counterexamples, including example 6 (see Barker (2012)).

- (7) *His_{*i*} mother loves every boy^{*i*}.

There is also a requirement in many situations that the quantifier must linearly precede the pronoun in order for binding to be available, as illustrated by the mild ungrammaticality of example 7. This is an instance of weak crossover (Ruys (2000), Büring (2004), Shan & Barker (2006), Barker & Shan (2014), Chierchia (2020)).

See Brasoveanu (2007) and Gotham (2019) for discussions of quantificational subordination, and see section 5.8 for donkey anaphora.

3. Theories of scope taking

This section discusses theories that aim to provide a general scope-taking mechanism, concentrating on accounts that have some importance historically or conceptually. Section 5 below will discuss additional scoping mechanisms that specifically target indefinites.

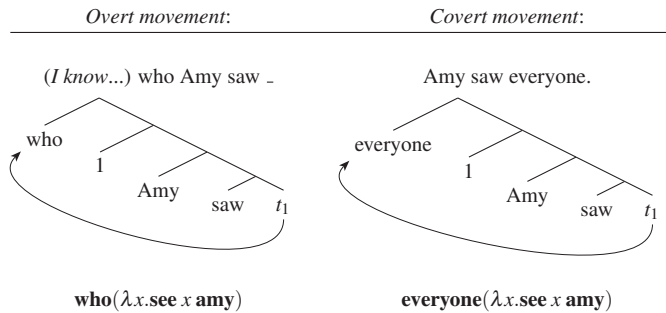
The dominant approach by a wide margin is Quantifier Raising, in which taking scope is conceived as a form of movement.

3.1. Scope as covert movement: Quantifier Raising

The role of scope-taking in semantics is parallel to movement in syntactic theory, both in terms of its central importance, and in many specific details. In fact, one widespread view is that scope quite

literally is a form of syntactic movement, though the movement is silent ('covert'). If so, this would explain why scope-taking is so prevalent and characteristic of natural language.

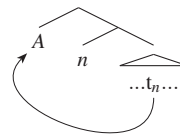
I'll illustrate the idea using wh-movement as a representative of overt movement, adopting the integer notation for binding traces from Heim & Kratzer (1998):



The wh phrase *who* overtly moves to the front of the embedded clause, leaving behind a trace t_1 , so that the movement remnant denotes the property of being seen by Amy. In the covert movement analysis, the quantifier *everyone* moves to the front of its clause, leaving behind a trace, so that the denotation of the complement of the quantifier after movement (its 'nuclear scope') also denotes the property of being seen by Amy.

May (1977) named this covert movement operation Quantifier Raising (QR):

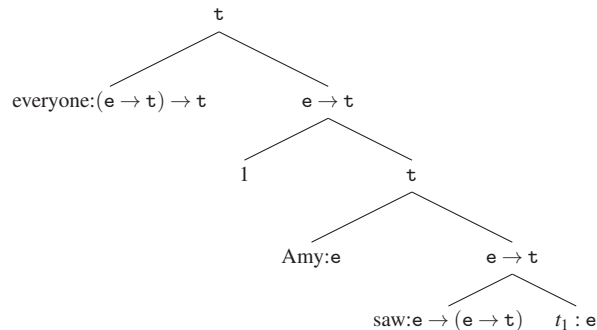
- (8) Quantifier Raising: $[...A...] \Rightarrow [A [n [...t_n...]]]$



This operation can apply to a subpart of a structure (that is, the landing site does not need to be the root node). Since Quantifier Raising is covert movement, the output of QR is called a Logical Form (LF) to distinguish it from syntactic structures that feed PF.

Types for Quantifier Raising are straightforward. For both wh-movement and Quantifier Raising, the interpretation of "[$n [...t_n...]$]" (where n is an index created by movement) when evaluated with respect to an assignment function g will be $\lambda x[[...t_n...]]^{g[t_n \mapsto x]}$, where $g[t_n \mapsto x]$ is the assignment function just like g except that it maps the trace variable t_n to the value x . So if the trace t_n has type α , and the LF constituent $[...t_n...]$ has type β , then $[n [...t_n...]]$ has type $\alpha \rightarrow \beta$. Heim and Kratzer call this mode of semantic composition Predicate Abstraction. (A technical point: an index must c-command its trace in order to be typeable and interpretable, so unbound traces are ruled out.)

For instance, in the example above, we have the following types for the LF of *Amy saw everyone* after Quantifier Raising:



The mode of composition in this LF is Function Application throughout, except for the second highest branching node, which composes via Predicate Abstraction. The net semantic value is $\mathbf{everyone}(\lambda x.\mathbf{saw} x \mathbf{amy})$.

Scope ambiguity. Quantifier Raising gives a simple and satisfying account of both kinds of scope ambiguity: in example 4, the scope depends on the landing site of Quantifier Raising, and in example 5, the relative scope of the quantifiers depends on the order in which they undergo Quantifier Raising.

