The scope of alternatives: Indefiniteness and islands

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Abstract I argue that alternative-denoting expressions interact with their semantic context by taking scope. With an empirical focus on indefinites in English, I show how this approach improves on standard alternative-semantic architectures that use point-wise composition to subvert islands, as well as on in situ approaches to indefinites more generally. Unlike grammars based on point-wise composition, scope-based alternative management is thoroughly categorematic, doesn't under-generate readings when multiple sources of alternatives occur on an island, and is compatible with standard treatments of binding. Unlike all in situ (pseudo-scope) treatments of indefinites, relying on a true scope mechanism prevents over-generation when an operator binds into an indefinite.

My account relies only on function application, some mechanism for scope-taking, and two freely-applying type-shifters: the first is Karttunen's (1977) proto-question operator, aka Partee's (1986) IDENT, and the second can be factored out of extant approaches to the semantics of questions in the tradition of Karttunen (1977). These type-shifters form a decomposition of LIFT, the familiar function mapping values into scope-takers. Exceptional scope of alternative-generating expressions arises via (snowballing) scopal pied-piping: indefinites take scope over their island, which then itself takes scope.

1 Introduction and overview

In the last four decades, the idea that utterances invoke alternatives — roughly, things a speaker could have said — has underwritten insightful semantic analyses of indefiniteness, disjunction, questions, focus, adverbial quantifiers, scalar implicature, and more.

Despite these considerable, varied successes, alternatives raise fundamental questions about semantics and the syntax-semantics interface. First, theories oriented around alternatives standardly proliferate syncategorematic rules of interpretation, individually tailored to expressions that interact with alternatives in 'non-default' ways. Second, the standard approach to compositionally integrating alternatives — pointwise functional application — is fundamentally unselective and for that reason prone to under-generation in configurations with multiple sources of alternatives (e.g., Rooth 1996, Wold 1996, Krifka 2006). Third, pointwise composition turns out to be incompatible with standard treatments of functional abstraction and binding (Poesio 1996, Shan 2004).

This paper motivates a new picture, in which expressions that invoke alternatives *take scope*. I'll demonstrate that this can be accomplished by decomposing Partee's (1986) LIFT into two freely applying type-shifters, and argue — with a focus on English indefinites — that this approach allows us to make progress on each of the above fronts. These moves underwrite the first empirically robust reckoning with alternatives, and an empirically advantageous account of the exceptional scope properties of indefinites.

The tools I propose for handling alternatives and explaining exceptional scope are, in fact, already implicit in the semantics literature — specifically, in approaches to questions following Karttunen (1977). For this reason, the proposal here is fundamentally conservative in orientation, even as it argues for a new way to organize and extend these familiar pieces, and points out some novel consequences of them.

2 Indefinites on islands

2.1 Basic data: exceptional scope

The scope-taking of indefinites is unbounded (Fodor & Sag 1982, Farkas 1981, Ludlow & Neale 1991, Reinhart 1997, Brasoveanu & Farkas 2011, and many others). Sentence (1) can describe a situation in which I've got exactly one rich relative who's put me in her will (though I may not know who she is) (Reinhart 1997: 342). This reading requires the existential quantifier contributed by the indefinite *a rich relative of mine* to take scope over the conditional.[1] DPs headed by quantificational determiners like *every* and *no* lack this flexibility. Sentence (2) can't be interpreted with the embedded quantifier scoping over the conditional. In other words, (2) cannot mean that for each of my rich relatives x, x's death would sufficient to guarantee me a house.

(1) If [a rich relative of mine dies], I'll inherit a house. ✓$\exists \gg$ if

(2) If [every rich relative of mine dies], I'll inherit a house. *$\forall \gg$ if

Let's call the [bracketed] domains in such examples — out of which indefinites can take scope, but other quantificational DPs cannot — *scope islands*, and call an indefinite that takes scope out of a scope island an *exceptionally scoping* indefinite.

Though Fodor & Sag (1982), Heim (1982) claim that exceptionally scoping indefinites are necessarily interpreted with widest scope, Farkas (1981) points out that examples like (3) allow *intermediate* exceptional scope readings. Thus, (3) can mean that for each student x, there is some condition y proposed by Chomsky such that x has to come up with three arguments showing that y is wrong. (See Ludlow & Neale 1991, Ruys 1992, Abusch 1994, Reinhart 1997 for additional data and arguments buttressing this conclusion.) Here, the indefinite is embedded in a relative clause, which is a scope island for quantifiers like *every condition proposed by Chomsky*.

(3) Each student has to come up with three arguments showing that [some condition proposed by Chomsky is wrong]. ✓$\forall \gg \exists \gg 3$

Though in all of these examples, *overt* movement (e.g., *wh* movement) out of the bracketed domains is illicit, scope islands are not generally islands for overt movement. For example, tensed clauses are reasonably strong scope islands (e.g., Farkas & Giannakidou 1996, Reinhart 1997, Kayne 1998), though they aren't islands for overt movement:

(4) A professor swore that [every student had passed]. *?$\forall \gg \exists$

1 When I talk about an indefinite 'taking scope' out of a scope island, I'm really talking somewhat loosely about readings which make it seem as if the indefinite had done so. The question, of course, is how such readings are to be derived if the indefinite is trapped on its island.

Exceptional scope isn't limited to indefinites. Examples (5)–(10) demonstrate exceptional scope for *wh* in situ (e.g., Huang 1982, Nishigauchi 1990, Dayal 1996, Reinhart 1998), disjunction (e.g., Rooth & Partee 1982, Schlenker 2006, Charlow 2014), indeterminate pronouns (e.g., Nishigauchi 1990, Kratzer & Shimoyama 2002, Shimoyama 2006), association with focus (e.g., Rooth 1985, 1996, Krifka 2006), supplementation (e.g., Potts 2005), and presupposition projection (Singh 2015). In each of these cases, the *italicized* expression may make some semantic effect felt beyond the borders of the [island]. In the interest of space, I refer readers to the cited literature for further details.

(5) Which linguist will be offended if [we invite *which philosopher*]?

(6) Everyone who [takes semantics or phonology] gets an A. (I can't remember which.)

(7) [[*Dono hon-o* yonda] kodomo]-mo yoku nemutta.
which book-ACC read child MO well slept
'For every book x, the child who read x slept well.'

(8) John only gripes when [*MARY* leaves the lights on].

(9) John gripes when [Mary, *who's a talented linguist*, leaves the lights on].

(10) John gripes when [*the King of France* leaves the lights on].

Thus, theories of exceptionally scoping indefinites gain additional support when they offer a general way to explain exceptional scope phenomena in other empirical domains.

The empirical focus of this paper is exceptionally scoping indefinites in English (though the technique explored in this paper has much broader applicability, as discussed briefly in the conclusion). My principal aim is to show how a novel conception of the grammar of alternatives predicts exceptional scope behavior for indefinites. This turns out to be so, even though — like Karttunen's (1977) theory of questions — the account I propose is oriented around scope and scope-taking, in contrast with more standard *in situ* treatments of exceptionally scoping indefinites (e.g., Reinhart 1997, Winter 1997, Kratzer & Shimoyama 2002, Brasoveanu & Farkas 2011). Indeed, I argue that placing scope front and center allows the theory to achieve better empirical coverage than treatments of exceptional scope which leave indefinites in situ.

2.2 Alternative semantics and pseudo-scope

Alternative semantics, originally devised by Hamblin (1973) for questions and Rooth (1985) for focus, conceives of compositional interpretation as fundamentally *relational* (cf. e.g., Larson & Segal 1995): just as $[\![\cdot]\!]$ maps a structure into a single, determinate meaning, an alternative-semantic interpretation function $\{\!\{\cdot\}\!\}$ maps a structure into a set of alternative meanings. Thus, wherever $[\![\cdot]\!]$ associates some phrase marker X with a meaning of type a, $\{\!\{\cdot\}\!\}$ will associate X with a meaning of type $\mathsf{S}a$, the type of (the characteristic function of) a set of a's.[2]

2 Notational conventions for types: $\ulcorner a ::= b \urcorner$ means that type a is being defined as b, $\ulcorner a \to b \urcorner$ names the type of functions from type a to type b, and $\ulcorner x : a \urcorner$ means that x has type a. Types associate to the right: thus, $a \to b \to c$ is equivalent to $a \to (b \to c)$. Finally, though no harm will arise if the reader chooses to think of $\mathsf{S}a$

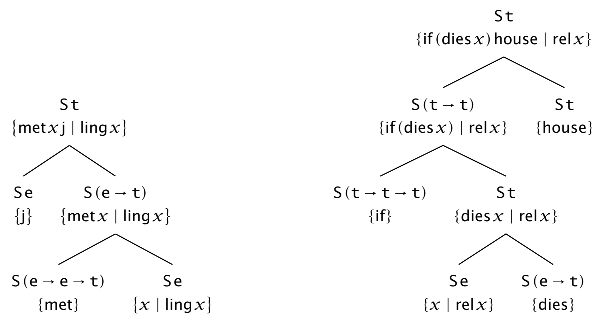


Figure 1: Two derivations in alternative semantics: on the left, *John met a linguist*; on the right, the wide-scope-indefinite reading of *if a rich relative of mine dies, I'll inherit a house.* In both cases, the indefinite's alternatives expand to yield sets of alternative propositions.

For example, on an alternative-semantic approach to indefiniteness (cf. Ramchand 1997, Kratzer & Shimoyama 2002), $\{\!\{\cdot\}\!\}$ associates the DPs *John* and *a linguist* with sets of individuals: $\{\!\{\text{John}\}\!\}$ is the singleton set $\{\mathsf{j}\} : \mathsf{S\,e}$, and $\{\!\{\text{a linguist}\}\!\}$ is $\{x \mid \mathsf{ling}\,x\} : \mathsf{S\,e}$ (generally, a set with more than one element). Transitive verb meanings are singleton sets containing the usual relations on individuals: e.g., $\{\!\{\text{met}\}\!\} = \{\mathsf{met}\} : \mathsf{S}\,(\mathsf{e} \to \mathsf{e} \to \mathsf{t})$. For now, I suppress intensional details (e.g., world-, time-, and assignment- sensitivity). Intensionality is taken up in Section 6 and Appendix B.

To recursively calculate meanings for complex constitutents, $\{\!\{\cdot\}\!\}$ upgrades functional application into an operation that composes a set of functions with a set of arguments, as in (11) below. This operation is known as *point-wise* functional application.

(11) $\{\!\{A\ B\}\!\} := \{f\,x \mid f \in \{\!\{A\}\!\} \wedge x \in \{\!\{B\}\!\}\}$

Of course, $\{\!\{A\ B\}\!\}$ also needs to cover cases where $\{\!\{B\}\!\}$ is the set of functions and $\{\!\{A\}\!\}$ the set of arguments (the point-wise counterpart of backwards functional application), as well as cases where $\{\!\{A\}\!\}$ and $\{\!\{B\}\!\}$ are both sets of predicates (the point-wise counterpart of Predicate Modification). These extensions are obvious, and I omit them here. Binding (minimally, of pronouns and traces of overt movement) will also need to be transpire, one way or another. However, binding in alternative semantics turns out to be problematic. See Section 6.5 for discussion.

A derivation of *John met a linguist* using these pieces is given in Figure 1, left (p. 4). The indefinite object induces a set of alternative linguists, which 'expands' into a set of alternative VP-type meanings by point-wise functional application, and finally into a set of alternative propositions. Notice that, though the indefinite remains in situ, point-wise composition gives it a kind of 'scope' over the resulting set of propositions. This is why I call point-wise composition a *pseudo-scope* mechanism for alternatives.[3]

as an abbreviation for $a \to \{\mathbb{T}, \mathbb{F}\}$, it is probably advisable in the end to type-theoretically distinguish sets of a's from characteristic functions of a's (and, indeed, to distinguish multiple sub-types of $\mathsf{S}\,a$, cf. fn. 7).

3 Application associates to the left, and parens are omitted if possible. So, ⌜$\mathsf{met}\,y\,x$⌝ in lieu of ⌜$((\mathsf{met}\,(y))\,(x))$⌝.

The central utility of alternative semantics is that it allows alternatives to expand beyond islands.[4] For example, a case like (1), with an indefinite taking apparent scope out of the antecedent of a conditional, can be handled as in Figure 1, right (p. 4). As before, the indefinite's alternatives expand as we climb the tree, and this expansion continues up and out of the conditional's antecedent, to the top-most level. Again, the indefinite has acquired a kind of 'scope' over a large domain, without undergoing any movement, let alone any movement out of an island. A quantified DP like *every linguist*, which we may assume for illustration has the alternative-semantic meaning $\{\lambda f.\forall x \in \mathsf{ling} : f\,x\} : \mathtt{S}((\mathtt{e} \to \mathtt{t}) \to \mathtt{t})$, will not be able to acquire scope over the conditional in a parallel way.

In alternative semantics, it's standard to counter-balance expressions that generate alternatives with operators that tame them. A rule for *propositional closure* is defined in (12) below. This rule turns a set of alternative propositions into a singleton set containing an existentially quantified proposition (one that's true iff there's a true member of $\{\!\{X\}\!\}$). For example, attaching $\not\ni$ to the top-most levels of the trees in Figure 1 yields singleton sets containing the expected existentially quantified propositions: $\{\exists x \in \mathsf{ling} : \mathsf{met}\,x\,\mathsf{j}\}$ and $\{\exists x \in \mathsf{rel} : \mathsf{if}\,(\mathsf{dies}\,x)\,\mathsf{house}\}$, respectively.

(12) $\{\!\{ \not\ni X \}\!\} \coloneqq \{\mathbb{T} \in \{\!\{X\}\!\}\}$

When multiple propositional nodes exist in a sentence, propositional closure can be applied at non-root nodes to generate non-maximal 'scope' for indefinites. For example, the $\mathsf{if} \gg \exists$ interpretation of (1) — on which any of my relatives dying would guarantee me a house — can be generated by applying $\not\ni$ to the antecedent, as in (13). This halts the upward expansion of alternatives, ultimately resulting in a proposition where the indefinite takes scope under the conditional: $\{\mathsf{if}\,(\exists x \in \mathsf{rel} : \mathsf{dies}\,x)\,\mathsf{house}\}$.

(13) $\{\!\{ \not\ni$ [a rich relative of mine dies]$\}\!\} = \{\exists x \in \mathsf{rel} : \mathsf{dies}\,x\}$

Notice that this rule is defined syncategorematically: because point-wise composition is baked into $\{\!\{\cdot\}\!\}$, any behavior deviating from this default — such as interacting 'globally' rather than point-wise with a set of alternatives — must be secured by triggering some non-default mode of composition, for example via a syncategorematic rule.

To be clear, nobody has (to my knowledge) argued for an alternative-semantic approach to English indefinites or their exceptional scope properties — perhaps because there seem to be major obstacles to doing so (as we'll see later).[5] Nevertheless, the idea that English indefinites denote (or can denote) sets of individuals (or characteristic functions thereof) is a commonplace one, since indefinites readily occur in predicative positions in examples like *I'm a linguist* or *I consider her a philosopher* (e.g., Partee 1986, among many others). That predicative uses of indefinites exist doesn't, of course, settle the question of how predicative uses of indefinites relate to indefinites in argument

4 Rooth (1985) was the first to note this fact and use it to motivate alternative semantics. Hamblin (1973) used alternative semantics for questions because no other options had yet been discovered for compositionally deriving sets of alternative propositions, which Hamblin considered a good candidate for question meanings.

5 Though see Alonso-Ovalle & Menéndez-Benito 2013 for a partial account of exceptionally scoping Spanish indefinites in terms of standard alternative semantics.

positions (where something of type e is expected), and accounts of predicative indefinites are not generally stated in terms of alternative semantics, but rather in frameworks built on a standard interpretation function like $[\![\cdot]\!]$. See Section 3.1 for more on these points.

In what follows, I will argue that the predicative use of indefinites is fundamental — i.e., indefinites simply denote sets of individuals — propose a mechanism for interpreting set-denoting things in argument positions, and show that this mechanism immediately generates exceptional scope readings for island-bound indefinites. The account will be stated within a scope-based framework that draws on some innovations pioneered in the questions literature, beginning with Karttunen (1977). The next section offers some background on such accounts, after which we move on to the main proposal.

