# Semantics with assignment variables*

Alex Silk • a.silk@bham.ac.uk

Draft of April 2018

**Abstract**

This paper develops a framework for compositional semantics, and begins illustrating its fruitfulness by applying it to certain core linguistic data. The key move is to introduce variables for assignment functions into the syntax; semantic values are treated systematically in terms of sets of assignments. Assignments are theoretically interpreted as representing possibilities in the model. The framework provides an alternative to traditional "context-index"-style frameworks descending from Kamp/Kaplan/Lewis/Stalnaker. A principal feature of the account is that it systematizes a range of seemingly disparate linguistic "shifting" phenomena, such as with quantifiers, intensionality, and context-sensitivity under modals and attitude verbs. The treatment of the syntax/semantics provides an elegant standardization of quantification across domains (individuals, worlds, assignments), via a generalized (type-flexible, cross-categorial) binder-index resulting from type-driven movement. The account affords a unified analysis of the context-sensitivity of expressions such as pronouns, epistemic modals, etc., in the spirit of contextualist theories, while compositionally deriving certain recalcitrant shifting/binding phenomena and providing a framework for theorizing about differences in tendencies for local/global readings.

Extensions to questions, conditionals, and relative clauses are explored. I show how certain independently motivated syntactic analyses can be implemented in the foregoing assignment variable framework. Restrictive relative clauses are treated as complements of the matrix determiner, which introduces quantification over assignments. 'If'-clauses are treated as free relatives/correlatives, interpreted as plural definite descriptions of possibilities.

*Thanks to the audience and commentators Dilip Ninan and Brian Rabern at the 2018 Pacific APA symposium session, and to Ivano Caponigro, Salvatore Florio, Daniel Rothschild, and Ede Zimmermann for discussion.

Interrogative sentences denote a set of possible answers, conceived as sets of possibilities. Additional shifting data are compositionally derived, e.g. concerning "interrogative flip," information-sensitivity, indexical shift, and donkey anaphora. Speculative applications to weak crossover are briefly considered. The account affords a uniform compositional semantics for 'if'-clauses in diverse conditional constructions (adjoined to NP/VP/IP/CP, with/without a main clause modal or proform), and a unified approach to the syntax/semantics of interrogatives, conditionals, and relativization. The semantics avoids introducing added interpretive principles or composition rules such as for quantification, binding, movement (e.g. Predicate Abstraction, Predicate Modification, Trace Conversion). The semantics is fully compositional.†

## Contents



†Short version: A very long formal footnote to Stalnaker 1988.

This paper develops a framework for compositional semantics, and begins illustrating its fruitfulness by applying it to certain core linguistic data. The key move is to posit variables for assignment functions in the syntax; semantic values are treated systematically in terms of functions from assignments, now included in the model. The core data to be considered involve a spectrum of linguistic "shifting" phenomena, such as with quantifiers, intensionality, and context-sensitivity under modals and attitude verbs. Extensions to questions, conditionals, relative clauses, and various types of pronominal anaphora such as donkey anaphora are provided. The proposed assignment-variable-based theory provides an elegant standardization of quantification across domains (individuals, worlds, assignments), and a unified treatment of shifting phenomena in natural language.

## 1 Introduction

An overview of the account's theoretical context and key features is as follows.

Following Stalnaker (1970), Kamp (1971), Lewis (1980), and Kaplan (1989), a standard move in formal semantics is to treat expressions as interpreted with respect to two general parameters: to a first approximation, a context $c$ which takes expressions to intensions, and circumstance $i$ which takes intensions to extensions. To handle (e.g.) quantification and free/bound pronouns, the context parameter may be treated as an assignment function $g_c$, mapping typed numerical indices $\langle n, \tau \rangle$ (abbreviated: $n\tau$) to items in the model.[1] Nuances aside, the interpretation function returns Truth for a sentence such as $S$ = 'It$_7$ laughed', $[\![S]\!]^{g_c,i} = 1$, iff such-and-such individual relevant in $c$, $g_c(7e)$, laughed in the circumstance $i$, where 7 is an arbitrary index for the free pronoun (type $e$ for individuals):