Type mismatch. Given that generalized quantifiers have (extensional) type $(e \rightarrow t) \rightarrow t$, there is no way to compose a quantifier directly with a transitive verb of type $e \rightarrow (e \rightarrow t)$ via Function Application. Something must be done in order to interpret sentences like *Amy saw everyone*. As we have just seen, QR resolves this tension. However, type mismatch is by no means present in every instance of scope taking. For instance, in order to explain the scope ambiguity in example 5, it is usually assumed that the quantifier in subject position can undergo QR in order to take wide scope over the (raised) direct object, despite the fact that there is no type mismatch between a quantifier in subject position and a verb phrase complement.

Formal constraints. What constraints are there on what undergoes Quantifier Raising, and what constraints are there on where a scope-taker lands?

The only truly essential formal constraint (as opposed to empirically-motivated constraints) on Quantifier Raising is that the final LF resulting from a series of Quantifier Raising operations must have a coherent type analysis. In the terms given here, that means that each internal node of the final LF must be an instance of either Function Application or Predicate Abstraction, as in the diagram above. (Other modes of combination, such as Predicate Modification, can be added if desired; see Heim & Kratzer (1998), Bumford & Charlow (2026).)

Decidability. Given type coherence, what other formal constraints are necessary? Barker (2020) proves that Quantifier Raising remains decidable without any formal constraints whatsoever, besides the non-negotiable type coherence. That is, given an arbitrary syntactic structure, it is possible to decide whether there is a coherent Quantifier Raising analysis in a finite amount of time that depends on the length of the input. Furthermore, all semantically distinct analyses can be found in finite time as well. That means that none of the following strategies are problematic from the point of view of decidability: vacuous movement (Fox (2000)), re-raising (Fox (2000)), remnant raising (Johnson (2008), Barker (2013)), raising of names (Reinhart (1983), Heim & Kratzer (1998), p. 210), raising of traces (Barker (2020)), higher-order traces (Landman (2006), Poole (2024)), or repeated type lifting (Steedman (2012), p. 81).

Complexity. Sanger (2025) shows that the decidability problem for QR is NP-complete.

3.2. Quantifying In

Montague’s (1974) hugely influential Proper Treatment of Quantification (PTQ) defines an operation called Quantifying In. Quantifying In is essentially the inverse of Quantifier Raising: instead of raising the scope taker to its scope position as in QR, it lowers the scope-taker from its LF position into its surface position. Quantifying In is rarely if ever seen in modern work, but it preceded and inspired Quantifier Raising.

QR as beta expansion. In the lambda calculus, an abstract applied to an argument can undergo beta reduction. For instance, $(\lambda x.\mathbf{saw} x \mathbf{amy})(\mathbf{bill}) \rightsquigarrow_{\beta} \mathbf{saw} \mathbf{bill} \mathbf{amy}$. Allowing for the differences in function/argument linear order between the lambda calculus and natural language, Quantifying In is a form of beta reduction, and so QR is beta expansion (Barker (2020)).

3.3. Cooper Storage

Cooper Storage (Cooper (1983), Kobele (2018)) is a prominent early alternative method for computing scope. Cooper Storage associates each semantic representation with a multiset called a ‘store’. Composition proceeds bottom up, starting with an empty store. Ordinary expressions contribute to the semantic value in the usual way via Function Application, while the stores of the functor and the argument are combined. When a scope-taking expression Q is first encountered, a fresh variable v stands in for Q in the construction of the semantic value, and Q is added to the store, along with a copy of the variable. At the level in the derivation at which the scope-taker takes scope, Q and its variable are removed from the store, the semantics undergoes an operation that binds v , and the denotation of Q applies to the abstracted semantic value. A derivation is complete only when the store is empty.

Cooper storage has some pleasant properties. Scope taking is relegated entirely to the semantic component, so there is no creation of syntactic structures that do not correspond to the structure of the expression under analysis. Composition proceeds bottom up, with no lowering or other modification of previously constructed representations. Since the store is an unordered multiset, quantifiers can be removed from the store in any order, accounting for quantifier scope ambiguity.

3.4. Type shifting approaches

3.4.1. Lift. Lift (Montague (1974), Partee & Rooth (1983), p. 378) is a type-shifting operation that is part of every type-shifting approach to scope. One compelling motivation for Lift is that it allows proper names to have type e , at the same time their lifted versions can coordinate with generalized quantifiers of type et, τ (e.g., *every state and the District of Columbia*). Partee (1987) says of lift that it “falls directly out of the type theory,” and observes that it generalizes to lift expressions of type α to type $(\alpha \rightarrow \beta) \rightarrow \beta$ for any types α and β . She speculates that although it may not be universal, it should be available in any particular language “at ‘low cost’ or ‘no cost’.”

Although Lift is usually encoded as a semantic type shifting operator, it has a simple implementation as an LF structural manipulation, on a conceptual par with Quantifier Raising (compare to example 8 above):

(9) Lift: $A \Rightarrow [n [t_n A]]$



For instance, the Lifted name $[1 [t_1 Amy]]$ composes via Predicate Abstraction to the generalized quantifier $\lambda P_{et}.P(\mathbf{amy})$. This structural LF implementation of Lift will play a role in the comparison of QR scope theories with in-situ type shifting theories below in section 3.4.3.