2.3 Generating alternatives with scope

If you're interested in generating sets of alternatives, alternative semantics isn't the only game in town. Karttunen (1977) proposed a theory of questions that (following Hamblin 1973) treated question denotations as sets of propositions — the possible answers to the question — and suggested a mechanism for deriving sets of propositions oriented around a standard interpretation function $[\![\cdot]\!]$. In this section, we'll first see how Karttunen's theory works for *wh* questions, and then show how this theory can be extended to indefinites (following Heim 2011a, 2014). Again, I'll postpone explicit consideration of intensional details.

Karttunen's theory has two pieces. First, declarative sentences (type t) are converted into 'proto-questions' (sets of alternative propositions, type St) via a function we'll call η, as in (14). (Readers may recognize η as Partee's (1986) IDENT type-shifter. See Section 3.1 for more on this connection.) Second, *wh* words are assigned meanings of type $(\mathsf{e} \to \mathsf{St}) \to \mathsf{St}$, as in (15), which allows them to take scope over question meanings.[6]

(14) $\eta := \lambda p.\, \lambda q.\, p = q$ $\qquad \eta : \mathsf{t} \to \mathsf{St}$

(15) $\mathsf{who} := \lambda f.\, \lambda p.\, \exists x \in \mathsf{human} : f\, x\, p$ $\qquad \mathsf{who} : (\mathsf{e} \to \mathsf{St}) \to \mathsf{St}$

We'll adopt a set-theoretic notation for these functions, as in (16) and (17) below. In terms of sets, the η function maps a proposition p into a singleton set containing only p, and who feeds the humans one-by-one to f, itself a function into sets of propositions, and finally collects the resulting sets of propositions by unioning them.

(16) $\eta := \lambda p.\, \{p\}$ $\qquad \eta : \mathsf{t} \to \mathsf{St}$

(17) $\mathsf{who} := \lambda f.\, \bigcup_{x \in \mathsf{human}} f\, x$ $\qquad \mathsf{who} : (\mathsf{e} \to \mathsf{St}) \to \mathsf{St}$

A basic derivation of *who did John meet?* using these pieces is depicted in Figure 2. An application of η yields a proto-question, over which the overtly moved *wh* word takes

6 There are a few departures here from the letter of Karttunen's (1977) semantics. For example, Karttunen treated *wh* words as generalized quantifiers, type $(\mathsf{e} \to \mathsf{t}) \to \mathsf{t}$, and used a special compositional rule to allow *wh* words to take scope over questions (see Karttunen 1977: 19). (Cresti (1995) re-factors this compositional rule as a +wh morpheme. See Section 3.2 for discussion.) And in contrast with Hamblin (1973), Karttunen treated questions as sets of their *true* answers. Following Dayal (1996: 87) and many others, I will assume that the restriction to true answers (when in evidence) is not part of a question's meaning per se.

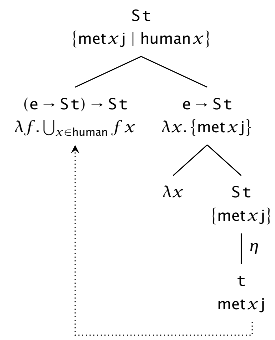


Figure 2: A Karttunen (1977)-esque derivation of *who did John meet?* (or, alternatively, of *John met someone*). The *wh* expression moves to a position above η (or, in the case of the indefinite, takes scope). Composition results in a set of alternative propositions.

scope (setting aside for now details of how the trace of the overt movement comes to be bound). The result, as indicated, is a set of alternative propositions, $\{\mathsf{met}\,x\,\mathsf{j} \mid \mathsf{human}\,x\}$. Examples with two *wh* words such as *who saw whom?* are derived in a parallel way, but involve two 'movements', one of which corresponds to an overt movement, and one of which corresponds to a covert scoping. The result, as expected, ends up being a set of propositions of the form $\{\mathsf{saw}\,x\,y \mid \mathsf{human}\,x \wedge \mathsf{human}\,y\}$.

As noted by Heim (2011a, 2014) (see also Ciardelli, Roelofsen & Theiler 2016 for a similar idea), it's straightforward to generalize Karttunen's approach to allow indefinites to generate sets of alternatives (specifically, Heim explores a Karttunen-esque treatment of Japanese indeterminate pronouns).[7] If we assign meanings like (18) to indefinites, and similarly help ourselves to a η-like operation, *John met someone* will have a derivation exactly parallel to Figure 2 — though in this case, the relevant 'movement' corresponds to covert scope-taking rather than overt displacement (the same goes, mutatis mutandis, for *someone met someone*). In sum, for simple cases a scope-based theory of alternatives achieves the same ends as alternative semantics, using only functional application (along with some mechanism for covert 'movement', i.e., scope).

(18) $\mathsf{someone} \coloneqq \lambda f.\, \bigcup_{x \in \mathsf{human}} f\,x$ $\qquad$ $\mathsf{someone} : (\mathtt{e} \to \mathtt{S\,t}) \to \mathtt{S\,t}$

As in alternative semantics, sets of alternative propositions can be tamed by closure operators. A simple example is given in (19) below. Applying this $\lightning$ operator to, e.g., the set of alternative propositions derived in Figure 2 yields the expected existentially quantified meaning: $\exists x \in \mathsf{human} : \mathsf{met}\,x\,\mathsf{j}$.

(19) $\lightning \coloneqq \lambda m.\, \mathbb{T} \in m$ $\qquad$ $\lightning : \mathtt{S\,t} \to \mathtt{t}$

7 We shouldn't conflate sets of alternative propositions *qua* question denotations with a set of alternative propositions *qua* denotations of declarative sentences with indefinites. English indefinites aren't *wh* words, and vice versa — though many languages do, in fact, use the same morphemes for *wh* words and indefinites (e.g., Haspelmath 1997). It's straightforward to make the relevant distinction type-theoretically, e.g. by splitting $\mathtt{S}\,a$ into two types $\mathtt{Q}\,a$ (for question-y sets of alternatives) and $\mathtt{I}\,a$ (for indefinite-y sets of alternatives).

Unlike alternative semantics, such operations needn't be stated syncategorematically. Because the grammar doesn't insist on point-wise application, $\lightning$ can be defined directly.

2.4 Wrapping up

We have seen two possible ways for indefinites to give rise to sets of alternatives. The alternative-semantic route takes the denotations of indefinites to be sets of alternative individuals, and upgrades the standard interpretation function $[\![\cdot]\!]$ into a point-wise composition function $\{\!\{\cdot\}\!\}$. Because point-wise composition expands alternatives indefinitely upwards — until a closure operator is encountered — exceptional scope for indefinites is predicted (at least, in the simple cases we have seen here).

By contrast, the scope-based approach assigns indefinites a higher-order meaning, type $(\mathsf{e} \to \mathsf{S\,t}) \to \mathsf{S\,t}$, and leaves the interpretation function untouched. The η operation conjures up an initial, maximally boring, singleton set of alternative propositions, over which indefinites are happy to — indeed, must — take scope. However, because this latter account is oriented around scope and scope-taking, it's far from obvious how it predicts exceptional scope behavior for indefinites. In fact, it seems like it's straightforwardly incompatible with such data: an indefinite can scopally wander to an island's edge, but no further. At that point, a set of alternative propositions is generated, and the jig is up.

This pessimistic conclusion is too hasty. It presupposes, after all, that indefinites simply denote things of type $(\mathsf{e} \to \mathsf{S\,t}) \to \mathsf{S\,t}$. (Among other things, one might wonder how predicative uses of indefinites are supposed to be handled given this rather high type.) Indeed, in what follows I'll argue that unpacking the scope-based approach (in a way that takes predicative uses of indefinites as basic) both predicts exceptional scope-taking and, in fact, yields *better* predictions than alternative semantics in a wide range of cases.

3 The proposal

3.1 The many guises of indefinites

Three possible meanings for an indefinite like *someone* are listed below. Respectively, we have a set of individuals, an existential generalized quantifier, and a function that expects to scope over and return a set of alternative propositions.

(20) $\{x \mid \mathsf{human}\, x\}$ type: $\mathsf{S\,e}$

(21) $\lambda f.\, \exists x \in \mathsf{human} : f\, x$ type: $(\mathsf{e} \to \mathsf{t}) \to \mathsf{t}$

(22) $\lambda f.\, \bigcup_{x \in \mathsf{human}} f\, x$ type: $(\mathsf{e} \to \mathsf{S\,t}) \to \mathsf{S\,t}$

How do these possible meanings relate to each other? Could one be taken as basic? To begin, it is well known that (21), the generalized quantifier, is derivable from (20), a set of individuals, via an operation dubbed the A-shifter by Partee (1986).[8]

(23) $\mathsf{A} \coloneqq \lambda m.\, \lambda f.\, \exists x \in m : f\, x$ $\mathsf{A} : \mathsf{S\,e} \to (\mathsf{e} \to \mathsf{t}) \to \mathsf{t}$

8 In fact, (20) and (21) are inter-derivable given Partee's BE-shifter, type $((\mathsf{e} \to \mathsf{t}) \to \mathsf{t}) \to \mathsf{S\,e}$.

Notice that A and η (aka Partee's IDENT, generalized here to apply to things of type $\mathtt{e}$ in addition to things of type $\mathtt{t}$) form a decomposition of LIFT, the familiar mapping from values into scope-takers, as shown in (24). Thus, there's no need to define a primitive LIFT operation, since it can be recovered by successively applying η and A.

(24) $\mathsf{A}\,(\eta x) = \lambda f.\exists y \in \{x\} : f\,y$
$= \lambda f.f\,x$

Similarly, (22) is derivable from (21), as originally pointed out by Karttunen (1977) (who used the operation in question to characterize a compositional rule for *wh* question formation). Cresti (1995: 96, fn. 17) formulates the relevant operation as a +wh function, defined in (25) (here, I've recast Cresti's definition using set-theoretic notation). An example of how +wh applies to an existential quantifier is given in (26). The result is equivalent to $\lambda f.\bigcup_{x \in \mathsf{human}} f\,x$, the alternative-friendly meaning given in (22).

(25) $+\mathsf{wh}\,Q \coloneqq \lambda f.\{y \mid Q\,(\lambda x.y \in f\,x)\}$ $\qquad +\mathsf{wh} : ((\mathtt{e} \to \mathtt{t}) \to \mathtt{t}) \to (\mathtt{e} \to \mathtt{S\,t}) \to \mathtt{S\,t}$

(26) $+\mathsf{wh}\,(\lambda f.\exists x \in \mathsf{human} : f\,x) = \lambda f.\{y \mid \exists x \in \mathsf{human} : y \in f\,x\}$
type: $(\mathtt{e} \to \mathtt{S\,t}) \to \mathtt{S\,t}$

The relationships between η, A, LIFT, and +wh are summarized in Figure 3, which extends (a portion of) the famous Partee (1986) triangle with +wh. Several features of the diagram are notable. First, it *commutes*: where there exist multiple paths between two points, those paths are equivalent. Second, the types are more specific than they need to be, given the definitions of the mappings in question. Specifically, there's no real reason to assume that we're talking about the nominal domain (type $\mathtt{e}$) per se. (Indeed, Partee & Rooth (1983) point out that type-shifting operations like LIFT should be defined for arbitrary input types; see, e.g., Hendriks 1993, Barker & Shan 2014 for more on this point. Likewise, we have already seen that it makes sense to apply η to things of type $\mathtt{t}$ as well as type $\mathtt{e}$.) Similarly, there's no need to stipulate that a +wh-shifted meaning ultimately scopes over and returns a set of propositions (given the definition of +wh, any set would do). Third — and most importantly — there's a rather vast uncharted territory in the diagram's right half: no mappings from $\mathtt{e}$ or $\mathtt{S\,e}$ to $(\mathtt{e} \to \mathtt{S\,t}) \to \mathtt{S\,t}$ are provided.

3.2 Starting with sets instead

My proposal is to replace this suite of three primitive type-shifters (η, A, and +wh) with two. Specifically, we'll retain the η mapping, but instead of taking the long way around — mapping sets into generalized quantifiers, and then applying +wh — we'll directly define a function that maps sets into things that scope over and return new sets. In other words, we'll map out the uncharted space in Figure 3, and then move there.

As a first step, it's a simple matter to give a mapping from sets of individuals like (20) into alternative-friendly scope-takers like (22) (indeed, a great deal more straightforward than defining +wh!). The function in question, which we'll call '$\ggg=$', is defined in (27). The $\ggg=$ function takes a set of alternatives m as an argument, feeds those individuals

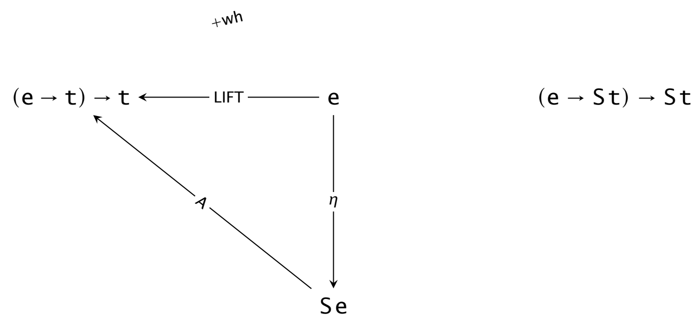


Figure 3: A portion of the Partee (1986) triangle, extended with Cresti's (1995) +wh operation.

one-by-one to a scope argument f (itself a function into sets), and collects the results into a final set. As required, applying $\gg=$ to (20) yields (22).

(27) $m^{\gg=} := \lambda f.\bigcup_{x\in m} f\,x$ $\qquad\qquad \gg= : \mathsf{S}a \to (a \to \mathsf{S}b) \to \mathsf{S}b$

Notice that I have defined $\gg=$ as maximally polymorphic. It places no restrictions on the sorts of sets it can apply to, or on the sorts of sets it ultimately returns.

With the $\gg=$ mapping in hand, we can redraw and extend the Partee (1986) triangle, as in Figure 4. As before, the diagram commutes. For example, just like η and A, η and $\gg=$ are a decomposition of LIFT (though $(\eta\,x)^{\gg=}$ presupposes a different 'result' type then $\mathsf{A}\,(\eta\,x)$; this difference is reflected as type subscripts in Figure 4):

(28)
$$\begin{aligned}(\eta\,x)^{\gg=} &= \lambda f.\bigcup_{y\in\{x\}} f\,y\\ &= \lambda f.f\,x\end{aligned}$$

Furthermore, as Figure 4 suggests, A and +wh are a decomposition of $\gg=$. In other words, the key 'innovation' I'm proposing really isn't one: $\gg=$'s already there, hiding, if you combine the Karttunen/Cresti account of questions with Partee (1986).

(29)
$$\begin{aligned}+\mathsf{wh}\,(\mathsf{A}\,m) &= \lambda f.\{y \mid (\lambda g.\exists x \in m : g\,x)\,(\lambda z.y \in f\,z)\}\\ &= \lambda f.\{y \mid \exists x \in m : y \in f\,x\}\\ &= \lambda f.\bigcup_{x\in m} f\,x\end{aligned}$$

In sum, I propose taking the predicative, type S e sense of indefinites as basic, and use η and $\gg=$ (rather than η, A, and +wh) to grease the compositional skids.

3.3 Basic meanings and derivations

Let's warm up with some simple meanings and derivations. First, some meanings for indefinites. Like alternative semantics, we take these to be sets of individuals. A set-based meaning for *a linguist* is given in (30). To typographically distinguish meanings

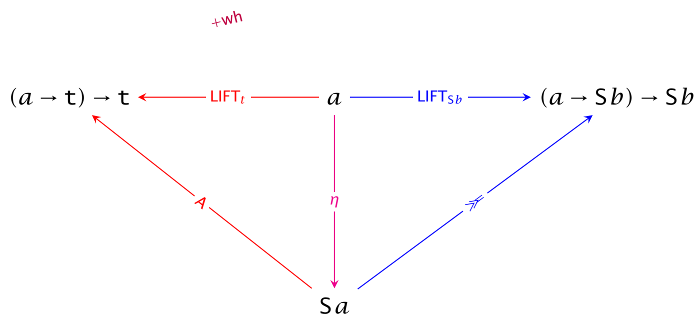


Figure 4: Figure 3, made maximally polymorphic, and extended with $\gg=$ and (derivatively) $\mathsf{LIFT}_{\mathtt{S}b}$ (the subscript here indexes the polymorphic 'result' type $\mathtt{S}\,b$). As before, the diagram 'commutes': where there exist multiple paths between two nodes, those paths are equivalent.

that essentially refer to sets (e.g., indefinites) from meanings that do not (e.g., simple predicates and transitive verbs), I write the former in **bold sans** and the latter in sans.