(1) a. LF: [ It$_7$ laughed ]
b. $[\![(1a)]\!]^{g_c,i} = 1$ iff $g_c(7e)$ laughed in $i$

A trend in linguistic semantics has been to incorporate various parameters of interpretation as elements of the model, and to posit linguistic reference to these elements via covert variables.[2] For instance, verbs may be treated as denoting sets of events; modals may be treated as binding world pronouns; tenses may be treated as

[1] For discussion of differences among single-/double-indexing variants of the views, see Lewis 1980. Some authors distinguish the coordinates $c$ and $g_c$, reserving $c$ for specific features of discourse contexts such as speaker, addressee, world, etc. Given our purposes I simplify by identifying the context coordinate with the contextually determined assignment.

[2] E.g., Partee 1973, Cresswell 1990, Percus 2000, Schlenker 2003, Büring 2004, Hacquard 2006, 2010; for general discussion see Schlenker 2006.

pronouns referring to times. Compositional details aside, and bracketing tense and aspect, the interpretation function, now $[\![\cdot]\!]^{g_c}$, may return a semantic value for $S$ as in (2) (type $s$ for worlds; world-variable left free).

(2) a. LF: [ $\text{It}_7$ [ laughed $\mathbf{w}_3$ ]]
b. $[\![(2a)]\!]^{g_c} = 1$ iff $g_c(7e)$ laughed in $g_c(3s)$

A natural question at this stage is whether there might also be object-language reference or variables with *assignments*. Indeed, diverse linguistic data involving quantifiers have led some theorists to introduce a semantic type for assignments (Janssen 1997, Sternefeld 1998, Kobele 2010, Rabern 2012, Kennedy 2014). The aim of this paper is to begin exploring the prospects for a linguistic framework that goes the further step of positing variables for assignments in the syntax; semantic values are treated systematically in terms of sets of assignments, now also included in the model.

One way of understanding the assignment-variable-based approach is as formally implementing Stalnaker's (1988, 2014) seminal "multiple context" treatment of attitude ascriptions (cf. Swanson 2011). On Stalnaker's view, there are multiple contexts "available to be exploited" (1988: 156) in describing individuals' states of mind — the "basic" ("global") discourse context, and a "derived" ("local," subordinate) context representing the subject's attitude state. In (3), whereas the discourse context $c_1$ supplies the interpretation of the embedded demonstrative 'that woman', the derived context $c_2$ representing (what is presupposed to be) Tom's beliefs is also available for interpreting the embedded change-of-state verb. In the case of "Russell's notorious yacht" (Stalnaker 1988: 158–159) in (4), the intuitive idea is that whereas the second 'it' is interpreted in the discourse context, the first 'it' is interpreted in the context representing (what is presupposed to be) Phoebe's beliefs; hence the belief being ascribed isn't necessarily false. In some cases either the discourse context or derived context may be available for interpreting an expression, as reflected informally in (5).

(3) [Context: It's presupposed that Sue, the woman being demonstrated in the discourse context $c_1$, never smoked.]
Tom believes that [that woman]$^{c_1}$ has quit$^{c_2}$ smoking.
a. ≈ Tom believes that Sue used to smoke and no longer smokes
(Swanson 2011: cf. ex. 31)

(4) Phoebe believes it$^{c_2}$ is longer than it$^{c_1}$ is. (cf. Stalnaker 1988: 158–159)

(5) [Context: We're talking about Bert. ($s_{c_1}$ represents the standard for counting

as rich accepted in the discourse; $s_{c_2}$ represents (what is presupposed to be) Alice's standard for counting as rich.)]