In the same spirit that QR corresponds to beta expansion in the lambda calculus, Lift corresponds to eta expansion (Barker (2020)), as long as we once again allow for type-driven function/argument linear order flexibility.

3.4.2. Combinatory Categorical Grammar. Steedman 1988; 1996; 2000; 2012; 2026 develops an in-situ account of scope that involves type shifting and no movement. Additional modes of combination (equivalent to combinators in the sense of Curry & Feys (1958)) allow a limited degree of syntactic associativity via certain instances of function composition, e.g., $[X_{\tau \rightarrow \delta} Y_{\sigma \rightarrow \tau}]_{\sigma \rightarrow \delta}$. This generates a wider range of syntactic structures than usual, notably including instances of Right Node Raising:

- (10) [Every woman saw] and [every man said he liked] some movie.

This example illustrates how scope-taking interacts with associativity. Steedman argues that only universals should be thought of as genuine scope takers, and that indefinites in particular should be

managed through a process called Skolemization (see section 5.4). The net result is that example 10 is correctly predicted to have an interpretation on which it is true even if each man and each woman saw a different movie, as if there were separate instances of *some movie* in the scope of each of the universals.

In CCG, universals take scope via a lexical type-shifting schema call Type Raising. Type Raising has the same type signature as Lift (namely, $\sigma \Rightarrow (\sigma \rightarrow \tau) \rightarrow \tau$), but a different semantics. Type Raising enables universals to take scope over a clause from a variety of non-subject positions, including some possessive constructions (Steedman (2012), p. 133):

(11) Every boy’s father loves him.

However, type Raising is limited to a finite number of lexical instances. As a result, unlike most other theories of scope, CCG does not provide a general mechanism that is capable of allowing a scope taker to take scope from any structural position.

(12) The word “snowflake” should be at the top of everyone’s list.

For instance, Steedman (2012) fails provide an analysis for the interpretation of example 12 on which there is a different list for each person.

3.4.3. Flexible Montague Grammar. Hendriks’s 1993 Flexible Montague Grammar is a paradigm example of an in-situ (i.e., movement-free) theory of scope taking. Expressions are allowed to freely undergo spontaneous type shifting. The two key type shifting principles are Argument Raising and Value Raising. Lift is a special case of Value Raising, so the system allows arbitrary lifting.

(13) Everyone’s mother left. $[[\text{everyone } (\lambda \mathcal{P}_{et,t} \lambda P_{et} \cdot \mathcal{P}(\lambda x_e \cdot P(x \text{ mother})))]] \text{ left}]$

(14) Someone saw everyone. $[\text{someone } [(\lambda \mathcal{Q}_{et,t} \lambda \mathcal{P}_{et,t} \cdot \mathcal{Q}(\lambda x_e \cdot \mathcal{P}(\lambda y_e \cdot \text{saw } x y))) \text{ everyone}]]$

One striking feature of the system is that it is not the scope takers themselves that undergo shifting, but rather, the nearby predicates that embed the scope takers. In example 13, the nominal predicate *mother* has first undergone Value Raising, and then the result of that shift has undergone Argument Raising. In example 14, the transitive verb *saw* has undergone two instances of Argument Raising, one that targets the first argument and then one that targets the second argument, leading to inverse scope.

Each quantifier remains in its surface syntactic position, and combination proceeds in the same order as surface syntactic constituency.

Equivalence between Flexible Montague Grammar and QR. In-situ type shifting is often thought of as a conceptually different approach to scope taking compared to movement theories. However, both Value Raising and Argument Raising are theorems of any system that includes both QR and Lift (Barker (2020)). Here’s an illustration:

(15) $[1[2[t_1[3[t_2[\text{mother}]]]]]]$ derivation: Lift (n=1), Lift (n=2), QR on trace t_1

(16) $[1[2[t_1[4[t_2[3[t_3[\text{saw } t_4]]]]]]]]$ derivation: Lift (n=1), Lift (n=2), QR on t_2 , QR on t_1

The standard interpretation of these Logical Forms are exactly the shifted predicates provided by Flexible Montague Grammar in examples 13 and 14.

Direct Compositionality. One of the advantages of many type-shifting approaches (including CCG and Flexible Montague Grammar) is that they are Directly Compositional (Jacobson 1999; 2002, Barker & Jacobson (2007)): every surface syntactic constituent has a complete and well-formed model

theoretic denotation. This is not a property of typical Quantifier Raising derivations. For instance, in *Amy saw everyone*, the verb phrase *saw everyone* is a surface syntactic constituent, but cannot be composed into a single semantic value. However, because QR (given Lift) can fully and completely simulate Flexible Montague Grammar, we can convert arbitrary QR derivations into different but semantically equivalent QR derivations that are Directly Compositional whenever desired.