(30) $\quad \textbf{a.ling} := \{x \mid \mathsf{ling}\,x\}$ $\qquad$ type: $\mathtt{S\,e}$

Given that $\textbf{a.ling}^{\gg=}$ is completely analogous to Karttunen (1977)-esque meanings for *wh* phrases and indefinites, derivations of simple sentences are essentially unchanged from Figure 2 (page 7). In Figure 5, I give basic derivations for *John met a linguist*, and *a linguist met a philosopher*. (To simplify the presentation of these and subsequent examples, branching nodes in derivations are labeled only with types. Because $\gg=$ is doing nothing more than propagating alternatives from a set to a scope, the reader can be confident that abstracting away from the nitty-gritty is harmless.) As in Figure 2, η coerces a proposition into a maximally boring singleton set of propositions, over which the indefinite takes scope. The principal difference from before is that the indefinite isn't primitively defined as a scope-taker, but shifts into one via an application of $\gg=$.

To this stock of basic meanings, we can add closure operations for discharging alternatives. An obvious first candidate is the categorematic $\lightning$ operator defined in (19):[9]

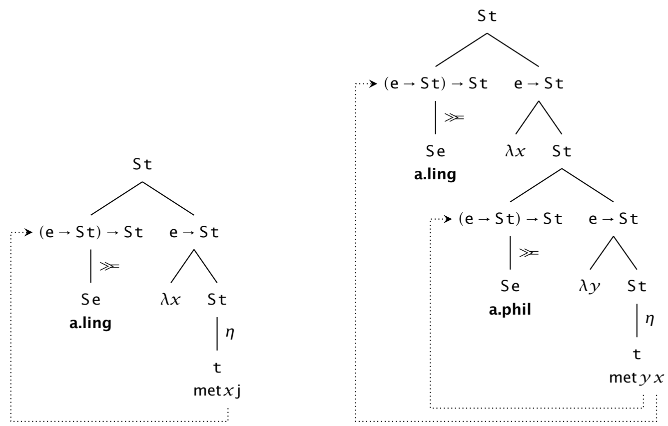
(19) $\quad m^{\lightning} := \mathbb{T} \in m$ $\qquad$ $\lightning : \mathtt{S\,t} \to \mathtt{t}$

We can use $\lightning$ to define other, more complex closure operations. As an example, a closure-style conditional operator **if**, which tames the alternatives in both its first and second argument, is defined in (31). Combining **if** with the two meanings derived in Figure 5 gives the meaning for *if John met a linguist, a linguist met a philosopher* in (32).

(31) $\quad \textbf{if}\,m\,n := \{\mathsf{if}\,m^{\lightning}\,n^{\lightning}\}$ $\qquad$ $\textbf{if} : \mathtt{S\,t} \to \mathtt{S\,t} \to \mathtt{S\,t}$

(32) $\quad \textbf{if}\,\{\mathsf{met}\,x\,\mathsf{j} \mid \mathsf{ling}\,x\}\,\{\mathsf{met}\,y\,x \mid \mathsf{ling}\,x \wedge \mathsf{phil}\,y\} =$
$\qquad \{\mathsf{if}\,(\exists x \in \mathsf{ling} : \mathsf{met}\,x\,\mathsf{j})\,(\exists x \in \mathsf{ling} : \exists y \in \mathsf{phil} : \mathsf{met}\,y\,x)\}$

9 The definition of $\lightning$ here presupposes for illustration that m is a set of truth values. See Appendix B for a discussion of how the proposal accommodates intensionality.



$= \{\mathsf{met}\,x\,\mathsf{j} \mid \mathsf{ling}\,x\}$ $\qquad$ $= \{\mathsf{met}\,y\,x \mid \mathsf{ling}\,x \wedge \mathsf{phil}\,y\}$

Figure 5: Derivations of *John met a linguist* (on the left) and *a linguist met a philosopher* (on the right), with set-denoting indefinites and η and $\gg=$ greasing the skids.

One might wonder why we go to the trouble of defining **if** directly, rather than simply ↯-ing each of if's arguments — and, for that matter, why we insist on returning a boring singleton set when all is said and done. There's no deep reason for this. The definition in (31) makes subsequent derivations go a bit more smoothly, and so I adopt it here.

4 Deriving island-sensitivity

4.1 Scoping the island

So far so familiar! We've moved some furniture around, but we seem perilously close to having just restated the scope-oriented theory of alternative generation (Section 2.3) in terms of some somewhat different primitives.

Indeed, because the η-and-$\gg=$ method for compositionally handling alternatives relies crucially on scope (and not point-wise composition), it may appear as if, like the previous scopal account of alternatives, we are unable to generate all the readings we'd like to when an indefinite lives on an island: indefinites turn into scope-takers with an application of $\gg=$, but scope-taking can carry them no further than the island's edge.

Perhaps surprisingly, then, exceptional scope readings turn out to be predicted by η-and-$\gg=$. In fact, we would need additional stipulations to rule them out.

The fundamental point is that, because $\gg=$ is polymorphic, it can apply to *any* set of alternatives m, turning m into something that takes scope. Island-escaping readings can thus be generated in two steps. First, the indefinite takes scope at the island's edge (helped along by $\gg=$), turning the island's meaning into a set of alternatives. Second, $\gg=$ applies to the island *itself*, turning it into something that takes scope.[10] Because the

10 Readers may recognize this strategy as an instance of scopal pied-piping à la Nishigauchi 1990, Moritz &

island's alternatives are ultimately due to the indefinite, this has the effect of expanding the indefinite's alternatives beyond the island's boundaries.

Figure 6 shows how η and $\ggg=$ can be used to generate an island-escaping reading of *if a rich relative of mine dies, I'll inherit a house.* I demarcate the scope island — the indefinite's minimal tensed clause — in yellow.[11] The derivation of the island itself is mundane: the indefinite moves to its edge, deriving a set of alternative propositions about different relatives of mine: $\{\mathsf{dies}\,x \mid \mathsf{rel}\,x\}$. Because the meaning of the island is a set of alternatives, $\ggg=$ can apply once more. This has the effect of turning the island itself into something that takes scope: $\lambda f.\bigcup_{p\in\{\mathsf{dies}\,x \mid \mathsf{rel}\,x\}} f\,p$, which has type $(\mathtt{t} \to \mathtt{St}) \to \mathtt{St}$, and which is equivalent to $\lambda f.\bigcup_{x\in\mathsf{rel}} f\,(\mathsf{dies}\,x)$. This expression takes scope at the matrix level (assuming no further islands along the way; cf. fn. 11), ultimately yielding the expected set of alternative propositions: $\{\mathsf{if}\,(\mathsf{dies}\,x)\,\mathsf{house} \mid \mathsf{rel}\,x\}$. In sum, the meaning of Figure 6's top-most node is calculated as follows — here, to minimize parentheses, I adopt an infix notation for $\ggg=$, such that $m \ggg= \lambda x.\phi$ is equivalent to $m^{\ggg=}\,(\lambda x.\phi)$:

(33)
$$\begin{aligned}\{\mathsf{dies}\,x \mid \mathsf{rel}\,x\} \ggg= \lambda p.\{\mathsf{if}\,p\,\mathsf{house}\} &= (\lambda f.\textstyle\bigcup_{x\in\mathsf{rel}} f\,(\mathsf{dies}\,x))\,(\lambda p.\{\mathsf{if}\,p\,\mathsf{house}\})\\ &= \textstyle\bigcup_{x\in\mathsf{rel}}\{\mathsf{if}\,(\mathsf{dies}\,x)\,\mathsf{house}\}\\ &= \{\mathsf{if}\,(\mathsf{dies}\,x)\,\mathsf{house} \mid \mathsf{rel}\,x\}\end{aligned}$$

Figure 6 also invokes a couple η's in the first and second arguments of **if**. These are just house-keeping: **if** expects its arguments to be of type $\mathtt{St}$, and η makes it so.

4.2 Associativity in the semantics

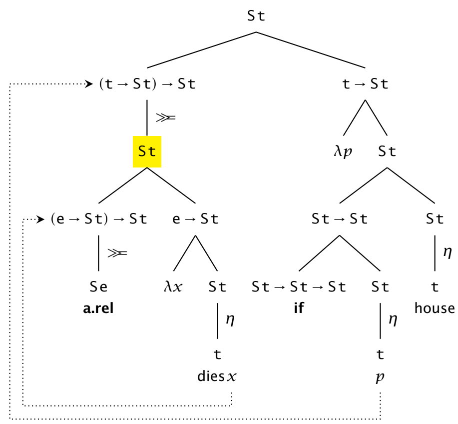
The reason $\ggg=$ generates island-escaping readings is that $\ggg=$ turns out to display a kind of ASSOCIATIVITY. Consider Figure 7. On the left, we have a schematic derivation looking very much like the derivation depicted in Figure 6, with a potential island in yellow. ASSOCIATIVITY amounts to the claim that the tree on the left, with only local scope-taking of m, is in general equivalent to the tree on the right, where m moves up and out of the potential island. See (34) below for a more concrete demonstration of this equivalence, for arbitrary f and g.

(34)
$$\begin{aligned}(m \ggg= \lambda x.f\,x) \ggg= g &= m \ggg= (\lambda x.f\,x \ggg= g)\\ &= \{z \mid x \in m \wedge y \in f\,x \wedge z \in g\,y\}\end{aligned}$$

The consequences of ASSOCIATIVITY for exceptional scope phenomena are far-reaching. Let's imagine, for example, that an indefinite is embedded three islands deep, as in Figure 8. In such configurations, the indefinite can acquire maximal scope by first taking scope at the edge of the deepest island, which then takes scope at the edge of the next-deepest island, which finally takes scope at the edge of the outermost island (with each of these movements mediated by an application of $\ggg=$).

Valois 1994, von Stechow 1996. See Section 4.3 and Appendix B for discussion of this point.

11 I've elected to treat the indefinite's minimal tensed clause as the only relevant island. It's also possible to treat the *if*-phrase as an island, though the derivation is accordingly more complex: the indefinite scopes to the edge of its minimal tensed clause, which scopes to the edge of the *if*-phrase, and so on.



$= \{\text{if}\,(\text{dies}\,x)\,\text{house} \mid \text{rel}\,x\}$

Figure 6: Alternative percolation out of a (scope) island, without movement out of the island. The indefinite shifts into a scope-taker via ≫=, moves to the edge of the island, and then pied-pipes the island to a scope position over the conditional (again, facilitated by ≫=).

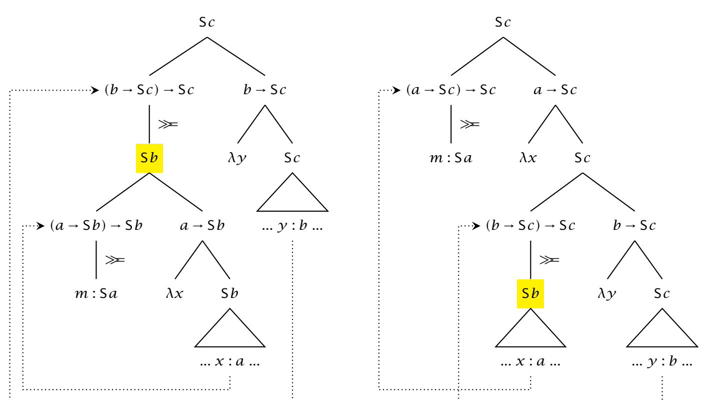
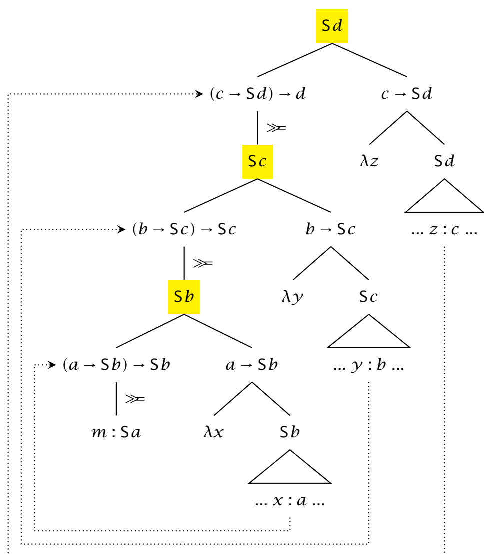


Figure 7: ASSOCIATIVITY of ≫=: the tree on the left, with m taking scope at the edge of a potential island via ≫=, which then takes scope via ≫=, is guaranteed equivalent to the tree on the right, with m scoping out of the potential island. Exceptional scope behavior is derived without any island-violating movement.



$$= m \gg\!= \ldots = \{\ldots\ x\ \ldots \mid x \in m\ \ldots\}$$

Figure 8: A schematic depiction how an indefinite may come to acquire apparent maximal scope, though embedded three islands deep. A set of alternatives m moves to the edge of an island, turning the island into a set of alternatives, which moves to the edge of another island, and so on. This iterated scope-taking expands m's alternatives up and over three separate island boundaries, even as composition remains conservative — i.e., oriented around functional application and scope.

At each step, a bigger and bigger chunk of stuff takes scope, but at no point does anything ever scope out of an island. Neverthless, ASSOCIATIVITY of $\ggcurly$ guarantees that the result is just as if the indefinite had directly undergone one vast island-disrepecting scoping: at each step in the derivation, an application of ASSOCIATIVITY allows us to rebracket our term into something of the form $m \ggcurly \ldots$, which in turn feeds further applications of ASSOCIATIVITY as we continue climbing the tree. Furthermore, if non-maximal exceptional scope is desired (cf. example (3)), we are always free to forego one or more of the secondary island scopings, come what may higher up in the tree.

4.3 On roll-up pied piping

The strategy I use to give a general account of exceptional scope — iteratively scoping things to the edges of islands, while still respecting island boundaries — turns out to have a rather striking parallel with certain *overt* movement strategies cross-linguistically. In particular, derivations like the ones schematized in Figure 8, are covert/scopal counterparts of an overt movement phenomenon commonly known as roll-up (or sometimes, more colorfully, snowballing) pied-piping.

Consider in this respect the following data from Bavarian German, taken from Heck 2008: 115, exs. (198a) and (199a) (and credited therein to Felix 1983). In (35), a relative clause is formed by extracting the relative pronoun *die* out of a conditional antecedent. In principle, the observed word order here is consistent with the relative pronoun having completely evacuated the conditional clause. Crucially, however, the ungrammaticality of example (36) suggests that this is not so: if the relative pronoun isn't adjacent to the conditional clause, the result is ill-formed.[12]

(35) Das ist die Frau, [die$_i$ wenn du t_i heiratest] bist du verrückt.
this is the woman who if you marry are you crazy
'This is the woman that you are crazy if you marry her.'

(36) *Das ist die Frau, die$_i$ du verrückt bist [wenn du t_i heiratest].
this is the woman who you crazy are if you marry

Thus, the grammaticality of (35) seems to be due to the relative pronoun moving to the edge of an overt movement island (a process Heck terms 'secondary *wh*-movement'), and subsequently pied-piping the island into the canonical position for relative pronouns in relative clauses. This process — moving to the edge of an island, and then moving the island — is the overt counterpart of the covert (i.e., scopal) procedure that we use to derive exceptional scope.[13]

12 The contrast seems to be replicated to an extent in English, though *this is the dude who, if you marry, you're crazy* is somewhat marginal to begin with.

13 Notice that such cases suggest an asymmetry between constraints on overt and covert movement. If quantifiers such as *every linguist* could covertly scope in a way parallel to the overt movement of *die* in (35), we should expect quantifiers in the antecedent of a conditional to be able to systematically scope over the conditional operator, contrary to fact. Perhaps this is not so surprising. As discussed briefly in Section 2.1, tensed clauses seem to function as reasonably strong scope islands, though they aren't islands for overt movement.