Alice believes that he$^{c_1}$ is rich$^{c_1/c_2}$.

a. ≈ Alice believes that Bert is $s_{c_1}/s_{c_2}$-wealthy

(cf. Silk 2016: 165–166, 2017: 1787–1788)

Stalnaker doesn't offer specific technical implementations of these ideas (nor does Swanson). One might attempt a pragmatic explanation of the shifts in interpretation, perhaps drawing on general pragmatic accounts of local context (cf. Schlenker 2009, 2010). One might treat attitude verbs as context-shifting operators, and posit mechanisms for capturing the different ways shifting can occur within a single clause (cf. Cumming 2008, Santorio 2010, 2012, Ninan 2012). A natural alternative is to posit variables for the different "contexts." Roughly put, in (say) an attitude ascription, a context-sensitive expression receiving an intuitively global reading would combine with a (context-)variable representing the discourse, and a context-sensitive expression receiving an intuitively shifted reading would combine with a (context-)variable representing the attitude state. The "multiple contexts" with respect to which context-sensitive expressions may be interpreted are represented via object-language variables for assignments.

Although there are precedents for introducing variables for items interpreting referential expressions under attitude verbs (Percus & Sauerland 2003, Charlow & Sharvit 2014), the project of developing an account with object-language variables for assignment functions — variables for the sort of item responsible for interpreting context-sensitive language generally — hasn't been pursued. Indeed, puzzles of referential expressions in attitude ascriptions can be understood as instances of general phenomena of (what I call) *local* and *global* readings of context-sensitive expressions. Recent contextualism/relativism/expressivism debates have focused on embedding contrasts between epistemic modals (predicates of personal taste, etc.), and paradigm context-sensitive expressions such as pronouns which receive their interpretation from the basic context: whereas 'might' in (7) characterizes the subject's information, 'she' in (6) is infelicitous if its gender implication isn't accepted in the discourse.[3]

(6) #Al$_i$ thinks Bert$_j$ is a woman. He$_i$ thinks she$_j$ is smart.

a. ≉Al thinks $g(j)$ is a woman and is smart. (*global reading obligatory*)

[3]See Silk 2016, 2017 and Sudo 2012, respectively, for discussion of potential counterexamples. We will return to this.

(7) Alice thinks it might be raining.

a. #Alice thinks the information in the discourse context is compatible with its raining.

(*local reading obligatory*)

Yet most context-sensitive expressions fall somewhere in the middle regarding their tendencies for local/global readings — e.g., with gradable adjectives and degree standards, additives and implications of alternatives, quantifiers and domain restrictions, perspectival expressions and perspectives, etc. (Silk 2014a, 2016).

(8) *Bob:* Pete thinks Al is at a local bar.

a. ≈ Pete thinks Al is at a bar local to Bob (*global reading*)

b. ≈ Pete thinks Al is at a bar local to Pete (*local reading*)

(9) Beth thinks Chip smokes too.

a. [Context: We're talking about various of our colleagues C who smoke. We know Beth is good friends with Chip; we know nothing about her views on any of our other colleagues' habits.]

≈ People other than Chip in C smoke and Beth thinks Chip smokes.

(*global reading*)

b. [Context: We're talking about Beth; we know she is convinced that various of our colleagues smoke. We know none of our colleagues smoke.]

≈ Beth thinks that Chip along with other of our colleagues smoke.

(*local reading*)

(10) Alice thinks everyone can vote.

a. [Context: We're considering Alice's beliefs about the legal status of certain minority groups G, which we think are relevant in questions about voting rights; we know nothing about Alice's own moral/legal views.]

≈ Alice thinks everyone in G is legally permitted to vote.

(*global reading*)

b. [Context: We're considering Alice's moral/legal views; we know she is aware that certain minority groups aren't legally permitted to vote.]

≈ Alice thinks everyone in the groups she considers relevant to questions about voting rights is legally permitted to vote.