3.4.4. Continuations and weak crossover. Barker (2001), de Groot (2001), Shan (2001), Barker (2002), Shan & Barker (2006), Barker & Shan (2014), Barker (2020), and Bumford & Charlow (2026) develop theories of scope taking based on continuations, a concept from the theory of programming languages. One of the core applications of continuations is theorizing about order of evaluation. In natural languages, fine-grained control over order of evaluation allows a principled account of weak crossover and of reconstruction (Shan & Barker (2006), Barker & Shan (2014)).

3.5. Type-logical approaches (substructural logics)

Building on Lambek (1958), type logical grammars (Moortgat (1997)) use formal logic to describe natural language. Derivations are quite literally logical proofs. Thanks to the Curry-Howard isomorphism between logical proofs and lambda terms, the syntax/semantic interface is fully determined by the syntax. Because the logics are substructural (i.e., rejecting the usual logical inferences of exchange, weakening and contraction), they are resource-sensitive: every grammatical element must be used exactly once, so duplication is forbidden. The richer type system articulates logical implication (\supset) into left and right implication (\leftarrow and \rightarrow , usually written as \backslash and $/$). Because syntactic combination just is logical inference, the only way to control derivability is through the details of lexical entries, so type logical theories are strongly lexicalist.

There is a substantial body of work applying substructural logics to scope, including Morrill *et al.* (2011), and Kubota & Levine (2020). In addition, Barker (2007), Barker & Shan (2014), and Bernardi & Moortgat (2010) develop type-logical approaches that explicitly involve continuations. Barker (2020) defines a substructural logic whose proofs are isomorphic to QR derivations. This leads to a proof of the fact mentioned in section 3.1 that finding all coherent QR derivations is decidable.

4. Constraints on scope taking

Not all logically possible scope relations are available to native speakers. I can only mention a few of the better known empirical claims here. One clear overarching pattern is that existential quantifiers take wide scope much more easily than universal quantifiers; the scoping of indefinites will be discussed below in section 5.

If scope taking is an instance of movement, the obvious expectation is that scope-taking should be possible or not in the same situations in which overt syntactic movement is possible or not (e.g., May (1977), Ruys & Winter (2011), Dayal (2013), and many others). As many of the examples in this section suggest, this expectation is not correct, and constraints on scope-taking are essentially independent of constraints on syntactic movement (Barker (2022)).

It is a shortcoming of this article and, to some degree, of the literature, that it concentrates so heavily on English. Some, but certainly not all, of these patterns generalize to other languages.

4.1. Surface (linear) scope

Even for robustly ambiguous sentences, there is a definite preference for linear (left to right) scope, sometimes called surface scope:

(17) Someone loves everyone. $\exists > \forall, \forall > \exists$

In example 17, although both scopings are possible, the most salient interpretation matches the left to right order of the quantifiers (i.e., the $\exists > \forall$ scoping). This preference echos the situation in languages (such as Hungarian) that allow freer word order, and in which the scope reflects left to right (alternatively, top to bottom hierarchical) order. In situations in which there are restrictions on relative scope, the linear scoping is almost always among the permitted scopings.

4.2. Tensed clauses

Here's a classic contrast:

(18) a. Someone asked [everyone to leave]. $\exists > \forall, \forall > \exists$
 b. Someone thought [everyone left]. $\exists > \forall, * \forall > \exists$

Control predicates like *ask* that embed infinitival clauses allow universals to take scope outside of the complement clause, as in example 18a: for each guest, a different person asked them to leave. But attitude verbs like *thought* take a tensed clause as a complement, and the standard judgment is that wide scope for the universal is not possible, as in example 18b: there must be a single person having a single thought.

This contrast makes sense if we assume that tensed clauses are *scope islands*, that is, syntactic environments that do not allow QR to move a scope-taker that originates inside the island to a position that is outside of the island.

Rodman (1976) famously claims that relative clauses are scope islands:

(19) a. There is a bone in every corner of the house. $\exists > \forall, \forall > \exists$
 b. There is a bone that is in every corner of the house. $\exists > \forall, * \forall > \exists$

In example 19a, the universal *every corner* can easily take scope over the existential, so that there can be as many bones as there are corners. In example 19b, the universal is embedded inside a relative clause, and the only available interpretation is the physically impossible one on which a single bone is somehow simultaneously present in multiple locations. (See Barker (2022) for counterexamples.)

May (1977) strengthened this claim to all embedded clauses. Despite wide uptake for this claim, it is not true that universals never take scope outside of a tensed clause (Farkas & Giannakidou (1996), Szabolcsi (2010), Barker (2022)):

(20) a. Someone needs to clean the room after [each guest has left]. $\exists > \forall, \forall > \exists$
 b. A student made sure that [each speaker had a ride]. $\exists > \forall, \forall > \exists$

Wurmbrand (2018) suggests that any quantifier can take wide scope, though crossing certain syntactic boundaries (including clause boundaries) can increase processing cost.

Even with full appreciation for these and other counterexamples, universals often remain reluctant to scope out of many embedded clausal contexts, for reasons that remain obscure.