The situation is even more dramatic in Finnish. Huhmarniemi (2012: 225–6) notes that the canonical order within a PP-modified VP is verb-preposition-object, as in (37). However, when the PP object is a *wh* phrase, as in (38), overt *wh* movement results in fronting of the entire PP, along with a mirror-image word order: object-preposition-verb.

(37) Pekka näki Merjan [kävellessään [kohti puistoa]].
Pekka saw Merjan walk towards park
'Pekka saw Merja when he was walking towards a/the park.'

(38) [[Mitä$_i$ kohti t_i]$_j$ kävellessään t_j]$_k$ Pekka näki Merjan t_k?
What towards walk Pekka saw Merjan
'What was Pekka walking towards when he saw Merja?'

Huhmarniemi argues that the mirror-image word order is derived by repeated roll-up pied-piping: simplifying somewhat, the *wh* phrase moves to the edge of its PP, which moves to the edge of the VP, which in turn moves into the specifier of CP. Again, this is precisely the overt counterpart of the iterated roll-up scoping depicted in Figure 8.

Overt and scopal varieties of roll-up pied piping have been observed (or argued to exist) in a variety of typologically distant languages. See, e.g., Moritz & Valois 1994 on scopal roll-up pied-piping in French, Aboh 2004 on overt roll-up pied piping in Gbe, and Cinque 2005 on overt roll-up pied piping inside DP cross-linguistically.

Overt and scopal pied-piping have been argued to be problematic from a semantic point of view (see, e.g., von Stechow's (1996) criticisms of Nishigauchi's (1990) scopal pied-piping account of Japanese *wh* in situ). Essentially, the problem is that too much of the pied-piped material ends up interpreted in the scope position of the pied-piped phrase. Of course, any semantic problems for simple pied-piping will only snowball in cases of roll-up pied-piping. I take up this issue in Sections 5–6 and Appendix B.

4.4 Existential vs. distributive scope

As pointed out by Ruys (1992), the existential scope of plural indefinites is unbounded, but their distributive scope is tethered to scope islands (the 'existential' vs. 'distributive' scope terminology is due to Szabolcsi (2010)).

Consider example (39). The plural cardinal indefinite *two relatives of mine* can be construed with widest scope: we can interpret (39) as 'about' two particular relatives of mine (perhaps there is a line of succession for possession of the family compound, and I am third in line). As Ruys (1992) and Reinhart (1997) emphasize, the exceptional scope reading of (39) means that I have two relatives such that, if they *each* died, I'd inherit a house. It doesn't mean that two relatives of mine are *each* such that, if they died, I'd inherit a house (in which case, merely one of their deaths would be sufficient).

(39) If [two relatives of mine die], I'll inherit a house. ✓2 > if

This result is in fact expected: roll-up pied piping with $\ggg=$ succeeds in transmitting indefiniteness from an island-bound indefinite to domains outside the island, just as if the indefinite had taken scope out of the island, but it does not magically allow the indefinite to *actually acquire scope* over any constituents beyond the island's boundaries. As such, we expect that operations which require bona fide access to an expression's scope — saliently, distributivity operators — will be constrained by scope islands, even as indefiniteness is transmitted unboundedly upward.

We begin with some baseline assumptions about plurals and plural indefinites. Following, e.g., Link (1983), Schwarzschild (1996), we take the domain of individuals, type e, to include plural as well as atomic individuals, and define **two.lings** as the set of pluralities containing two atomic linguists, as in (40). Clearly, given such a meaning, the account of exceptional scope carries over to plural indefinites: they generate alternatives, which can be expanded outside an island by scopally pied-piping the island.

(40) $\textbf{two.lings} \coloneqq \{X \mid \mathsf{2.lings}\, X\}$ $\qquad \textbf{two.lings} : \mathtt{S\,e}$

Distributive readings of plurals (indefinite or otherwise) can be derived via a silent distributivity operator, defined in (41), which universally quantifies over the atomic members of a plurality, feeding each of them to a scope argument f, and existentially closing the result via an application of $\lightning$. As its type suggests, Δ can be thought of as a scope modifier: a plural expression takes scope, after which Δ is appended to its scope.

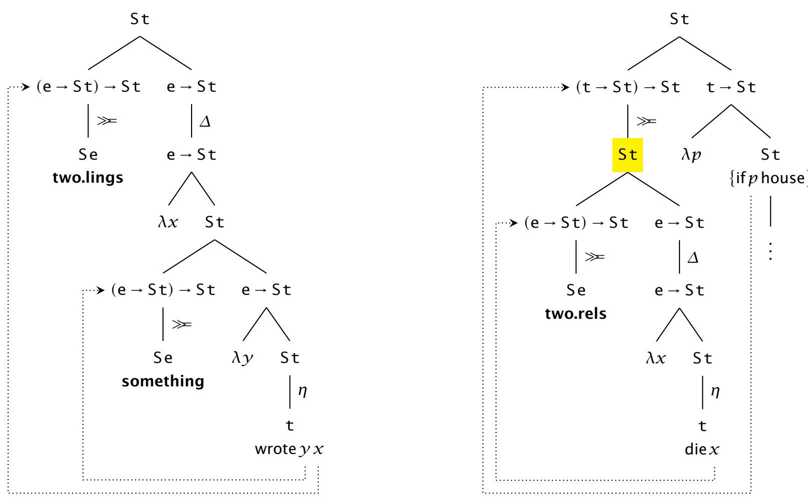
(41) $\Delta f \coloneqq \lambda X.\{\forall x \leqslant_{\mathsf{at}} X : (f\,x)^{\lightning}\}$ $\qquad \Delta : (\mathtt{e} \to \mathtt{S\,t}) \to \mathtt{e} \to \mathtt{S\,t}$

A simple example using Δ to derive the distributive reading of *two linguists wrote something*, is given in Figure 9, left. Here, both indefinites denote sets of individuals (sets containing pluralities of two linguists, and atomic things, respectively). Each takes scope via $\gg\!=$ (with a η downstairs, as usual). The Δ splits the two-linguist pluralities into their atomic components, each of which is required to have written something. The end result is a set of distributively quantified propositions, implicating different pluralities of two linguists.

Figure 9, right shows how exceptional existential scope for plural indefinites is derived, even as a plural indefinite's distributive scope remains tethered to the nearest scope island. The derivation differs from the basic exceptional scope derivation in Figure 6 (page 14) only in two respects: the plural expression **two.rels** replaces the singular **a.rel**, and a Δ operator is appended to the scope of **two.rels**. This results in exceptional existential scope for the indefinite — the scopally pied-piped island passes the indefinite's indefiniteness to the conditional — along with island-bounded scope for Δ. In particular, since Δ must attach to the actual scope of **two.rels**, and the latter can't scope out of the island, the only possible attachment site for Δ is island-internal.

4.5 On monads

Together, η and $\gg\!=$ comprise something known to category theorists, computer scientists, and functional programmers as a *monad*. Essentially, a monad is a way of relating operations in a restricted type-space with operations in an extended type-space which supports additional kinds of composition. Monads were initially proposed as a way to structure so-called 'impure' extensions to the λ-calculus by Moggi (1989), and were



$= \{\forall x \leqslant_{\text{at}} X : \exists y : \text{wrote}\, y\, x \mid \text{2.lings}\, X\}$ $\quad$ $= \{\text{if}\, (\forall x \leqslant_{\text{at}} X : \text{die}\, X)\, \text{house} \mid \text{2.rels}\, X\}$

Figure 9: Distributive readings with η, $\gg\!=$, and Δ. On the left, I derive the distributive reading of *two linguists wrote something.* On the right, I demonstrate that the distributive scope of a plural indefinite is island-bound, even as its existential scope is unbounded.

first applied to natural language semantics by Shan (2002). Wadler (1994) pointed out a close connection between monads and *delimited continuations*, which forms the basis of the present work (in particular, delimited continuations bear a close correspondence to scope-taking in natural language; cf., e.g., Barker 2002, Barker & Shan 2014). See Wadler 1992, 1995 for accessible introductions to the use of monads in functional programming.

Formally, a monad is a triple $(T, \eta, \gg\!=)$ of a 'type-constructor' T that specifies the enriched type-space, a polymorphic η function, type $a \to T\, a$, that trivially injects values into the enriched type-space, and a polymorphic $\gg\!=$ operation, type $T\, a \to (a \to T\, b) \to T\, b$, that characterizes composition in the enriched type-space. The η and $\gg\!=$ operations are required to satisfy the following three laws:

(42) Left identity $\quad \eta\, x \gg\!= f = f\, x$
Right identity $\quad m \gg\!= \eta = m$
Associativity $\quad (m \gg\!= \lambda x. f\, x) \gg\!= g = m \gg\!= (\lambda x. f\, x \gg\!= g)$

Our monad is $(\mathsf{S}, \eta, \gg\!=)$, with $\eta\, x := \{x\}$, and $m \gg\!= f := \bigcup_{x \in m} f\, x$. The enriched notion of composition it embodies is *nondeterministic* or *relational* composition. In fact, we've already verified that our η and $\gg\!=$ operations satisfy two out of the three monad laws: Left identity is equivalent to the claim that η and $\gg\!=$ form a decomposition of LIFT, and Associativity was demonstrated in (34). It's also straightforward to observe that Right identity is satisfied. For any m of type $\mathsf{S}\, a$, $m \gg\!= \eta = \bigcup_{x \in m} \{x\} = m$.

Monads underlie a great deal of semantic theorizing, usually implicitly. Since Shan's (2002) pioneering work (which includes a treatment of interrogatives using the same monad we use to treat indefiniteness, though Shan does not discuss exceptional scope phenomena), an increasing amount of research makes explicit reference to monads. Recent examples include Giorgolo & Unger (2009), van Eijck & Unger (2010), Giorgolo & Asudeh (2012), Unger (2012), Charlow (2014), Barker & Shan (2014), and Bumford (2015).

Because any monad's $\gg\!=$ operation definitionally obeys ASSOCIATIVITY, monads represent a powerful tool for theorizing about exceptional scope phenomena. I return to this point briefly in the paper's conclusion.

5 Selectivity via higher-order alternative sets

5.1 The selectivity of exceptional scope

We've seen that the η-and-$\gg\!=$ theory of alternatives predicts exceptional scope phenomena in simple cases. We have not, however, demonstrated why one should prefer this account of exceptional scope to alternative semantics — or, for that matter, to other in situ accounts of indefinites such as the choice-functional theory of Reinhart 1997, Winter 1998. Our two central arguments for the present approach have to do with the fundamental *selectivity* of exceptional scope-taking, and the interaction of indefinites and pronominal binding. The first of these points cuts against alternative semantics and is discussed in this section. The second cuts generally against in situ approach to indefinites generally and is discussed in Section 6.

Let's begin with some data. Sentence (43) has two indefinites on an island, rather than one. How many exceptional scope readings does it allow? No fewer than three: the conditional could be about a specific lawyer (and any old relative), about a specific relative (and any old lawyer), or about specific lawyers and relatives. (A non-exceptional reading, with both indefinites scoping inside the conditional, is of course possible too.)

(43) If [a persuasive lawyer visits a rich relative of mine], I'll inherit a house.

$^{\checkmark}\exists_{\text{lawyer}} \gg \text{if} \gg \exists_{\text{relative}}$
$^{\checkmark}\exists_{\text{relative}} \gg \text{if} \gg \exists_{\text{lawyer}}$
$^{\checkmark}\exists_{\text{relative}} \gg \exists_{\text{lawyer}} \gg \text{if}$

Thus, when multiple indefinites live on an island, it is possible for those indefinites to take exceptional scope in different ways outside the island. In a slogan: exceptional scope-taking is fundamentally *selective*.

Data like this may appear problematic at first because it looks as if our account only generates one reading for such constructions. We derive exceptional scope, as before, by composing up a meaning for the island (see Figure 5, right on page 12 for a reminder of how this goes), and then scopally pied-piping this island over the conditional with a further application of $\gg\!=$ (cf. Figure 6, page 14), as in (44) below.

(44) $$\{\text{visits}\, y\, x \mid \text{lawyer}\, x \wedge \text{rel}\, y\} \gg\!= \lambda p.\, \textbf{if}\, (\eta\, p)\, (\eta\, \text{house}) = \{\text{if}\, (\text{visits}\, y\, x)\, (\text{house}) \mid \text{lawyer}\, x \wedge \text{rel}\, y\}$$

As indicated, this gives *both* indefinites 'scope' over the conditional operator. While this certainly represents a possible exceptional-scope reading of (43), the remaining two exceptional-scope readings, with the island-bound indefinites taking scope in different ways outside the island, are as yet unaccounted for.

One might think the problem has a straighforward solution: insert a covert closure operator (say, $\lightning$) inside the island, and then give one indefinite scope over it and the other scope under it. This results in a meaning for the island like (45), which could then be used to percolate lawyer-indefiniteness alone out of the island.

(45) $\{\exists y \in \mathsf{rel} : \mathsf{visits}\, y\, x \mid \mathsf{lawyer}\, x\}$

This approach, however, is insufficiently general, in that it differentiates the indefinites outside the island by forcing one of them to take maximally local scope. It isn't too difficult to construct examples with readings requiring both indefinites to take exceptional scope in different ways outside an island. Example (46) minimally modifies example (3) by replacing *Chomsky* with *a renowned syntactian*, and can be understood as follows: there's a famous syntactician x, such that for each student y, there's some condition z proposed by y, such that x has to come up with three arguments showing that z is wrong. Example (47) makes a similar point: it can be understood as about a specific seminar, even as papers vary with grads outside the scope of the conditional (imagine, for example, that every grad is taking the semantics seminar, and the grads like different papers on indefinites).[14]

(46) Each student has to come up with three arguments showing that [some condition proposed by a famous syntactician is wrong]. $^{\checkmark}\exists_{\mathsf{syntactician}} \gg \forall \gg \exists_{\mathsf{condition}} \gg 3$

(47) Every grad would be overjoyed if [some paper on indefinites was discussed in a popular grad seminar being offered this term]. $^{\checkmark}\exists_{\mathsf{seminar}} \gg \forall \gg \exists_{\mathsf{paper}} \gg \mathsf{if}$

We conclude that two indefinites on an island can take (exceptional) scope in different ways outside the island, and that simply targeting one of the indefinites for existential closure by $\lightning$ isn't sufficient to generate the full range of attested readings for such cases.

5.2 Higher-order alternative sets

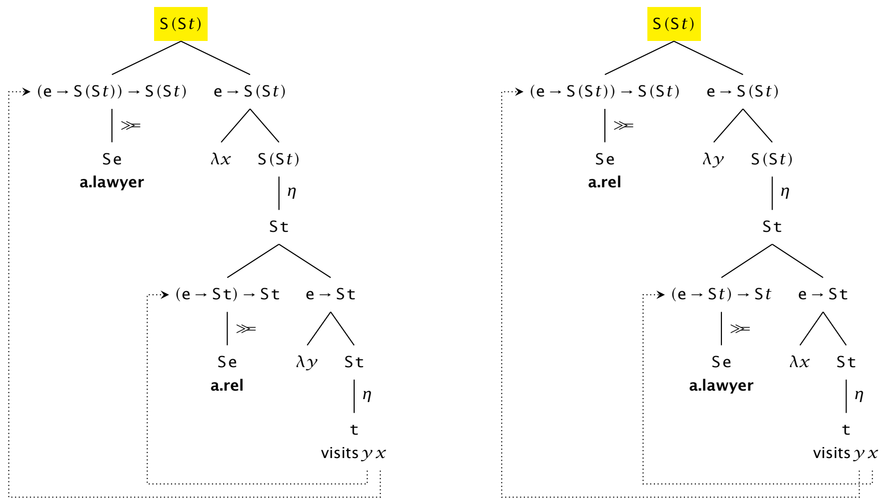
Though the ASSOCIATIVITY-based approach to exceptional scope appears at first to be too flat-footed to yield selectivity outside islands, selectivity is in fact lurking in the theory. Let us begin by noting the fact in (48): in cases where a scope argument f is a function into sets, a further application of η leads us to generate a set of sets as a result. We will call such objects *higher-order* alternative sets.

(48) If $m : \mathsf{S}a$ and $f : a \to \mathsf{S}b$, then $m \mathbin{>\!\!>\!\!=} \lambda x.\eta\,(f\,x)$ is of type $\mathsf{S}\,(\mathsf{S}b)$.