(*local reading*)

Mechanisms for capturing the varieties of shifting phenomena — as involving

quantifiers, modals/attitude ascriptions, indexical shift, local/global readings — have grown increasingly complex in current "context-index"-style frameworks. Adding assignment variables to the object-language is far from trivial. Yet I'll show how an account with assignment variables can provide a unified treatment of various linguistic shifting phenomena via an elegant standardization of quantification. Key features of the proposed account are as follows:

- **standardizes quantification**, as over individuals, worlds, assignments
  - provides a **general (type-flexible) definition for a binder-index** to combine with quantifiers, attitude verbs, modals, etc.
- provides **compositional, non-syncategorematic** treatments of quantification and relativization
- posits **no added parameters of interpretation**
- **unifies seemingly disparate shifting phenomena** — ordinary quantification, intensionality, local/global readings, linguistic anaphora — and captures them via familiar mechanisms of quantifier movement and variable binding
- offers a **unified analysis of the context-sensitivity** of epistemic modals, pronouns, etc., in the spirit of contextualist theories; yet improves in compositionally deriving certain distinctive shifting/binding phenomena (e.g. with epistemic modals), and providing a framework for theorizing about **differences in tendencies for local/global readings**

Though detailed theory comparison would be premature at this stage, features such as these should make the project of interest to ongoing work on topics such as quantification, modality, and context-sensitivity. The specific account to be developed of course isn't the only way of implementing a syntax/semantics with object-language assignment variables. There will be various choice points, many of them unforced, along the way. I leave additional applications, development of alternative implementations, and comparisons with existing frameworks for future research.

An overview of the paper is as follows: §2 introduces principal elements of the basic syntax/semantics. §3 motives a more complex clausal architecture by examining how an assignment-variable-based theory can be integrated into independently motivated treatments of the syntax-semantics interface. The resulting account captures intensionality and local/global interpretations of context-sensitive expressions via general mechanisms of movement and variable binding, and it affords an elegant standardization of quantification. A definition for a generalized binder index,

which attaches directly to moved expressions, is provided; the semantics is fully compositional. §4 illustrates compositional derivations of various examples involving quantifiers, attitude ascriptions, and modals using the syntax/semantics from §3. Working through these examples will afford opportunities for examining issues regarding quantification in the metalanguage, binding with pronouns vs. traces, and (non-)conventionalized locality/globality principles for constraining readings. An improved formalization of assignment modification captures binding relations in derivations with long-distance binding. §5 recaps the main developments thus far.

§§6–8 explore how an assignment-variable-based framework might be extended to other complex constructions — in particular, relative clauses (§6), conditionals (§7), and interrogatives (§8). I examine how certain independently motivated syntactic analyses can be implemented in the assignment-variable-based framework and treatment of the syntax/semantics interface from §§3–4. Headed restrictive relative clauses are treated as complements of the matrix determiner, which introduces quantification over assignments (§6). 'If'-clauses are treated as free relatives/correlatives, interpreted as plural definite descriptions of assignments (§7). Interrogative sentences denote a set of possible answers, with answers conceived as sets of assignments (possibilities) (§8). Derivations of various additional linguistic shifting phenomena are provided, as concerning local readings in questions and conditionals, information-sensitivity, and donkey anaphora. Applications to binding phenomena with pronouns, including inverse linking, genitive binding, and weak crossover effects, are also considered. Certain features of the treatments of questions, conditionals, and relativization in these sections are of general interest, independent of the particular assignment-variable-based implementation — e.g., a distinction between trace-binding and pronoun-binding, with potential applications to crossover; an analysis of various types of apparent binding out of DPs such as donkey anaphora. a formalization of "interrogative flip" in questions; with conditionals, derivations of apparent single- vs. double-modal readings, indexical shift, conditional questions, and shifting with adnominal conditionals and sentence-initial and sentence-final 'if'-clauses; compositional treatments of relativization and interrogatives which avoid additional composition rules or interpretive principles (Predicate Abstraction, Predicate Modification, Trace Conversion); a unified analysis of *wh*-words, relative determiners, and (at least some) indefinites; and a unified approach to the syntax/semantics of conditional, correlative, and interrogative clauses.