4.3. Larson's generalization (inverse linking)

One proposed constraint on relative scope is sometimes known as Larson's Generalization (Larson (1985b)):

(21) Two famous artists painted [a picture of every Factory regular] $* \forall > 2 > \exists$

Given unconstrained QR, it is a mystery why the universal can't QR high enough to outscope the subject indefinite. One possible explanation is that DP is a scope island (May (1985), Büring (2004), May & Bale (2005), Sauerland (2005), Charlow (2010), Kobele (2010), Thoms (2024)).

4.4. Scope freezing

Some syntactic alternations constrain relative scope.

(22) Amy sent an article to every reviewer. $\exists > \forall, \forall > \exists$

(23) Amy sent a reviewer every article. $\exists > \forall, * \forall > \exists$

Aoun & Li (1989) note that in contrast with example 22, in the double-object construction in example 23, the universal is unable to take inverse scope over the existential. There have been other constructions that are supposed to trigger scope-freezing (e.g., Collins (2017)).

4.5. Negation and universals

Universals resist taking scope over negation (Horn (1989[2001]) pp. 226 ff.). For instance, Jespersen observes that *All that glisters is not gold* is usually heard as expressing the proposition $\neg \forall x. \text{glisters}(x) \rightarrow \text{gold}(x)$. That is, it favors the $\neg > \forall$ reading instead of the surface scoping $\forall > \neg$. In addition, downward monotone quantifiers resist allowing rightward or lower quantifiers to take scope over them, and downward monotonic quantifiers are reluctant to take inverse scope.

(24) a. No man loves no woman. man > woman, *woman > man

b. No woman is loved by no man. woman > man, *man > woman

Unlike many instances of scope ambiguity, the predicted interpretations are logically independent (neither one entails the other). However, in these sentences it is all but impossible for native speakers to access the inverse scoping, showing one way that active sentences and their passive counterparts can behave differently semantically.

In addition to negation and monotonicity, scope relations are sensitive to numerals and distributivity implications. For a fine-grained exploration of the facts and how to model them, see Beghelli *et al.* (1997) and Szabolcsi (2010) chapter 11.

4.6. Kennedy's Generalization

Kennedy (1997) shows that comparatives do not scope over nominal quantifiers (Heim (2001), Abels & Martí (2010)).

(25) a. Amy is 5 feet tall. Every boy is exactly 3 inches taller than that.

b. This paper is 10 pages long. It is required to be exactly 5 pages longer than that.

Assuming that comparatives are quantifiers over degrees, there could be a reading of example 25a on which the maximal degree of height d such that every boy is taller than $5' + d$ is exactly 3 inches (the shortest boy is $5'3''$). But there isn't. Heim (2001) refines this generalization to allow comparatives to scope over intensional verbs: example 25b can mean that the maximal length d that the paper is required to be $10 + d$ pages long is exactly 5 pages (the shortest acceptable length is 15 pages).

4.7. Ellipsis and Economy

Quantifier scope interacts with ellipsis in ways that Fox (2000) argues constrains both the theory of scope-taking and the theory of ellipsis.

- (26) a. A woman watched every movie, and a man did too.
 b. A woman watched every movie, and Mary did too.

In the verb phrase ellipsis example in example 26a, the right conjunct is interpreted as if the missing verb phrase were *watched every movie*. The unelided sentence *a man watched every movie* is ambiguous with respect to linear scope versus inverse scope. Either scoping interpretation is indeed possible, as long as the scope interpretation of the first conjunct is parallel.

However, when the indefinite subject of the elided VP is replaced with a proper name, as in example 26b, the ambiguity disappears. According to Fox (2000), this is due to general considerations of derivational economy, which allow a quantifier to take inverse scope only if doing so has a detectable effect on truth conditions. Taking inverse scope over a proper name like *Mary* has no effect on truth conditions, so Economy limits the interpretation of the elided VP to linear scope; and the fact that the scope of the ellipsis clause must match the scope of its antecedent limits the interpretation of the left conjunct to the only scoping that is consistent with Economy in the second clause. See also Johnson & Lappin (1997, 1999).

4.8. Negative Polarity Items

One strong and clear constraint on scope involves weak NPIs.

- (27) If any relative of mine dies, I'll inherit a fortune. if > any, *any > if

NPIs must take scope that is no wider than their licensing environment (Ladusaw (1979)). Thus in example 27, since the weak NPI is licensed by appearing in the antecedent of the conditional, it must take scope no wider than the antecedent clause.

A second observation concerning the scope of NPIs is that certain operators, including universal quantifiers, cannot intervene in between an NPI and its licenser (Linebarger (1987), Guerzoni (2007)):

- (28) Amy didn't wear any earrings at every party. $\neg > \exists > \forall, \forall > \neg > \exists, * \neg > \forall > \exists$

Given that the NPI must scope below its licensing negation, that still leaves three possible scopings for the universal, but only two are available.