Notice that this fact turns on the polymorphism of $\mathbin{>\!\!>\!\!=}$, which demands nothing more of its right argument than that it be a function into sets.

Extra applications of η thus allow us to generate higher-order meanings for sentences with two indefinites. Two such possibilities for the sentence *a persuasive lawyer visits a*

14 Cases like (46) and (47) are also discussed by Ciardelli, Roelofsen & Theiler (2016).



$= \{\{\text{visits}\, y\, x \mid \text{rel}\, y\} \mid \text{lawyer}\, x\}$ $\qquad$ $= \{\{\text{visits}\, y\, x \mid \text{lawyer}\, x\} \mid \text{rel}\, y\}$

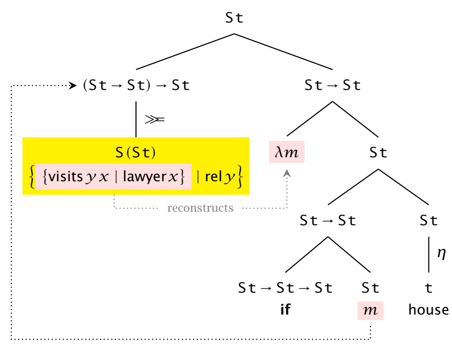
Figure 10: Two higher-order derivations of *a persuasive lawyer visits a rich relative of mine*, differing in the relative scopes of the two indefinites.

rich relative of mine, the antecedent of (43), are given in Figure 10. These derivations differ from previous examples only in that they invoke two applications of η, rather than one (cf. Figure 5, right on page 12). They differ from each other only in the relative scopes of the two indefinites. In both cases, we derive a higher-order alternative set. Concretely, if L_1 and L_2 are the lawyers, and R_1 and R_2 are the relatives, these two higher-order results correspond (respectively) to the following:

$$\left\{\begin{matrix}\{\text{visits}\,\mathsf{R}_1\,\mathsf{L}_1,\ \text{visits}\,\mathsf{R}_2\,\mathsf{L}_1\}, \\ \{\text{visits}\,\mathsf{R}_1\,\mathsf{L}_2,\ \text{visits}\,\mathsf{R}_2\,\mathsf{L}_2\}\end{matrix}\right\} \qquad \left\{\begin{matrix}\{\text{visits}\,\mathsf{R}_1\,\mathsf{L}_1,\ \text{visits}\,\mathsf{R}_1\,\mathsf{L}_2\}, \\ \{\text{visits}\,\mathsf{R}_2\,\mathsf{L}_1,\ \text{visits}\,\mathsf{R}_2\,\mathsf{L}_2\}\end{matrix}\right\}$$

Higher-order alternative sets like these allow different sources of alternatives to be distinguished outside islands — in other words, they can be used to derive selective exceptional scope when multiple indefinites occur on an island. For example, if we wish to derive the specific-relative, any-old-lawyer reading of example (43), we can begin with the higher-order meaning derived in Figure 10, right (where the *relative*-indefinite takes widest scope). If we scopally pied-pipe this higher-order set above the conditional, the outer layer of alternatives scopes in the pied-piped island's scope position, while the inner layer of alternatives *semantically reconstructs* to within the scope of the conditional operator **if**. In more detail, the calculation looks as follows:

(49) $$\begin{aligned} \{\{\text{visits}\, y\, x \mid \text{lawyer}\, x\} \mid \text{rel}\, y\} \gg\!= \lambda m.\, \textbf{if}\, m\, (\eta\, \text{house}) \\ = \textstyle\bigcup_{y \in \text{rel}} \textbf{if}\, \{\text{visits}\, y\, x \mid \text{lawyer}\, x\}\, (\eta\, \text{house}) \\ = \textstyle\bigcup_{y \in \text{rel}} \{\text{if}\, (\exists x \in \text{lawyer} : \text{visits}\, y\, x)\, \text{house}\} \\ = \{\text{if}\, (\exists x \in \text{lawyer} : \text{visits}\, y\, x)\, \text{house} \mid \text{rel}\, y\} \end{aligned}$$



$$= \{\mathsf{if}\,(\exists x \in \mathsf{lawyer} : \mathsf{visits}\, y\, x)\, \mathsf{house} \mid \mathsf{rel}\, y\}$$

Figure 11: Selectivity in scopal pied-piping. A higher-order meaning for the island (derived in Figure 10, right) takes scope above **if**. The inner layer of alternatives semantically reconstructs to within the scope of **if**. The effect is ultimately to distinguish the different sources of alternatives outside the island, even as neither source of alternatives leaves the island.

Notice that this derivation presumes (indeed, requires) that the 'trace' m of the scopally pied-piped island be of type St, rather than type t.[15] The derivation thus bears a family resemblance to semantic theories of scope reconstruction (e.g., Cresti 1995, von Fintel & Heim 2011), which likewise rely on higher-typed 'traces'.

Higher-order alternative sets have been appealed to in the questions literature, as well. For example, Hagstrom (1998) and Fox (2012) explore how higher-order questions can be used to derive pair-list readings in multiple-*wh* questions. Dayal's (1996) account of the '*wh* triangle' (e.g., the availability of pair-list readings in questions like *who knows who read what?*) bears a particularly close relationship to the present proposal (see also Dayal 2002). Dayal's account of the pair-list reading treats the *wh*-island *who read what* as denoting a higher-order alternative set, which scopes out of its base position and into the left periphery. The eventual effect is to give the appearance of matrix scope to *what*, while semantically reconstructing the rest of the *wh*-island into its base position.

5.3 Generalized selectivity

Though we've considered only one selective exceptional scope derivation in any detail, it should be reasonably clear that the account generalizes so as to guarantee *full* selectivity

15 The reason for the scare-quotes around 'traces' is that I'd rather not commit to QR-based theory of scope. QR requires a formal relationship to be established between a scope-taking expression and its trace. Generally this happens by construing traces as variables, and establishing operator-trace binding relationships via assignment modification (e.g., Heim & Kratzer 1998, Büring 2005). While such a view has much to recommend it, it's convenient — particularly in the present setting (though by no means necessary!) — to theorize directly about scope-taking without explicit reference to variables and assignments (many such approaches to scope exist; see, e.g., Hendriks 1993, Moortgat 1997, Barker & Shan 2014, along with Barker & Shan 2008, Charlow 2014 for treatments of islands within such theories). Footnote 17 elaborates a bit on this point.

for any number of indefinites in arbitrary syntactic arrangements. If, for example, we wanted to derive the specific-lawyer, any-old-relative reading of (43), we can carry out the derivation in Figure 11, replacing the highlighted portion with the meaning derived in Figure 10, left, with the relative scopes of the two island-bound indefinites reversed.

More generally, if an island hosts n independent indefinites (i.e., no indefinite is contained within any other, and no indefinite binds into any other), it will be possible to derive $n!$ maximally higher-order meanings for the island (i.e., with as many occurrences of ⌜S⌝ in the type signature as there are indefinites on the island). These $n!$ possibilities correspond to different scopings of the island-bound indefinites, with η's sprinked in between any two indefinites (as, for example, in Figure 10). Thus, the grammar never needs to conflate different sources of alternatives — island-bound indefinites can always be distinguished outside the island, and in any order.

In sum, using higher-order alternative sets and semantic reconstruction, we're able to exert a high degree of control over which indefinites on any island end up evaluated where. Doing so requires no additional stipulations beyond the combinatorial apparatus posited for semantically integrating alternatives in simple sentences: η, and $\gg=$.

5.4 The unselectivity of alternative semantics

Whereas general selectivity for indefinites on islands is a consequence of the η-and-$\gg=$ approach to alternative management, alternative semantics is fundamentally *unselective*. Because an alternative-semantic interpretation function $\{\!\{\cdot\}\!\}$ insists on composing meanings point-wise, the type of any island with any number of indefinites necessarily ends up St. As we have seen, this type is too coarse to allow multiple indefinites on an island to be distinguished outside the island. Thus, the full range of exceptional scope readings for cases like (46) and (47) cannot be derived using alternative semantics alone.

A related problem has been noted for accounts of association with focus formulated within alternative semantics (following Rooth 1985). In brief, alternative semantics for association with focus posits that focused expressions (things with F-marks) invoke alternatives, which are expanded by $\{\!\{\cdot\}\!\}$ up to the nearest closure operator (generally, a focus-sensitive adverb, or alternatively a focus interpretation operator ⌜~⌝ à la Rooth 1992). This allows association with focus to happen across island boundaries, as required by cases like (8), repeated here (with an F-mark on the focused expression *MARY*):

(8) John only gripes when [MARY$_F$ leaves the lights on].

An apparent problem for the alternative-semantic treatment of association with focus is that association with multiple island-embedded foci is arguably selective. To date, the empirical arguments aiming to establish this point have involved complex data (generally, involving two focus-sensitive adverbs associating with multiple island-embedded foci) — and, accordingly, have required extremely subtle judgments (see, e.g., Wold 1996, Rooth 1996, Beck 2006, Krifka 2006). Fortunately, the point can be made with relatively simple examples whose grammatical status is clear.

I present the argument in an abbreviated form here (readers are referred to the previously cited works on focus in alternative semantics for full formal details). Consider a sentence like *John only gripes when MARY leaves the lights on, and MARY only gripes when JOHN leaves the lights on.* This sentence is well-formed. A putative parse in given in (50). Association with *only* in both conjuncts motivates F-marks on the first occurrence of *MARY*, and on the second occurrence of *JOHN*. Moreover, the second conjunct clearly contrasts with the first, which motivates a $\sim C$ operator on the second conjunct (co-indexed with the first conjunct), along with F-marks on the second occurrences of *MARY* and *JOHN* (Rooth 1992; see also Schwarzschild 1999).[16]

(50) [John only gripes when [MARY$_{\text{F}}$ leaves the lights on]]$_C$, and
[MARY$_{\text{F}}$ only gripes when [[JOHN$_{\text{F}}$]$_{\text{F}}$ leaves the lights on]]$_{\sim C}$

The problem posed by (50) occurs in the second conjunct: intuitively, both *only* and $\sim C$ should *selectively* associate with one of the F-marks on *JOHN*. However, selective association is impossible if alternative propagation is ultimately due to $\{\!\{\cdot\}\!\}$, which associates the island with a flat set of alternative propositions, type $\mathtt{S\,t}$: it seems impossible for a meaning with this type to register the presence of two F-marks, one embedded within the other, which *a fortiori* precludes selective association with these F-marks by *only* and $\sim C$. This situation closely parallels example (46), where two indefinites standing in a containment relationship may take exceptional scope in different ways beyond the boundaries of an island.

Presenting a complete analysis of such cases would take us too far afield (but see Shan 2002 for a monads-based treatment of focus and Charlow 2014 for an analysis of configurations like (50) that parallels the treatment of selective exceptional scope-taking for indefinites given here). Still, we can take the following to the bank: while $\{\!\{\cdot\}\!\}$ requires unselectivity as the price of exceptional scope, η and $\ggg$ predict fully selective exceptional scope-taking. This fact underlies empirically robust accounts of English indefinites (a point we're still in the process of drawing out), while offering a plausible way forward for selectivity in association with focus, as well.

In sum, a lot more can be done with alternatives than is traditionally supposed: alternatives-based accounts of exceptional scope phenomena are not fundamentally at cross-purposes with selectivity in exceptional scope taking. In the next section, we'll turn our attention to the interactions of indefinites and pronominal binding, arguing that our account of exceptionally scoping indefinites improves on standard accounts which leave them in situ. We'll see that the scope-oriented nature of the η-and-$\ggg$ approach underwrites these successes.

6 Alternatives and binding

6.1 Pronouns (on islands)

The semantics so far has been maximally simple: we've been dealing only with individuals, truth values, functions built out of those domains, and sets thereof. As with any

16 To adhere to the letter of Rooth (1992), the actual parse will be somewhat more complicated, though in a way that does not affect the present point. Specifically, Rooth suggests that *only* is not itself a closure operator. Instead, a second focus interpretation operator, attached within the scope of *only*, indirectly fixes the value of a domain variable associated with *only*.

theory, though, we'll need to say some things about the interpretations of *variable* elements — specifically, pronouns and traces of overt movement — as well as how variable elements can come to be bound. Ultimately, this requires generalizing η and $\ggg\!=$, to functions that incorporate reference to *assignment functions*.

The task may seem especially pressing, because it looks as if we might make incorrect predictions about cases like (51). This example, with both an indefinite and a pronoun on an [island], can be understood with the indicated binding relationship, and with the indefinite taking maximally wide scope — i.e., over the universal subject.

(51) Everybody^x loves it when [a famous expert on indefinites cites him$_x$]. $^{\checkmark}\exists \gg \forall$

On the present proposal, deriving the exceptional scope reading requires the [island] itself to take scope over the universal subject — but this inevitably scopes the pronoun over the subject, as well. The worry, then, is that we under-generate — i.e., that the scoping required for exceptional scope is inconsistent with the pronoun being bound.

We've already seen that η and $\ggg\!=$ allow us to exert a fine degree of control over which things on an island are evaluted where — when multiple indefinites are on an island, it's possible to build higher-order meanings for the island which enable us to interpret some of the island-bound indefinites high, even as others are interpreted low. One might hope, then, that cases like (51) might be amenable to a parallel explanation. Once we extend our grammar with some apparatus for handling pronouns and binding, we'll see that this indeed turns out to be the case.

Another core piece of data pertaining to the interaction of indefinites and binding is something termed the 'Binder Roof Constraint' by Brasoveanu & Farkas (2011): when an operator binds into an indefinite, it is impossible for the indefinite to scope over the operator. Thus, Brasoveanu & Farkas's (2011: 27) example (49), given here as (52), is unambiguous with the indicated binding relationship: the indefinite is bound into by its host DP, and so its upward scopability is delimited there. Example (53), Schwarz's (2001: 28) example (41), makes a similar point: the subject binds a pronoun inside the indefinite, which makes a wide-scope-indefinite reading impossible. The issue is also taken up by Winter (1998), Geurts (2000), and Heim (2011b).

(52) Every boy^x who talked to a friend of his$_x$ left. $^*\exists \gg \forall$

(53) No candidate^x submitted a paper he$_x$ had written. $^*\exists \gg \textsf{no}$

In situ treatments of exceptionally scoping indefinites — including accounts making use of choice functions, Independence-Friendly Logic, and alternative semantics — either over-generate wide-scope interpretations for constructions like (52) and (53), or require additional stipulations to rule them out. This point is discussed in Sections 6.4 and 6.5.

6.2 Upgrading the semantics

To allow for sets of alternatives, alongside variable meanings and variable binding, we need (like anybody) to add some apparatus that lets us (i) assign meanings to pronouns and (ii) effect pronominal binding. The standard approach is to conceive of all meanings as determined relative to a way of valuing free pronouns, generally an assignment function, and then to upgrade the interpretation function accordingly — i.e., by saying how it composes two assignment-relative denotations at an assignment.

This kind of approach is notably similar to the standard formulation of alternative semantics, where all meanings are conceived of as sets, and the interpretation function is upgraded by specifying how it composes two sets of meanings (i.e., the grammar is lexically and compositionally generalized to the worst case).

As with alternative sets, we'll take a more modular perspective on this shift. Thus, instead of assuming that all meanings are assignment-relative, and upgrading the interpretation function accordingly, we directly build assignment dependence into the monad that underwrites composition in the presence of alternatives. Taking $\mathtt{i}$ to be the type of assignment functions, we posit a type constructor $\mathsf{S}_\mathtt{i}$ such that for any type a, an $\mathsf{S}_\mathtt{i}\, a$ is the type of functions from assignments into sets of a's:

(54) $\mathsf{S}_\mathtt{i}\, a ::= \mathtt{i} \to \mathsf{S}\, a$

Alongside this upgraded type constructor, we define upgraded, assignment-friendly versions of η and $\gg\!=$ in (55) and (56) below. These definitions replace our previous ones. Other than the explicit invocations of assignments, the definitions are unchanged: η upgrades any value x into a maximally boring *constant function from assignments* into the singleton set x, and $\gg\!=$ extracts a set of alternatives from m relative to an assignment i, feeds those one-by-one to a scope argument f (which is likewise fed i), and collects the resulting sets.