Before getting started, a preliminary methodological remark: The project in this paper isn't to provide a possibility proof; the question isn't whether it is possible to construct a formal syntax/semantics with object-language assignment-variables. I would be surprised if it wasn't. The project is to examine the specific prospects for a

syntax/semantics of natural language developed along these lines so as to provide a concrete basis for overall theory comparison. Taking on this more demanding goal will require sustained investigation into a variety of linguistic phenomena. One must ensure that particular choice points and analyses generalize across the spectrum of examples, and can be systematized into an overall account that plausibly rivals accounts in traditional frameworks (or an operator-based account introducing assignments simply into the model); the devil is in the details (lambdas, trees). It will be critical to motivate particular syntactic implementations and apply the account to diverse expressions and constructions. I ask for the reader's patience along the way. I hope the preliminary developments in this paper may illustrate the fruitfulness of an assignment-variable-based framework for linguistic theorizing and provide a more adequate basis for future theory comparison.

## 2 Basics

### 2.1 Formal overview: Semantic values, models, domains, assignments, composition

I begin with core elements of the basic syntax/semantics.

Rather than having a traditional interpretation function $(\llbracket\cdot\rrbracket^g)_{g\in G}$ parameterized by assignments (worlds, etc.), we have an **unrelativized interpretation function** $\llbracket\cdot\rrbracket$, which assigns expressions semantic values in terms of sets of assignments in the model. (I'll ignore tense/aspect and times/events.)

(11) **Models** $\mathcal{M}$:
- $E$: set of entities
- $T$: set of truth-values, $\{0, 1\}$
- $W$: set of worlds
- $G$: set of assignments

Theoretically, I treat assignments as representing a **possibility**. This interpretation is in keeping with common talk of "contextually determined" assignments representing what world is actual, objects' relative saliences, speakers' intentions, attention, etc. (Heim & Kratzer 1998, Schlenker 2003, Heim 2008). For instance, a syntactic representation $\mathbf{it}_7$ and assignment mapping $\langle 7, e\rangle$ to Fluffy might represent an intention to refer to Fluffy with a token use of 'it' and a possibility in which Fluffy is the center of attention.

It's common to identify basic semantic types with sets in the model. Since all expressions' semantic values will be treated as involving functions from assignments, it will simplify our formalism to define semantic types in terms of such functions

(cf. Kobele 2010; contrast Sternefeld 1998). Functions from assignments to truth-values in $T$ become type $t$, functions from assignments to entities in $E$ become type $e$, etc.

Care must be taken in our formalization of assignments and the set of semantic types. Including assignment variables and variables of arbitrary types has the potential for paradoxes or non-wellfoundedness (cf. Groenendijk & Stokhof 1990, 1991; for discussion see Chierchia 1994). For instance, one cannot have a case where $g(i) = g$, for some assignment-index $i$, lest there be assignments $g$ in their own codomain. Likewise, we cannot allow ourselves to ask whether an assignment $g$ is in the value assigned to an index $k$ for a set of assignments, i.e. whether $g \in g(k)$: given that functions are sets of ordered pairs, having a case where $\langle k, S\rangle \in g \wedge g \in S$, for some set of assignments $S$, would violate standard set-theoretic bans on $\in$-chains.

Let the **set of assignments** $G$ in the model be a set of ordinary assignments $h$ — functions from typed numerical indices $\langle n, \tau\rangle$, for any non-assignment type $\tau$, to elements of the model. For instance, $h(\langle 4, e\rangle)$ returns an entity $o \in E$, say Fluffy; $h(\langle 4, et\rangle)$ returns (the characteristic function of) a set of entities in $E$, say {Fluffy, Fido}; and so on. Ordinary assignments $h \in G$ are undefined for indices for assignments or functions involving assignments. I let the **domain of assignments** $D_g$ be a set of assignments whose domain also includes indices $\langle n, a\rangle$ for assignments — i.e., where $dom(g) = dom(h) \cup \{\langle n, a\rangle : n \in \mathbb{N}\}$, and $range(g) = range(h) \cup G$. For instance, for some $g \in D_g$, $g(\langle 2, a\rangle)$ is an ordinary assignment $h \in G$; $g(\langle 2, e\rangle)$ is an entity $o \in E$, say Fido; and so on. (For purposes of the present exposition, I refer to ordinary assignments $h \in G$ as "assignments$_M$" (for assignments in the Model), and to the richer assignments $g \in D_g$ as "assignments$_D$" (for assignments in the Domain). When the distinction is irrelevant I ignore the subscripting; context should disambiguate elsewhere. For readability I often abbreviate indices $\langle i, \alpha\rangle$ with $i\alpha$, e.g. $g(1e)$.)