5. Indefinites

The scope behavior of indefinites has inspired considerable theoretical creativity. Here's why: the standard assumption is that QR is clause bounded (though, as discussed in section 4, this assumption is not correct in any simple sense). Thinking of indefinites as scope takers, their scope is certainly not clause bounded. For this reason, it is common to talk about indefinites taking 'exceptional scope'. It follows that indefinites must take scope via some formal mechanism other than QR and that is not clause bounded.

A bewildering variety of mechanisms have been proposed. At the end of the day, the net result of all of these scope mechanisms delivers a denotation that could have been arrived at by simply allowing QR to move an existential quantifier out of a clause. Barker (2022) calls this coincidence the exceptional-scope conspiracy.

5.1. Referential indefinites vs. wide-scope indefinites

The scope of indefinites is not clause bounded.

- (29) Nobody believes the rumor that a (certain) student of mine was expelled.

Fodor & Sag (1982) noted that example 29 has a reading on which the speaker may have a specific student in mind, as if the indefinite took scope over the entire sentence, despite its being embedded inside of a clausal nominal complement (a particularly strong scope island for universal quantifiers).

Fodor and Sag suggest that in addition to the usual quantificational meaning, indefinites can have a specific or referential interpretation. Schwarzschild (2002) proposes a similar but distinct idea by noting that pragmatic domain restriction can narrow the set of objects in the extension of the indefinite's nominal to a single entity, what he calls a **singleton indefinite**. He argues that *certain* signals that the indefinite is quantifying over a singleton domain. Singleton indefinites behave logically as if they were referential or scopeless.

Complicating the picture, an indefinite can sometimes take wide scope with respect to scope islands at the same time that it takes narrow scope with respect to some other operator in the sentence (Farkas (1981 [2003]); Abusch (1993)).

(30) Each student read every paper that discussed some problem. each > some > every

Such examples show that a referential or singleton strategy can't be a complete explanation.

5.2. Choice functions, the Donald Duck problem

Reinhart (1997) points out that there is one way to handle wide-scope indefinites that is clearly wrong: leaving the descriptive content in place, but allowing the existential quantifier to take wide scope.

(31) If we invite a certain philosopher to the party, Max will be annoyed.
 $\exists x. (\text{philosopher } x \wedge \text{invite } x) \rightarrow \text{annoyed max}$

Moving just the existential to the front of the sentence gives rise to the paraphrase in example 31. But these truth conditions are too weak: the fact that Donald Duck is not a philosopher makes example 31 true.

Reinhart (1992, 1997); Winter (1997, 2004), and many others suggest that the Donald Duck problem and other considerations motivate representing indefinites using choice functions. (See also Egli & Von Stechow (1995) and Geurts (2000).) A choice function f with type $(e \rightarrow t) \rightarrow e$ maps a property to an object that satisfies that property. Special care must be taken if P might be empty.

Quantifying over choice functions solves the Donald Duck problem, since we can now give the following analysis for example 31:

(32) $\exists f. (\text{invite}(f(\text{philosopher})) \rightarrow \text{annoyed max})$

Instead of quantifying over individuals, we quantify over choice functions. Then the truth conditions will require that there be some way of choosing a philosopher such that if we invite that particular philosopher, Max will be annoyed. We achieve the effect of choosing a philosopher before executing the conditional, but without moving any lexical material out of the conditional.

5.3. Pseudoscope

Kratzer (1998) proposes an analysis similar to that depicted in example 32, but without explicit existential quantification over choice functions (just leave the " $\exists f$ " off of example 32). Instead, the choice function f is a free variable whose value must be supplied by context. Presumably the speaker must have in mind some way of selecting a particular philosopher.

On this view, the appearance that the indefinite is taking wide scope is just an illusion. It's not really wide scope, it's **pseudoscope**. And if what looks like wide scope is really pseudoscope, this clears the way to assuming that all true scope-taking uniformly obeys scope islands. See Chierchia (2001) and Szabolcsi (2010) Section 7.1.

5.4. Skolemized choice functions

In the context of mathematical proof theory, Skolem (1920[1967]) proved that it is always possible to replace existential quantifiers with functions over the set of individuals that are (now) called **Skolem functions**. For instance, the formula $\forall x \exists y. Px \wedge Qy$ is true iff $\forall x. Px \wedge Q(fx)$ is satisfiable, where f is a variable over Skolem functions with type $e \rightarrow e$.

Skolemized choice functions take zero or more individuals plus one property as arguments, returning an individual that possesses that property: type $e \rightarrow \dots \rightarrow e \rightarrow (e \rightarrow t) \rightarrow e$.

- (33) If every student improves in a (certain) area, no one will fail the exam.
 $\exists f. (\forall x. \text{student } x \rightarrow \text{improves-in}(f \ x \ \text{area}) \ x) \rightarrow \neg \text{fail}$

Here, f is a Skolemized choice function with type $e \rightarrow (e \rightarrow t) \rightarrow e$. Schlenker (2006) shows that these truth conditions cannot be rendered by first-order quantifiers: giving an ordinary existential wide scope over the universal is too restrictive, since it requires there to be a single area that all the students improve in. Giving an existential narrow scope under the universal is too permissive, since it predicts success merely if each student improves in any area, even if it's not the one the instructor had in mind.