(55) $\eta\, x \coloneqq \lambda i.\, \{x\}$ $\qquad \eta : a \to \mathsf{S}_\mathtt{i}\, a$

(56) $m \gg\!= f \coloneqq \lambda i.\, \bigcup_{x \in m\, i} f\, x\, i$ $\qquad \gg\!= : \mathsf{S}_\mathtt{i}\, a \to (a \to \mathsf{S}_\mathtt{i}\, b) \to \mathsf{S}_\mathtt{i}\, b$

$(\mathsf{S}_\mathtt{i}, \eta, \gg\!=)$ is still a monad: their types have the right shape (cf. Section 4.5), and they collectively obey Left and Right identity, as well as Associativity (as the reader can check). Thus, we can expect that our earlier results: principally, exceptional scope and selectivity, will seamlessly carry over (and will demonstrate as much shortly).

Simple indefinites can be upgraded by treating them as constant functions over assignments into the alternative sets used before, as in (57). And pronominal elements can be assigned denotations like (58), a non-constant function from assignments i into a singleton set containing the individual returned by i at some index (here, 0).

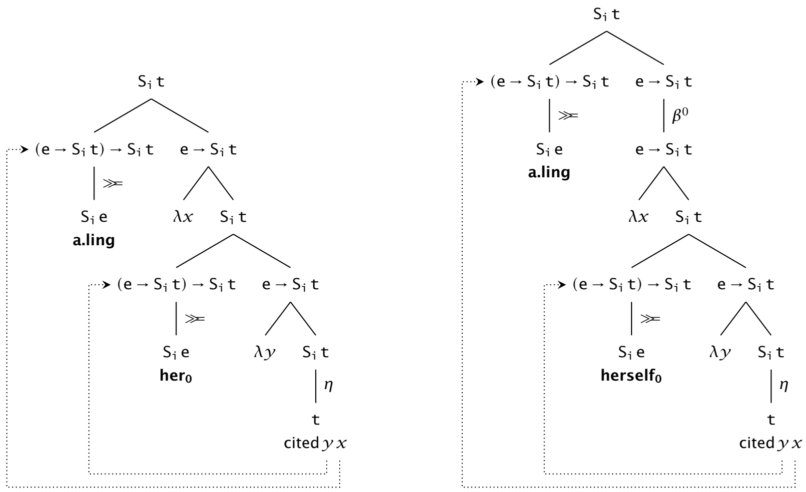
(57) $\textbf{a.ling} \coloneqq \lambda i.\, \{x \mid \mathsf{ling}\, x\}$ $\qquad \textbf{a.ling} : \mathsf{S}_\mathtt{i}\, \mathsf{e}$

(58) $\textbf{she}_0 \coloneqq \lambda i.\, \{i_0\}$ $\qquad \textbf{she}_0 : \mathsf{S}_\mathtt{i}\, \mathsf{e}$

Readers familiar with, e.g., Kratzer & Shimoyama 2002 will recognize these meanings as perfect analogs of the lexical entries those authors posit for indeterminates and pronouns (minus intensional details; see Appendix B).

A derivation of *a linguist cited her*$_0$ using these pieces is sketched in Figure 12, left.[17] This derivation is quite similar to Figure 5, right (page 12): instead of two indefinites

17 As in footnote 15, I should emphasize that I'm thinking of these trees as vertical expansions of linear 'logical



$= \lambda i.\,\{\text{cited}\, i_0\, x \mid \text{ling}\, x\}$ $\qquad$ $= \lambda i.\,\{\text{cited}\, x\, x \mid \text{ling}\, x\}$

Figure 12: On the left, a derivation of *a linguist met her*$_0$, with both the indefinite and pronoun taking scope via $\ggcurly$. On the right, a derivation of *a linguist* β^0 *cited herself*$_0$, where binding is effected by a β^0 operator applying to **a.ling**'s scope.

taking scope via $\ggcurly$, an indefinite and a pronoun take scope via $\ggcurly$ (upgraded to handle assignment-sensitivity alongside alternatives). The result, relative to an assignment i, is a set of propositions of the form $\ulcorner \text{cited}\, i_0\, x \urcorner$, with x ranging over linguists. In more detail, the calculation looks as follows:

(59) $$\begin{aligned} \textbf{a.ling} \ggcurly \lambda x.\, \textbf{her}_0 \ggcurly \lambda y.\, \eta\, (\text{cited}\, y\, x) &= \textbf{a.ling} \ggcurly \lambda x.\, \textbf{her}_0 \ggcurly \lambda y.\, \lambda i.\, \{\text{cited}\, y\, x\} \\ &= \textbf{a.ling} \ggcurly \lambda x.\, \lambda i.\, \textstyle\bigcup_{y \in \{i_0\}} \{\text{cited}\, y\, x\} \\ &= \lambda i.\, \textstyle\bigcup_{x \in \text{ling}} \bigcup_{y \in \{i_0\}} \{\text{cited}\, y\, x\} \\ &= \lambda i.\, \{\text{cited}\, i_0\, x \mid \text{ling}\, x\} \end{aligned}$$

Pronominal binding can be effected in a relatively standard way, i.e., by introducing an operator or operators that trigger assignment functions shifts. A standard abstraction operator, λ^n, is defined in (60): it binds n in f by anchoring n to a newly introduced functional abstract λx (cf. the Predicate Abstraction rule of Heim & Kratzer 1998). As usual, $\ulcorner i^{n \to x} \urcorner$ names the assignment j differing at most from i in that $j_n = x$. Of more use to us in what follows will be an operator β^n, which anchors n to an existing

forms', and simply assuming some non-LF mechanism for scope-taking. If one wishes to use LF for scope, something will need to be said about how traces get interpreted — and that something *can not be* the same thing we say about pronouns here (since our pronouns need to take scope, leaving a trace, which would itself need to take scope, and so on, ad infinitum)! While it would be straightforward to adopt a Büring (2005)-style solution, with a separate assignment-based system for binding the traces of QR (as opposed to pronouns), it's convenient to abstract away from those details in the present investigation.

functional parameter (cf. Büring's 2005 β-binding rule).[18]

(60) $\lambda^n f := \lambda x.\lambda i.f\, i^{n\to x}$ $\qquad \lambda^n : (\mathtt{i} \to b) \to a \to \mathtt{i} \to b$

(61) $\beta^n f := \lambda x.\lambda i.f\, x\, i^{n\to x}$ $\qquad \beta^n : (a \to \mathtt{i} \to b) \to a \to \mathtt{i} \to b$

β^n is used to derive *a linguist* β^0 *cited herself*$_0$, with an indefinite binding a pronominal expression, in Figure 12, right. As in Figure 12, left, the indefinite and the pronoun both take scope via $\ggcurly$. In addition, β^0 applies to the scope of **a.ling**, anchoring **herself$_0$** to the functional abstract λx (and thus, eventually, to **a.ling**). The result is an assignment-invariant set of propositions of the form $\ulcorner \mathsf{cited}\, x\, x \urcorner$, with x ranging over linguists.

Finally, closure operators are upgraded in a way that allows them to interact with assignment-relative sets of propositions. We replace $\lightning$ with an assignment-sensitive $\lightning_i$ in (62), and then use it to rewrite the definition of **if**, as in (63). The new entry for **if** can be combined with the meanings derived in Figure 12 to derive a meaning for *if a linguist cited her*$_0$*, a linguist* β^0 *cited herself*$_0$, as in (32).

(62) $m^{\lightning_i} := \mathbb{T} \in m\, i$ $\qquad \lightning : \mathsf{S_i\, t} \to \mathsf{t}$

(63) $\mathbf{if}\, m\, n := \lambda i.\{\mathsf{if}\, m^{\lightning_i}\, n^{\lightning_i}\}$ $\qquad \mathbf{if} : \mathsf{S_i\, t} \to \mathsf{S_i\, t} \to \mathsf{S_i\, t}$

(64) $\mathbf{if}\, (\lambda i.\{\mathsf{cited}\, i_0\, x \mid \mathsf{ling}\, x\})\, (\lambda i.\{\mathsf{cited}\, x\, x \mid \mathsf{ling}\, x\}) =$
$\lambda i.\{\mathsf{if}\, (\exists x \in \mathsf{ling} : \mathsf{cited}\, i_0\, x)\, (\exists x \in \mathsf{ling} : \mathsf{cited}\, x\, x)\}$

It bears emphasizing that the only way (62) and (63) differ from their counterparts in (19) and (31) is that they expect to interact with assignment-relative sets of propositions, rather than sets of propositions.

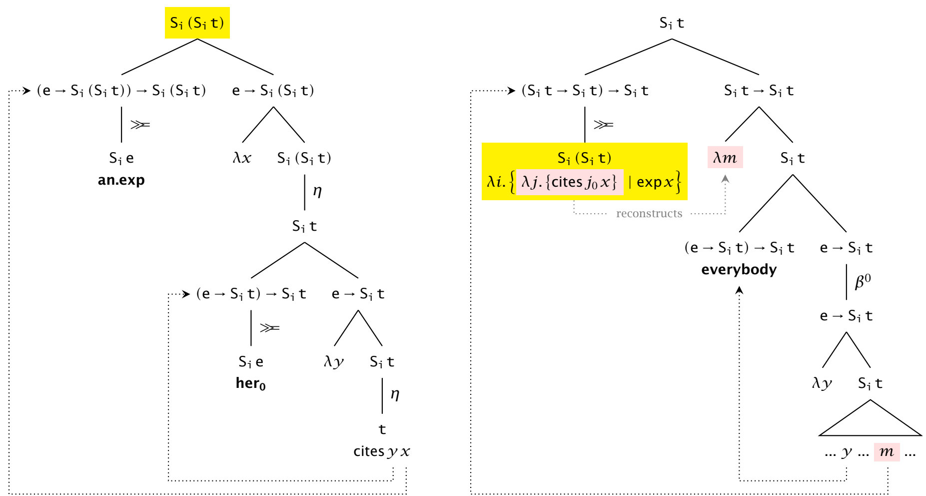
6.3 Generalized exceptional scope and selectivity

Like the S-based $\ggcurly$ operation, the $\mathsf{S_i}$-based $\ggcurly$ operation obeys Associativity. Thus, the principal results of the S-based η-and-$\ggcurly$ semantics — exceptional scope and selectivity for indefinites — immediately carry over to a η-and-$\ggcurly$ semantics based on $\mathsf{S_i}$. In particular, the derivations in Figure 6 (page 14) and Figure 11 (page 23) can be imported directly into the upgraded theory, simply by replacing all the S's with $\mathsf{S_i}$'s.

Furthermore, though pronouns, like indefinites, interact with their semantic context by taking scope (via $\ggcurly$), Associativity likewise guarantees that pronominal effects (i.e., assignment-sensitivity) will be able to be felt beyond the boundaries of an island.[19] In practice, this means that pronouns embedded arbitrarily deep may make their effects felt arbitarily far away — either at the matrix level (resulting in an unbound pronoun) or at some intermediate level (e.g., when a β^n operator binds the pronoun).

18 It's notable that, unlike standard treatments of binding, these definitions can be specified in a fully categorematic way — that is, we assign meanings directly to λ^n and β^n, rather than using them to syncategorematically invoke a compositional rule (cf., e.g., Sternefeld 1998, 2001b, Kobele 2010, Kennedy 2014). This is similar to the case of $\lightning$: the grammar does not insist on a particular 'default' way of handling assignments or alternatives, and there's no need to invoke syncategorematic rules subverting a default that doesn't exist.

19 This contrasts with other scope-based theories of pronouns (e.g., Dowty 2007, Barker & Shan 2014), which require pronouns to take scope under their binders, without any mechanism for accomplishing binding when a pronoun is separated from its binder by an island.



$$= \lambda i.\,\{\lambda j.\,\{\mathsf{cites}\, j_0\, x\} \mid \mathsf{exp}\, x\} \qquad = \lambda i.\,\{\forall y \in \mathsf{human} : \ldots\, \mathsf{cites}\, y\, x\, \ldots \mid \mathsf{exp}\, x\}$$

Figure 13: Left: a higher-order derivation of the scope island *a famous expert on indefinites cites her$_0$* (analogous to the higher-order derivation in Figure 10). Right: a schematic demonstration of how this higher-order meaning can be used to derive exceptional scope for the indefinite (by pied-piping the higher-order island), while simultaneously semantically reconstructing the assignment-dependent inner layer to within the scope of β^0 (which in turn occurs within the scope of **everybody**). The result is exceptional scope for the island-bound indefinite, along with binding of the island-bound pronoun.

Finally, we'll demonstrate that the upgraded semantics allows indefinites and pronouns on an island to be distinguished outside the island. Repeating our example (51):

(51) Everybody^x loves it when [a famous expert on indefinites cites him$_x$]. $^\checkmark\exists \gg \forall$

The problem posed by this example, recall, is that it allows an exceptional scope reading for the indefinite, even as the pronoun is interpreted as bound by *everybody*. As noted prior, this seems to have a similar shape as the problem of two indefinites on an island taking exceptional scope in different ways beyond the island: we would like scopally pied-piping the island to give the indefinite scope over a higher operator, without thereby preventing the pronoun from being bound by that operator.

With our upgraded η and $\gg=$, we can analyze the exceptional-scope reading of (51) in a way that parallels our analysis of selectivity for indefinites. We begin, as before, by deriving a higher-order meaning for the island in Figure 13, left. This derivation parallels the higher-order derivations in Figure 10 (page 22): an extra η, inserted in between the indefinite and the pronoun, leads to a higher-order meaning for the island, with type $\mathsf{S_i}\,(\mathsf{S_i}\,\mathsf{t})$. Here, the indefinite's effects (alternatives) live in the outer layer of the higher-order result, while the pronoun's effects (assignment-sensitivity) live in its inner layer.

With higher-order meanings in hand, we may (as with indefinites) control which parts of an island get evaluated where. A simplified derivation (abstracting away from everything but the island and the binder) is given in Figure 13, right (cf. Figure 11 on page 23). The higher-order island takes scope above **everybody**. This results in the indefinite's outer-layer effects being interpreted in the scope position of the pied-piped island, while the pronoun's inner-layer effects semantically reconstructs back into the island's base position, under β^0. Because the higher-order island's inner layer has the form $\ulcorner \lambda j.\{\mathsf{cites}\, j_0\, x\} \urcorner$ (with x ranging over famous experts on indefinites), and the β^0 operator under **everybody** shifts the assignments relative to which this assignment-relative set of alternatives is evaluated, binding can transpire.[20] Thus, exceptional scope for the indefinite is consistent with binding of its island-mate pronoun. As with multiple indefinites, this result can be generalized to guarantee full selectivity when any number of indefinites or pronouns occur on a given island (cf. Section 5.3).

The precise semantics of *everybody* is orthogonal to this point, but for concreteness we can posit the entry in (65). See Appendix A for more details on the compositional semantics of DPs within the present system.

(65) $\textbf{everybody} \coloneqq \lambda f.\lambda i.\{\forall y \in \mathsf{human} : (f\, y)^{\lightning_i}\}$ $\qquad$ $\textbf{everybody} : (\mathsf{e} \to \mathsf{S_i\, t}) \to \mathsf{S_i\, t}$

6.4 The Binder Roof Constraint

Our second key piece of data on the interaction of indefinites and binding is the Binder Roof Constraint: when an operator binds into an indefinite, the indefinite cannot scope over that operator. Examples (52) and (53), which establish this point, are repeated here.

(52) Every boy^x who talked to a friend of his$_x$ left. $\qquad$ $^*\exists \gg \forall$

(53) No candidate^x submitted a paper he$_x$ had written. $\qquad$ $^*\exists \gg \mathsf{no}$

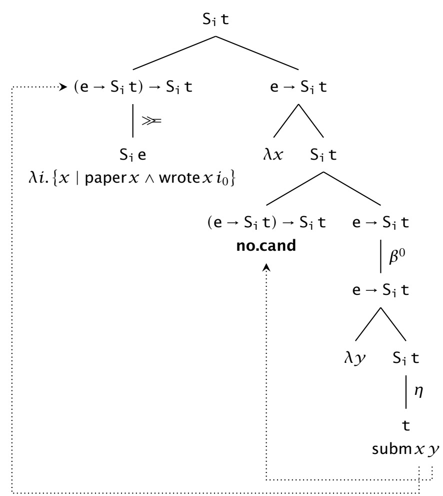
Because the η-and-$\ggg=$ account of indefinites is oriented around scope-taking (either by the indefinite itself, or by a constituent — perhaps an island — dominating it), we correctly predict that an indefinite cannot acquire scope over an operator that binds into it. We demonstrate this by sketching an analysis of (53).