Our system avoids the worries mentioned above regarding non-wellfoundedness and $\in$-chains. Since assignments$_D$ $g_g$ return elements *in the model*, there is no case of an assignment being in its own codomain. For $h \in G$, $h(\mathrm{i}a)$ is undefined; and for $g \in D_g$, $g(\mathrm{i}a) = h_j \neq g$. Since there are no high type assignment indices in the domain of assignments in $D_g$ (or $G$), expressions such as $h(\mathrm{i}at)$, $g(\mathrm{i}at)$, $g(\mathrm{i}a)(\mathrm{i}at)$, etc. are undefined. Such a restriction in assignments' domains is motivated by our posited theoretical role for assignment-variables as an object-language mechanism for tracking the interpretation of context-sensitive expressions; yet the assumption that there are no pronouns for sets of assignments is ultimately an empirical one.

So, our semantic types are as follows, where the set of assignments$_M$ $G$ and domain of assignments$_D$ $D_g$ are defined as above — i.e. where the inputs of assignments$_M$

$h \in G$ are (non-assignment-)indices $\langle n, \tau \rangle$ for $\tau \neq g, a, \langle \ldots g/a \ldots \rangle$, and the inputs of assignments$_D$ $g \in D_g$ are indices $\langle n, \sigma \rangle$ for $\sigma \neq g, \langle \ldots g/a \ldots \rangle$. (Although the formalization of assignments excludes pronouns for functions involving assignments, there may be other expressions of type $\langle a, t \rangle$, etc.; more on this below.)[4]

(12) **Domains / Semantic types:**

- $D_g$ = domain of assignments$_D$
- $D_e = E^{D_g}$
- $D_t = \{0, 1\}^{D_g}$
- $D_s = W^{D_g}$
- $D_a = G^{D_g}$
- $D_{\alpha\beta} = D_\beta^{D_\alpha}$

Unlike previous accounts introducing semantic types for assignments (§1), I let the object-language include **variables for assignments**. A natural preliminary idea would be to identify variable denotations with functions from assignments to elements in the model — e.g., treating the denotation of an individual-variable $[\![\mathbf{o_i}]\!]$ as $\lambda g_g.g(\mathrm{i}e)$, where $g(\mathrm{i}e) \in E$.[5] Such a move is unavailable in the system as developed thus far. For instance, an assignment-variable denotation (function $a : D_g \to G$) couldn't combine via (say) ordinary function application or function composition with functions $x : D_g \to E$ (individual-variable denotation), $p : D_g \to 2^W$ (proposition-variable denotation), etc.

As one way of allowing for variables of complex types, I treat non-assignment variables as having an initial argument of type $a$, and I treat semantic composition as proceeding via **function application**. Variables $\mathbf{v}_{\mathbf{i}\alpha}$ for basic non-assignment types $\alpha$ denote functions $[\![\mathbf{v}_{\mathbf{i}\alpha}]\!] \in D_{a\alpha}$ such that for any $a_a$, $g_g$, $[\![\mathbf{v}_{\mathbf{i}\alpha}]\!](a)(g) = a(g)(\mathrm{i}\alpha)$ — e.g., $[\![\mathbf{o}_1\ \mathbf{g}_1]\!] = [\![\mathbf{o}_1]\!]([\![\mathbf{g}_1]\!]) = \lambda g_g.g(1a)(1e)$. Variables of complex types may be defined via a metalanguage "down"-style operator $^\downarrow$ which maps an element of a domain to an item composed out of associated lowered elements of the model:

(13) For $\gamma$ of (possibly basic) type $\sigma = \langle \sigma_n, \langle \ldots, \sigma_0 \rangle \cdots \rangle$, $^\downarrow\gamma$ is defined by the condition that, for any $g_g$:
$(^\downarrow\gamma)(g)$ = the (possibly nullary) function $f \in \mathcal{M}$ s.t. for any $\gamma^n_{\sigma_n} \ldots \gamma^1_{\sigma_1}$,

[4] Thanks to Salvatore Florio, Dilip Ninan, and Ede Zimmermann for discussion.

[5] I use bold and single quotes for object-language expressions; I'll continue to use bold also in highlighting key points. I use $\mathbf{g_i}$ for assignment variables, $\mathbf{w_i}$ for world variables, and $\mathbf{o_i}$ for individual variables. I continue to use $h, h', \ldots$ for "ordinary" assignments$_M$ in $G$ in the model, and $g, g', \ldots$ for assignments$_D$ of type $g$ in $D_g$.

$$\gamma(\gamma^n)\dots(\gamma^1)(g) = f((^{\downarrow}\gamma^n)(g))\dots((^{\downarrow}\gamma^1)(g))$$

For the degenerate case where $\gamma_\beta$ is of basic type $\beta \in \{e, s, t, a\}$, $^{\downarrow}\gamma$ is a function from an assignment$_D$ $g_g$ to the item in the model that is the image under $\gamma$ of $g$. For instance, for $x \in D_e$, $(^{\downarrow}x)(g)$ is the individual (nullary function) $o \in E$ s.t. $o = x(g)$, i.e. $(^{\downarrow}x)(g) = x(g)$. For $P \in D_{\langle e,t\rangle}$, $(^{\downarrow}P)(g)$ is the function $f{:}E \to T$ such that for any $x_e$, $P(x)(g) = f((^{\downarrow}x)(g)) = f(x(g))$; and so on. The denotations of $\mathbf{v}_{\mathrm{i}\sigma}$ of complex types $\sigma = \langle\sigma_n, \langle\dots,\sigma_0\rangle\cdots\rangle$ can be defined accordingly as functions $[\![\mathbf{v}_{\mathrm{i}\sigma}]\!] \in D_{a\sigma}$ such that, for any $g_g, a_a, \gamma^n_{\sigma_n}, \dots, \gamma^1_{\sigma_1}$, $[\![\mathbf{v}_{\mathrm{i}\sigma}]\!](a)(\gamma^n)\dots(\gamma^1)(g) = a(g)(\mathrm{i}\sigma)((^{\downarrow}\gamma^n)(g))\dots((^{\downarrow}\gamma^1)(g))$. For instance, a pronoun for a set of worlds $[\mathbf{p}_2\ \mathbf{g}_1]$ denotes a function $[\![\mathbf{p}_2]\!]([\![\mathbf{g}_1]\!]) \in D_{st}$ such that for any $w_s, g_g$, $g(1a)(2st)((^{\downarrow}w)(g)) = g(1a)(2st)(w(g))$; a pronoun for a choice function $[\mathbf{F}_1\ \mathbf{g}_1]$ denotes a function $[\![\mathbf{F}_1]\!]([\![\mathbf{g}_1]\!]) \in D_{\langle\langle e,t\rangle,e\rangle}$ such that for any $P_{\langle e,t\rangle}, g_g$, $g(1a)(1ete)((^{\downarrow}P)(g))$ is a selected $o \in E$ in (the characteristic set of) $(^{\downarrow}P)(g)$, where $(^{\downarrow}P)(g)$ is the function $f{:}E \to T$ such that $f(x(g)) = f(x)(g)$ for any $x_e$; and so on. I treat the semantic values of traces equivalently yet lacking the initial type $a$ argument — e.g., $[\![\mathbf{t}_{1\mathrm{e}}]\!] = \lambda g_g.g(1e)$. For complex type $\sigma = \langle\sigma_n, \langle\dots,\sigma_0\rangle\cdots\rangle$, trace $\mathbf{t}$, and pronoun-variable $\mathbf{v}$ (variables of basic types may be understood degenerately where $n = 0$ and $\sigma^0 \in \{e, s, t, a\}$):