Schwarz (2001, 2011) points out that Skolemized choice functions are not available with *no*:

- (34) No student read a book I had recommended.
 $*\exists f \rightarrow \exists x. \text{student } x \wedge \text{read}(f \ x \ \text{recommend}) \ x$

By selecting a perverse choice for f , the truth conditions as given can be fulfilled even if each student read a book I had recommended, contrary to intuitions.

5.5. De dicto/de re

There can be variation in the commitments that arise from descriptive content that is sometimes thought of as a kind of scope ambiguity.

- (35) Lars wants to marry a Norwegian.

Example 35 can be used to describe a situation in which Lars has a desire that the person he marries will be from Norway (de dicto), or else a situation in which there is some specific person Lars wants to marry, and that person happens to be Norwegian (de re). Allowing the indefinite to take scope either within the embedded clause, or else at the level of the matrix clause gives truth conditions roughly in line with these two interpretations.

However, there are cases in which scope relations do not give a complete picture of the facts.

- (36) Mary wants to buy an expensive coat.

For instance, Fodor (1970); Szabó (2010) observe that in addition to the standard de dicto reading (Mary wants to spend a lot of money) and the standard de re reading (she's picked out a coat, but doesn't know its expensive), example 36 can be used to describe a situation in which Mary has narrowed down her choices to a small set of coats without picking a specific one, so the truth conditions of giving the indefinite wide scope aren't satisfied; and yet she isn't aware that the coats are expensive, so the truth conditions of giving the indefinite the narrow scope aren't satisfied. See Keshet (2010) for a scope-based proposal.

5.6. Alternative Semantics and Hamblin semantics

Chomsky (1976) argues, based on crossover effects, that focus involves scope-taking via QR. However, focus appears to ignore all traditional island boundaries (*I even know a guy who SMOKES bananas*).

In view of this fact, and appealing to the common assumption that QR respects islands (see section 4), Rooth (1985) provides a different scoping mechanism that he calls ‘alternative semantics’, on which expressions have two semantic values: an ordinary semantic value and a focus semantic value.

$$(37) \text{ Amy only ate a RED}_F \text{ apple.} \quad \llbracket \text{RED}_F \text{ apple} \rrbracket^f = \{\text{red apple, green apple}\}$$

$$\llbracket \text{RED}_F \rrbracket^f = \{\text{red, green}\} \quad \llbracket \text{apple} \rrbracket^f = \{\text{apple}\}$$

The focus semantic value of a focused expression (RED_F) is a set of contextually constrained alternatives. The focus semantic value of an expression that does not contain focus (*apple*) is a singleton set containing its ordinary value. Composition proceeds pointwise, that is, the focus value of a complex expression is the set constructed by applying each member of the functor focus value to each member of the argument focus value.

Krifka (2006) argues that association with focus involves both an alternative semantics phase and a movement phase in the same derivation (see also Wagner (2006)).

Alternative semantics bears a strong resemblance to Hamblin-style semantics for questions and for indefinites. In Hamblin semantics, wh-words contribute a set of alternatives that combine pointwise with embedding predicates, so that the top-level denotation is a set of possible answers (Hamblin (1973)). In a similar fashion, indefinites contribute a set of witnesses that combine pointwise with embedding predicates. This strategy provides popular accounts of negative polarity items (Krifka (1995), Chierchia (2013)), indeterminate pronouns (Kratzer & Shimoyama (2002)), intervention effects in wh-questions (Beck (2006)), and various modal constructions (Alonso-Ovalle (2008)). Care must be taken when pointwise composition interacts with Predicate Abstraction (Shan (2004), Bumford (2022)).

Because this method of scope taking involves a mechanism that is independent of QR, it provides a way for indefinites to take wider scope than universals, since universals are presumed to be governed by an island-respecting QR. Furthermore, there is explanatory power in the fact that wh-words, NPIs, and indefinites gain access to this scoping method by virtue of what they mean, since they all nondeterministically contribute alternatives.

Nevertheless, as discussed by Rooth (1996), alternative semantics and Hamblin semantics are indeed a form of scope taking, and can easily be implemented by a QR analysis. Surprisingly, Charlow (2020) shows how a QR analysis for indefinites can work even under the assumption that QR scrupulously respects islands: indefinites take scope via QR as far as the edge of their most local island, but then the island itself undergoes QR. This strategy is sometimes called “scope the island”. The net result, given certain other assumptions, is exactly as if the indefinite had taken extra wide scope directly via island-disrespecting QR.

5.7. Disjunction as a scope-taking indefinite

Logically, disjunction is a two-place counterpart of existential quantification (likewise, conjunction for universal quantification). And in parallel with indefinites versus universals, disjunction takes wider scope than conjunction (Larson (1985a), Hendriks (1993), AnderBois (2014)).

$$(38) \text{ Amy said that Bill called Carl or Disha.}$$

Example 38 is ambiguous depending on whether the disjunction takes scope only over the matrix VP (*...but she doesn't remember who*) or else over the entire sentence (*...but I don't remember who*).