First, we specify a meaning for the indefinite *a paper he*$_0$ *had written* in (66). For now, we simply take this meaning as given (Appendix A demonstrates how meanings for relative clauses and complex DPs are derived). For present purposes, it suffices to note that (66) is clearly the correct inhabitant of type $\mathsf{S_i\, e}$ to associate with *a paper he*$_0$ *had written* — relative to an assignment i, it's the set of papers that i_0 wrote.

(66) $\lambda i.\{x \mid \mathsf{paper}\, x \wedge \mathsf{wrote}\, x\, i_0\}$ $\qquad$ type: $\mathsf{S_i\, e}$

In Figure 14, this meaning for the indefinite is given scope over a quantifier corresponding to *no candidate* (the precise definition of which is again not very important, though see (65) for an entry that can be minimally modified to fit the present case), while doing our best to effect binding of the pronoun by inserting a β^0 operator co-indexed

20 Using semantic reconstruction to achieve binding reconstruction was pioneered by Sternefeld (1998, 2001b).



$$= \lambda i.\, \{\neg\exists y \in \text{cand} : \text{subm}\, x\, y \mid \text{paper}\, x \wedge \text{wrote}\, x\, i_0\}$$

Figure 14: Deriving a wide-scope-indefinite reading for *no candidate submitted a paper he$_0$ had written.* We attempt to effect binding with β^0, but this ends up being toothless: the indefinite takes scope over β^0, and so its pronoun necessarily remains free.

with the pronoun in the indefinite's restrictor. Correctly, binding does not succeed: because the indefinite scopes over β^0, the latter can have no effect on the former.[21]

This result generalizes to cases where an indefinite pied-pipes some larger chunk of meaning (e.g., an island), which then scopes over some higher operator: Associativity guarantees that the result in such cases is equivalent to what we'd obtain if the indefinite had directly scoped over the operator, in which case the operator cannot bind into it.[22,23]

21 The reader might wonder if it would be possible to pull off a higher-order trick here, to enable the pronoun to reconstruct, even as the indefinite is interpreted high. This is impossible: because the pronoun forms a part of the semantic restriction on the indefinite, there's no way to give the indefinite wide scope without also bringing the pronoun along for the ride. The situation is different in cases like (51), where the indefinite and pronoun are syntactically and semantically independent of each other.

22 Schwarz (2001) points out that *certain*-indefinites can receive a kind of wide-scope reading in configurations otherwise parallel to examples like (53): e.g., *no candidate^x submitted a certain paper she$_x$ had written* can truthfully describe a situation in which no candidate submitted the paper she wrote on indefinites, even if every candidate submitted one or more papers. Such cases might be analyzable by supposing that *certain* denotes something like an indexical NP modifier, i.e., such that *a certain paper she had written* comes out meaning the same thing as *a paper she had written with the property I have in mind.* Thus, the indefinite could take narrow scope (as required for binding), even as the definiteness of the contextually specified property gives the impression of wide scope. See Heim 2011b: 1023 for a suggestion along these lines.

23 An anonymous reviewer points out that 'summative' readings of cardinal indefinites may counter-exemplify the Binder Roof Constraint: *this election could have two winners* can be understood as claiming that there are two people who could each be winners of the election, i.e., with the modal *could* semantically intervening between the cardinal indefinite's quantificational force and its restrictor (Szabó 2011: 275). See Francez 2017 for a semantic account that allows a cardinal indefinite's quantificational force and restrictor to be dissociated in certain intensional contexts, in a way broadly consistent with the Binder Roof Constraint.

Importantly, these predictions are not shared by in-situ accounts of indefinites, which achieve wide-scope readings for indefinites without needing to scope the indefinite. Perhaps the most well-known of such accounts is the choice-functional theory of Reinhart (1997) (see also Winter 1998). A choice function is any function f such that, for any non-empty property P, $f\,P$ is an individual of whom P holds, as formalized in (67).[24]

(67) $\mathsf{CF} := \{f \mid \forall P \supsetneq \emptyset : P\,(f\,P)\}$

Exceptional-scope readings for indefinites may then be derived as follows (following the presentation of Heim 2011b). It is assumed that indefinite determiners are interpreted as choice function variables, and that these variables can be bound by arbitrarily distant operators that existentially quantify over choice functions. Thus, the exceptional scope reading of *if a rich relative of mine dies, I'll inherit a house* can be represented as follows:

(68) $\exists f \in \mathsf{CF} : \mathsf{if}\,(\mathsf{dies}\,(f\,\mathsf{rel}))\,\mathsf{house}$

One might informally gloss (68) as follows: there's a way to choose relatives of mine such that, if *that* relative (i.e., the value determined by f, the way of choosing relatives) dies, I'll inherit a house. This does a reasonably good job representing the exceptional scope reading in question (though see Reinhart 1997: 394 for some complications).

The ability to leave 'wide-scoping' indefinites in situ, characteristic of the choice-functional account of exceptional scope, is at odds with the Binder Roof Constraint. Example (53), for example, can be assigned a logical form like (69). Because the indefinite remains in situ, there's nothing to prevent it from being bound by *nobody*, even the existential quantifier over choice functions is given widest scope.

(69) $\exists f \in \mathsf{CF} : \neg\exists x \in \mathsf{candidate} : \mathsf{submitted}\,(f\,(\lambda y.\,\mathsf{paper}\,y \wedge \mathsf{wrote}\,y\,x))\,x$

As Schwarz (2001) points out, this represents an impossible reading of (53): (69) is true iff no candidate submitted *every* paper she had written (assuming that every candidate wrote at least one paper, cf. footnote 24).

Problematic predictions like these aren't limited to downward-entailing (or non-monotonic) quantifiers, as argued by Winter (1998: 444) and Geurts (2000: 734). Nor are they limited to choice-functional theories of indefinites. For example, Brasoveanu & Farkas's (2011) in situ theory of indefinites (using Independence-Friendly Logic) derives correct results for cases like (53). But doing so requires them to stipulate that in cases where an indefinite I is independent of an operator O — corresponding to an wide-scope interpretation of I with respect to O — the variable associated with O is inaccessible inside I's restrictor (Brasoveanu & Farkas 2011: 20, clause (36b)). Such a stipulation appears to be otherwise unmotivated.

All told, a scope-oriented theory of indefinites and their exceptional scope properties seems to improve on approaches which leave indefinites in situ. For an indefinite to receive a wide-scope interpretation relative to an operator O, the indefinite (or something it pied-pipes) must actually scope over O. This derives the Binder Roof Constraint.

24 Matters are more complicated when P is empty (Reinhart 1997, Winter 1998, Geurts 2000). To streamline the discussion, I will assume that for all of our examples, a choice function never receives an empty argument.

6.5 Binding in alternative semantics

The last point I'd like to highlight pertaining to the interaction of binding and alternatives concerns the status of binding within alternative semantics. The version of alternative semantics sketched in Section 2.2 made no provisions for variable elements or binding. Let's see what such an enrichment might look like. As a first step, incorporating variables and assignment functions into a point-wise grammar is straightforward enough. As in our proposal, we can take indefinites and pronouns to denote assignment-relative sets of individuals (as is done in Kratzer & Shimoyama 2002):

(70) $\{\!\{\text{a linguist}\}\!\} := \lambda i.\, \{x \mid \mathsf{ling}\, x\}$ type: $\mathsf{S_i}\,\mathsf{e}$

(71) $\{\!\{\text{she}_n\}\!\} := \lambda i.\, \{i_n\}$ type: $\mathsf{S_i}\,\mathsf{e}$

More generally, everything previously associated by $\{\!\{\cdot\}\!\}$ with a meaning of type $\mathsf{S}\,a$ will be re-associated with a meaning of type $\mathsf{S_i}\,a$. Then the interpretation of binary-branching nodes can be upgraded as follows:

(72) $\{\!\{A\ B\}\!\} := \lambda i.\, \{f\,x \mid f \in \{\!\{A\}\!\}\, i \wedge x \in \{\!\{B\}\!\}\, i\}$

How about abstraction? The result of interpreting a constituent of the form $[\lambda^n\ X]$ should be an assignment-relative set of functions. This turns out to be a sticking point. We make an initial attempt, as follows:

(73) $\{\!\{\lambda^n\ X\}\!\} \overset{?}{:=} \lambda i.\, \{\lambda x.\, \{\!\{X\}\!\}\, i^{n\to x}\}$

However, the right-hand side here has the wrong type: it's an assignment-relative set of functions *into sets*. The result, in other words, is incorrectly higher-order: if, for example, X is a propositional node, $[\lambda^n\ X]$ will be of type $\mathsf{S_i}\,(\mathsf{e} \to \mathsf{S}\,\mathsf{t})$, which will be impossible to compose with a quantifier meaning, type $\mathsf{S_i}\,((\mathsf{e} \to \mathsf{t}) \to \mathsf{t})$, via $\{\!\{\cdot\}\!\}$.

One way to get around this would be to flatten the inner layer of alternatives by quantifying over them — i.e., by treating abstraction as a *closure* operation. But this predicts that binding into an island necessarily short-circuits alternative percolation out of the island. Cases like (51) suggest that this is incorrect for indefinites, and similar arguments can be adduced for assocation with focus, indeterminate pronouns, etc.

Another possibility is to flatten the inner later of alternatives by using a choice function, as in (74). This option is pursued by Hagstrom (1998) and Kratzer & Shimoyama (2002), who in fact give the nearly equivalent formulation on the second line of (74).[25]

(74) $$\begin{aligned}\{\!\{\lambda^n\ X\}\!\} &:= \lambda i.\, \{\lambda x.\, f\,(\{\!\{X\}\!\}\, i^{n\to x}) \mid f \in \mathsf{CF}\}\\ &\approx \lambda i.\, \{P \mid \forall x : P\,x \in \{\!\{X\}\!\}\, i^{n\to x}\}\end{aligned}$$

With the inner layer of alternatives duly flattened by a choice function, the output of abstraction has the correct type. But the associated empirical predictions are problematic. Consider a structure like $[\lambda^0\ [t_0 \text{ met a linguist}]]$. According to (74), this receives

25 More precisely, the two formulations are equivalent if $\{\!\{X\}\!\}\, i^{n\to x}$ is non-empty, for every x. See footnote 24.

the interpretation on the left-hand side of (75) (ignoring assignment-relativity, which is idle here), which is in turn equivalent to the interpretation on the right-hand side, where we directly attach a *Skolemized* choice function to ling, the predicate contributed by the indefinite (where a Skolemized choice function is a function from a sequence of individuals into a choice function). This equivalence can be generalized as in (76).

(75) $\{\lambda x.f\,\{\mathsf{met}\,y\,x \mid \mathsf{ling}\,y\} \mid f \in \mathsf{CF}\} = \{\lambda x.\mathsf{met}\,(f_x\,\mathsf{ling})\,x \mid f \in \mathsf{SkCF}\}$

(76) $\{\lambda x.f\,\{g\,y\,x \mid h\,y\} \mid f \in \mathsf{CF}\} = \{\lambda x.g\,(f_x\,h)\,x \mid f \in \mathsf{SkCF}\}$

In other words, the abstraction operation in (74) has the effect of interpreting any indefinites in the scope of λ^n via an *obligatorily* Skolemized choice function!

This is problematic in two ways. First, (74) over-generates functional readings (as originally pointed by Shan (2004) for questions). There's a true member of (77) iff nobody met *every* phonologist — certainly not a possible reading of *nobody met a phonologist*. And there's a true member of (78) iff nobody submitted every paper she wrote (so just like properly choice-functional theories, the Binder Roof Constraint isn't derived).

(77) Nobody [λ^0 t_0 met a phonologist].
$\{\neg\exists x \in \mathsf{human} : \mathsf{met}\,(f_x\,\mathsf{phon})\,x \mid f \in \mathsf{SkCF}\}$

(78) Nobody [λ^0 t_0 submitted a paper she$_0$ had written].
$\{\neg\exists x \in \mathsf{human} : \mathsf{submitted}\,(f_x\,(\lambda y.\mathsf{paper}\,y \wedge \mathsf{wrote}\,x\,y))\,x \mid f \in \mathsf{SkCF}\}$

Second, (74) under-generates exceptional scope readings when an operator binds into an island with an indefinite (or, more generally, anything that creates alternatives). Because f_x, the Skolemized choice function used to interpret the island-bound indefinite in (79), varies with the island-external universal quantifier, the expert selected by f_x will also vary thusly. Thus, a widest-scope interpretation for the indefinite cannot be derived.

(79) Everybody [λ^0 t_0 loves it when [a famous expert on indefinites cites him$_0$].
$\{\forall x \in \mathsf{human} : \mathsf{loves.when}\,(\mathsf{cites}\,x\,(f_x\,\mathsf{exp})) \mid f \in \mathsf{SkCF}\}$

Poesio (1996) and Romero & Novel (2013) (cf. also Rooth 1985) propose swapping the layering of alternatives and assignment-sensitivity, such that $\{\!\{\cdot\}\!\}$ maps constituents into sets of assignment-dependent values, with the corresponding rule for binary-branching nodes in (80). This allows a standard abstraction operation to be defined as in (81).

(80) $\{\!\{A\ B\}\!\} := \{\lambda i.m\,i\,(n\,i) \mid m \in \{\!\{A\}\!\} \wedge n \in \{\!\{B\}\!\}\}$

(81) $\{\!\{\lambda^n\ X\}\!\} := \{\lambda i.\lambda x.f\,i^{n\to x} \mid f \in \{\!\{X\}\!\}\}$

While this approach improves on (74) for cases like (77) and (79), it is unclear how it might be extended to cases like (78). We must first settle on an interpretation for *a paper she$_0$ had written* of type $\mathsf{S}\,(\mathsf{i} \to \mathsf{e})$. Which set of assignment-relative individuals should this be, and how many assignment-relative individuals should it contain? The answer, it would seem, should depend on how *she$_0$* is understood: different individuals can write different numbers of papers, after all (cf. Shan 2004, Romero & Novel 2013, Charlow

2014). Paradoxically, though, the alternatives-over-assignments layering forces us to decide before we have seen the assignment — i.e., before we have fixed a value for *she*$_0$.

While is possible to side-step this issue by invoking choice functions as in (82) (Orin Percus, p.c.), treating bound-into indefinites as choice-functional incorrectly allows the bound-into indefinite to acquire a kind of scope over its binder (Section 6.4). Thus, the Binder Roof Constraint is ultimately not captured.[26]

(82) $⟦\text{a paper she}_0 \text{ had written}⟧ = \{\lambda i.\, f\,(\lambda x.\, \mathsf{paper}\, x \wedge \mathsf{wrote}\, x\, i_0) \mid f \in \mathsf{CF}\}$

type: $\mathsf{S}\,(\mathsf{i} \to \mathsf{e})$

Because the η-and-$\ggg$ approach uses a scopal mechanism rather than $⟦\cdot⟧$ to derive exceptional scope, standard mechanisms for abstraction and binding are immediately available (Section 6.2). Thus, we don't over-generate functional readings, under-generate exceptional-scope readings, or subvert the Binder Roof Constraint.

7 Conclusion

The paper has been long, but the conclusion will be brief. I hope to have convinced you that orienting a grammar around η and $\ggg$ contributes a lot to our understanding of the empirical properties of indefinites, as well as the grammar of alternatives. We've seen how these two functions, factored out of the post-Karttunen (1977) questions literature, could be repurposed and generalized to explain a wide range of data, from exceptional scope and selectivity to Binder Roofing. Because scope is at the heart of the account, the account improves on in situ theories of indefinites and/or alternatives, which try to achieve a simulacrum of wide scope for indefinites without bona fide scope mechanisms.

There were a number of issues I wasn't able to address here. First, my discussion of selectivity didn't touch on any of the arguments *for unselectivity* in alternative semantics (see, e.g., Kratzer & Shimoyama 2002, Krifka 2006, Beck 2006, Kotek & Erlewine 2016, among many others). I considered this choice justified, in part because my empirical remit was principally indefinites (for which selectivity is clear), and furthermore because there is no reason to suppose that this account of alternatives (for indefinites and indefiniteness) could not coexist alongside a $⟦\cdot⟧$-oriented account of some other empirical domain, within a single grammar. It should be emphasized, however, that the aforementioned theories generally assume that unselectivity is a fundamental, necessary property of any alternatives-based grammar that allows alternatives to expand beyond island boundaries. This paper has conclusively demonstrated that this isn't so.

Second, nondeterministic/relational semantic frameworks aren't the sole province of alternative semantics. Famously, *dynamic* treatments of indefiniteness (e.g., Bar-

26 Romero & Novel (2013) propose a solution using sets of *partial* functions from assignments to individuals (though their account is concerned primarily with *which*-questions, not indefinites). The basic idea would be to treat *a paper she*$_0$ *had written* as synonymous with *the paper she*$_0$ *had written identical to something* — i.e., with as many (partial) functions from assignments to individuals as there are in the domain e. Like (82) this approach is problematic from the point of view of the Binder Roof Constraint: if everybody collaborated on a paper x, $⟦\text{nobody } [\lambda^0\ t_0 \text{ submitted a paper she}_0 \text{ had helped write}]⟧$ will have a member that's true (relative to any assignment i) iff nobody submitted the paper she had helped write that's equal to x — i.e., iff nobody submitted x. But the sentence in question can only mean that nobody submitted any paper they helped write.

wise 1987, Groenendijk & Stokhof 1991, Dekker 1994, Muskens 1996) treat sentence meanings as relational (i.e., as relations on assignment functions), with indefinites once again functioning as the principal source of nondeterminism in the semantics. Moreover, dynamic semantics — just like alternative semantics — is motivated by a kind of exceptional scope phenomenon: the ability of indefinites to extend their binding scope indefinitely rightward. These theoretical and empirical considerations suggest that we are owed a unified alternative-dynamic-semantic perspective on indefiniteness. The approach developed in this paper can be generalized to give one (Charlow 2018).

Just one more thing. Back in Section 2.1, I noted that exceptional scope behavior was characteristic of a wide range of empirical phenomena, from presupposition and association with focus to supplementation and *wh* in situ. It is, then, tantalizing to notice that each of these domains can be theorized about in monadic terms — with an associated $\ggg\!=$ operation that (definitionally) obeys ASSOCIATIVITY. Once one starts to pursue this line, it becomes increasingly salient how piece-meal monadic accounts of different empirical domains might interact with each other in a single grammar. This is a topic of ongoing research.

A Building DPs

Though I have provided meanings for indefinite DPs (and the occasional quantificational DP), I have so far said nothing about how syntactically complex indefinites (and DPs more generally) are actually composed. This appendix fills that gap, providing meanings for determiners, showing how to derive denotations for syntactically complex DPs, and finally demonstrating how the treatment of exceptional scope advocated in this paper extends to indefinites embedded in relative clauses.

We begin with a couple meanings for determiners in (83) and (84). These functions take as an argument a function from individuals into assignment-relative sets of alternative propositions — the denotation of the restrictor NP. The indefinite determiner's meaning returns a set of individuals satisfying its restrictor (appealing to the closure operator $\lightning_i$), while the universal determiner's meaning quantifies over the individuals satifying its restrictor, requiring each of them to also satisfy its nuclear scope.

(83) $\mathbf{a}\, f \coloneqq \lambda i.\, \{x \mid (f\,x)^{\lightning_i}\}$ $\qquad\qquad \mathbf{a} : (\mathsf{e} \to \mathsf{S_i\, t}) \to \mathsf{S_i\, e}$

(84) $\mathbf{every}\, f\, g \coloneqq \lambda i.\, \{\mathsf{every}\,(\lambda x.\,(f\,x)^{\lightning_i})\,(\lambda x.\,(g\,x)^{\lightning_i})\}$
$\qquad\qquad \mathbf{every} : (\mathsf{e} \to \mathsf{S_i\, t}) \to (\mathsf{e} \to \mathsf{S_i\, t}) \to \mathsf{S_i\, t}$

Using these entries, simple cases of DP composition like *a linguist* or *every farmer* can be derived by scoping the determiner (cf., e.g., Heim 1982, Barker 1995) and applying η, as for example in (85). This derives an assignment-relative set of individuals (the sort of meaning we had been taking as primitive up to now).

(85) $\mathbf{a}\,(\lambda x.\,\eta\,(\mathsf{ling}\,x)) = \lambda i.\,\{x \mid \mathsf{ling}\,x\}$ $\qquad\qquad$ type: $\mathsf{S_i\, e}$

To compose up meanings for DPs with relative clauses, we require denotations for relative clause gaps, as well as a meaning for relative pronouns. These are provided in (86) and (87). The treatment of gaps as akin to pronominal elements is standard. The relative pronoun's meaning — somewhat less standard — conjoins two assignment-relative sets of propositions to yield a third.[27]

(86) $\textbf{gap}_\mathbf{0} \coloneqq \lambda i.\,\{i_0\}$ $\qquad\qquad$ $\textbf{gap}_\mathbf{0} : \mathsf{S_i\,e}$

(87) $\textbf{that}\,r\,l \coloneqq \lambda i.\,\{p \wedge q \mid p \in l\,i \wedge q \in r\,i\}$ $\qquad\qquad$ $\textbf{that} : \mathsf{S_i\,t} \to \mathsf{S_i\,t} \to \mathsf{S_i\,t}$

I emphasize that within the present system, a variety of possibilities is available for composing up complex NPs with relative clauses, all with broadly similar coverage. The specific proposal given here is intended mostly as a proof of concept to show that there are no deep problems lurking in this vicinity, and to provide a basis for showing how exceptional scope out of relative clauses is derived.

These pieces in place, we offer derivations of two complex DPs with relative clauses in Figure 15. On the left, we derive a meaning for *every linguist that John likes.* On the right, we offer a somewhat abbreviated derivation of *a paper (that) she*$_0$ *had written.* Notably, both derivations use an 'NP-S' syntax for the DP — i.e., the determiner and the head noun form a constituent to the exclusion of the relative clause (as argued for by Bach & Cooper 1978), out of which the determiner meaning scopes.[28]

Let's focus first on the derivation of *every linguist that John likes* (Figure 15, left). As in (85), the determiner take scope over the DP (with an application of η in its wake). Inside the relative clause, the gap takes scope as well via $\ggcurly$ (cf. Figure 12, page 28). An application of β^0 to the scope of **every** binds the relative clause gap, ultimately yielding a universal quantifier over linguists John likes.

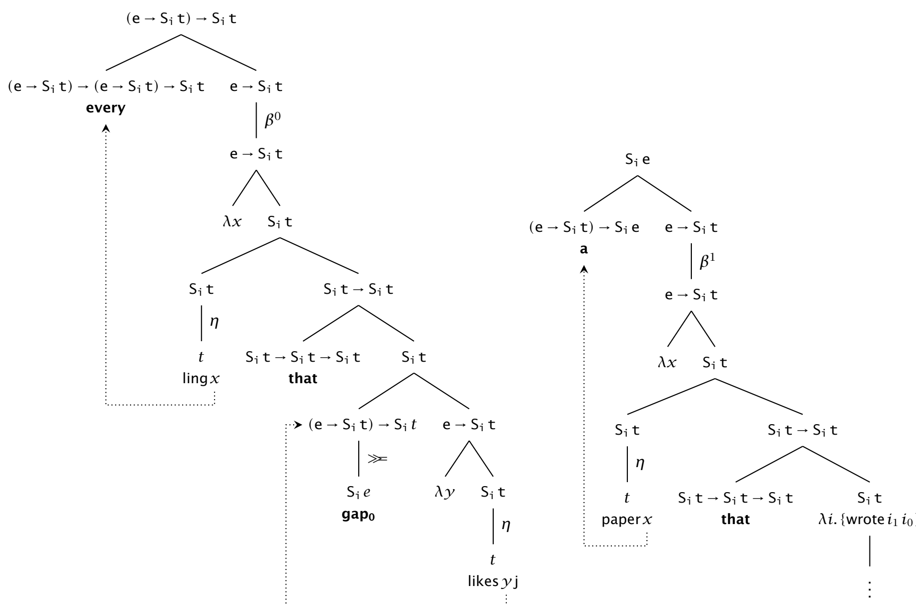
The derivation of *a paper (that) she*$_0$ *wrote* (Figure 15, right) is similar (though some of the details are omitted). As with the universal case, the determiner takes scope out of the NP and over the DP. Within the relative clause, $\textbf{she}_\mathbf{0}$ and $\textbf{gap}_\mathbf{1}$ both take scope via $\ggcurly$ (they can be scoped in any order). An application of β^1 binds the relative clause gap, and the derivation concludes with the expected meaning.

Finally, exceptional scope out of relative clauses — for example in constructions like *I gave As to every student who cited a famous expert on indefinites* — can be generated using higher-order meanings, analogously to examples like (51) (with an indefinite and bound pronoun on an island). We begin by building up a higher-order meaning for the relative clause island, invoking an extra η between the indefinite and the gap:

(88) $\textbf{an.exp} \ggcurly \lambda x.\,\eta\,(\textbf{gap}_\mathbf{0} \ggcurly \lambda y.\,\eta\,(\mathsf{cited}\,x\,y)) = \lambda i.\,\{\lambda j.\,\{\mathsf{cited}\,x\,j_0\} \mid \mathsf{exp}\,x\}$
type: $\mathsf{S_i\,(S_i\,t)}$

27 It would also be possible to take the meaning of relative pronouns to be simple boolean conjunction, type $\mathsf{t} \to \mathsf{t}, \to \mathsf{t}$, and then derive the effect of **that** indirectly via η, $\ggcurly$, and scope (Charlow 2014: 84). This option, though viable, results in more complicated derivations, and so I forego it here.

28 The NP-S syntax is negotiable, given other entries for gaps and relative pronouns. It isn't ridiculous, though, to imagine that the determiner could take scope in this way. For example, inverse linking — e.g., the $\forall \gg \exists$ reading of *a member of every department came to the meeting* — require a similar kind of scoping, from inside a nominal constituent, to the DP's edge (May 1985). Secondly, scope-taking of the determiner leaves a propositionally-typed meaning in its wake, as required for the $\mathsf{no} \gg \exists$ reading of *no owner of an expresso machine drinks tea* (cf. Heim & Kratzer 1998: 229).



$= \lambda f.\lambda i.\{\forall x \in \{x \mid \text{ling}\, x \wedge \text{likes}\, x\, \text{j}\} : \mathbb{T} \in f\, x\, i\}$ $\qquad = \lambda i.\{x \mid \text{paper}\, x \wedge \text{wrote}\, x\, i_0\}$

Figure 15: Composing up DPs with relative clauses, using an 'NP-S' constituency (à la Bach & Cooper 1978). The quantificational determiner takes scope over the entire DP, and β^0 applies to its scope, binding the relative clause gap.

If this higher-order meaning is pied-piped up and over **every**, the inner-layer effects (assignment-sensitivity for the gap) will reconstruct back to within the determiner's scope (where they can be bound by a β-operator), while the outer-layer effects (the alternatives contributed by the indefinite) will be interpreted in the scope position of the pied-piped island. Exceptional scope out of relative clauses is thereby derived.

B On intensionalization and pied piping

The theory up to now has been stated within a purely extensional system. This appendix shows one way to bring intensionality into the mix, and goes on to argue that the semantic problems traditionally associated with scopal pied-piping (see, e.g., von Stechow 1996) do not apply to the present theory (which crucially relies on scopal pied-piping).

In extensional systems, the propositional type $\mathtt{t}$ is identified with the domain of truth values $\{\mathbb{T}, \mathbb{F}\}$. A simple way to go intensional is to upgrade $\mathtt{t}$, first by generalizing $\mathtt{i}$ to the type of *indices* (i.e., tuples of worlds, times, assignments, and so forth, à la Lewis 1981), and then re-defining $\mathtt{t}$ as the type of functions from indices to $\{\mathbb{T}, \mathbb{F}\}$:

(89) $\mathtt{t} ::= \mathtt{i} \to \{\mathbb{T}, \mathbb{F}\}$

Given this shift, the meanings of expressions like $\ulcorner \mathsf{met}\, x\, y \urcorner$ can now be regarded as intensional. While $\ulcorner \mathsf{met}\, x\, y \urcorner$ doesn't wear its intensionality on its sleeve, we can remedy this by applying a routine λ-theoretic equivalence: $\mathsf{met}\, x\, y \equiv \lambda i.\, \mathsf{met}\, x\, y\, i$.

Intensionalization has ramifications downstream. For example, our closure operators will need to be massaged somewhat. The definition in (90) extracts the propositional content from an assignment-relative set of alternatives m, by returning the set of indices i relative to which some member of m is true.

(90) $m^{\lightning} := \lambda i.\, \exists p \in m\, i : p\, i$ $\qquad (\lightning) : \mathsf{S_i}\, \mathtt{t} \to \mathtt{t}$

Determiner meanings can be intensionalized along similar lines, as in (91). The result for a simple DP like *a linguist*, in (92), is similar to the result we've been happily using thus far, with one key difference: the linguists contained in the resulting set are now determined by the index of evaluation i (presumably, ling will be sensitive to the world and time components of i).

(91) $\mathbf{a}\, f := \lambda i.\, \{x \mid (f\, x)^{\lightning}\, i\}$ $\qquad \mathbf{a} : (\mathsf{e} \to \mathsf{S_i}\, \mathtt{t}) \to \mathsf{S_i}\, \mathsf{e}$

(92) $\mathbf{a}\, (\lambda x.\, \eta\, (\mathsf{ling}\, x)) = \lambda i.\, \{x \mid \mathsf{ling}\, x\, i\}$ $\qquad$ type: $\mathsf{S_i}\, \mathsf{e}$

The remaining lexical entries (**every**, **if**, and **that**) can be upgraded in analogous ways. I leave this as an exercise. Importantly, the underlying combinatorial apparatus (η and $\gg\!=$) is unchanged (other than the generalized conception of what, exactly, lives in type $\mathtt{i}$).

Now, scopal pied-piping, used extensively in this paper, has been criticized on the grounds that it forces too much of the pied-piped material to be interpreted in the scope position of the pied-piped phrase. E.g., von Stechow (1996) argues that scopal pied-piping must be accompanied by partial syntactic reconstruction in order to yield acceptable results. As emphasized by Dayal (2016: 203), stipulating partial reconstruction robs scopal pied-piping of much of its explanatory force — reconstruct enough of the island, and you might as well have just scoped the exceptional scope-taker out directly.

Standard criticisms of scopal pied-piping don't apply to the present account. With intensionality factored in, consider the schematic derivation in (93). As the equivalence indicates, for each relative x at index i, the scope argument f is fed $\mathsf{dies}\,x$ — essentially, a proposition amounting to everything on the island, with the indefinite's indefiniteness factored out. In other words, a form of partial (semantic) reconstruction is *automatic* in the semantics, and needn't be separately stipulated.[29]

(93) $(\lambda i.\,\{\mathsf{dies}\,x \mid \mathsf{rel}\,x\,i\}) \ggg f = \lambda i.\,\bigcup_{\mathsf{rel}\,x\,i} f\,(\mathsf{dies}\,x)$

Additionally, we've already seen that, when multiple indefinites or pronouns live on an island, we're able to generate higher-order meanings for the island which allow us to exert a fine degree of control over which of these elements is ultimately evaluated where. In particular, pied-piping an island to derive an exceptional-scope reading need not force any other pronouns or indefinites on the island to be interpreted in the pied-piped island's scope position. All of this is accomplished without special stipulations about reconstruction or, indeed, anything beyond our basic lexical entries, η, and $\ggg$.

29 Sternefeld (2001a) and Cable (2010) propose accounts of pied-piping using alternative semantics to project alternatives to the edge of a pied-pied phrase, where a choice function selects one of them. As Sternefeld (2001a: 482) himself notes, however, because this proposal relies on alternative semantics, it is committed to unselectivity for multiple island-dwelling alternative generators. Moreover, the use of a choice function to interpret the pied-piped phrase would cause us to run afoul of the Binder Roof Constraint (Section 6.4).

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