5.8. Donkey anaphora

There is a famous exception to the rule that a covarying pronoun must be in the scope of a quantifier.

$((\mathbf{et}, \mathbf{t}) \rightarrow \mathbf{t}) \rightarrow \mathbf{t}$ with value $\lambda F. \neg F(\lambda Q. \exists x. \mathbf{Auto} x \wedge Qx)$, then *alle Ärzte* raises first (index 1), followed by *kein Auto* (index 2), and finally the high-order trace t_2 raises (index 3). The net truth conditions assert that some doctors don't have cars. (See also Geurts (1996) and de Swart (2000).)

Cresti (1995), p. 99, following Higginbotham (1993) (see also Ginzburg & Sag (2000)) suggests that some wh-phrases, including *how many* questions, contribute two scope-taking elements, namely, a wh-operator over numbers (*what number n*) and a generalized quantifier (*n-many people*):

(42) How many people should I talk to?

One reading asks how many people have the property of my needing to talk to them. A second reading asks for a number such that it is necessary for me to talk to that many people. The wh-element always takes wide scope, and the difference between the readings depends on whether the quantifier element of the split meaning takes scope above or below *should*.

Heim (2001) speculates that scope ambiguity involving comparatives and modals (section 4.6) could be analyzed as split scope, an idea developed by Hackl (2000), Penka (2002), Abels & Martí (2010) and others (see Szabolcsi (2010), pp. 167 ff.).

Bumford (2017) gives a split scope analysis of Haddock descriptions such as *the rabbit in the hat*, which can be used in situations in which there is no unique rabbit and no unique hat, as long as there is only one rabbit that is in a hat. Bumford proposes that each definite determiner contributes a wide scope uniqueness implication and a narrow scope existential implication.

Charlow (to appear) shows how postsupposition analyses in general can be implemented using split scope, including various readings of sentences containing modified numerals (e.g., *Exactly three boys watched exactly five movies*).

6.3. Parasitic scope

Parasitic scope can arise when the target type (τ) and the result type (δ) match the type of the nuclear scope of some other scope taker. For instance, given that the nuclear scope of *everyone* has type $(\mathbf{e} \rightarrow \mathbf{t})$, an expression with type $(\sigma \rightarrow \mathbf{et}) \rightarrow \mathbf{et}$ (the type of a Lifted σ) can take parasitic scope over *everyone*. Barker (2007) proposes just such a type for *same*:

(43) The same waiter served everyone.
 [everyone [same [2 [1 [[the [t_2 waiter]] [served t_1]]]]]]]

Everyone raises first (index 1). Then *same* raises (index 2) to a position in between the raised quantifier and its nuclear scope. Because *same* does not have a suitable scope target before *everyone* has taken scope, the scope-taking of *same* is parasitic on the scope-taking of *everyone*.

Kennedy & Stanley (2009) propose a parasitic scope analysis for *average*, as in *The average American has 2.3 kids*.

Parasitic scope analyses have also been proposed for superlatives (Heim (1999)), phrasal comparatives (Pollard & Smith (2012), Erlewine (2023), Lechner (2021)), and various types of coordination in English and in Japanese (Kubota & Levine (2012); Kubota (2013)).

6.4. Recursive scope

Yet another logical possibility is for a scope-taking element to produce a result category (δ) that is itself scope-taking.

(44) Ann and Bill know [some of the same people].
 [ann-and-bill [[same [1 [some-of-the [t_1 people]]]]][3 [2 [t_2 [know t_3]]]]]]]

The (non-recursive) parasitic scope analysis of *same* sketched in example 43 requires that there is some set of people *X* such that Ann and Bill each know a subset of *X*. But nothing prevents the subsets from being disjoint, so that there might be no one that Ann and Bill both know, contrary to intuitions about the meaning of example 44. Solomon (2010) suggests that *same* takes recursive scope, as shown in the derivation in example 44: it first takes scope over the DP *some of the -- people* (index 1), then turns this DP into a parasitic scope-taker that distributes over the set containing Ann and Bill.

For a second application of recursive scope, Andrews Amalgams (Johnson (2013)) are a type of antecedent-contained ellipsis that involves sluicing.

(45) Sally will eat [I don't know what] today.

The sluiced clause is interpreted as *what Sally will eat today*. Barker (2013); Barker & Shan (2014) gives a recursive scope analysis.

Compared to split scope and parasitic scope, recursive scope is more complex, and not yet firmly established as a major scope-taking phenomenon. However, just like split scope and parasitic scope, recursive scope comes for free given the availability of Quantifier Raising.

7. Outlook

Restrictions on scope remain poorly understood. In particular, and contrary to widely held beliefs, constraints on overt movement are deeply different from constraints on covert movement.

Why don't universals take wide scope the way that indefinites do? How and why and when does negation and downward monotony interact with scope? Which empirical constraints on scope reflect genuine grammatical regulation, and which are merely pragmatic tendencies?

Progress in understanding constraints on scope will depend on both careful empirical investigation and the invention of new explanations.

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