(14) $[\![\mathbf{v}_{\mathrm{i}\sigma}]\!] = \lambda a_a.\lambda\gamma^n_{\sigma_n}\dots\lambda\gamma^1_{\sigma_1}.\lambda g_g\,.\,a(g)(\mathrm{i}\sigma)((^{\downarrow}\gamma^n)(g))\dots((^{\downarrow}\gamma^1)(g))$

a. For $\alpha \in \{e, s, t\}$, $[\![\mathbf{v}_{\mathrm{i}\alpha}]\!] = \lambda a_a.\lambda g_g\,.\,a(g)(\mathrm{i}\alpha)$ b. $[\![\mathbf{g}_{\mathrm{i}}]\!] = \lambda g_g\,.\,g(\mathrm{i}a)$

(15) $[\![\mathbf{t}_{\mathrm{i}\sigma}]\!] = \lambda\gamma^n_{\sigma_n}\dots\lambda\gamma^1_{\sigma_1}.\lambda g_g\,.\,g(\mathrm{i}\sigma)((^{\downarrow}\gamma^n)(g))\dots((^{\downarrow}\gamma^1)(g))$

a. For $\beta \in \{e, s, t, a\}$, $[\![\mathbf{t}_{\mathrm{i}\beta}]\!] = \lambda g_g\,.\,g(\mathrm{i}\beta)$

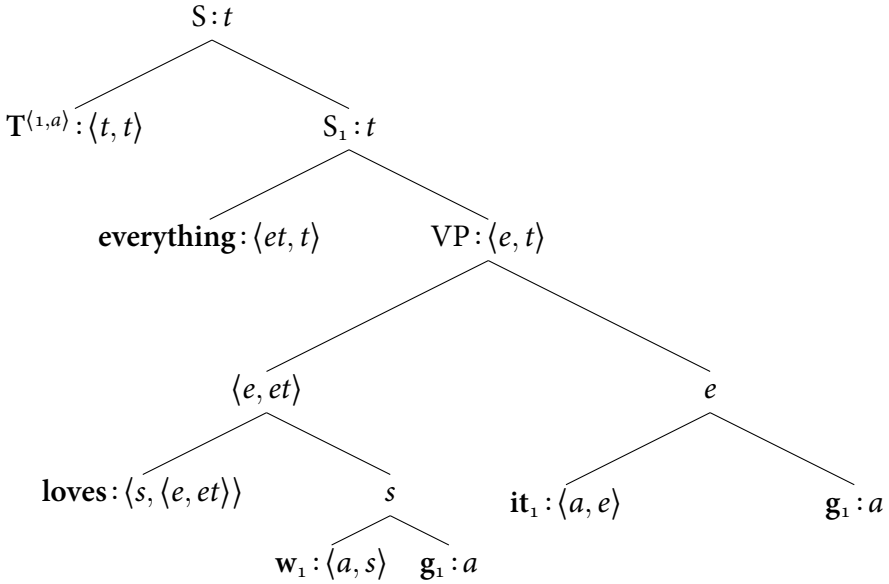
(Note that variables $\mathbf{g}$ for assignments are type $a$ (functions $D_g \to G$); there are no denotations of type $g$. Given our theoretical role for assignment-variables, there are no assignment-pronouns.)

### 2.2 Preliminary derivation: Pronouns, quantifiers, quantification

To get a feel for the basic system it will be instructive to consider a preliminary derivation. I begin with the simple sentence in (16) with a free pronoun and subject-position quantifier (see n. 5). ($\mathbf{T}$ is an assumed topmost assignment-binder, where $g^-$ is, intuitively, the counterpart assignment$_M$ $h$ of $g$ in $G$; see below. For space purposes I leave intermediate calculations to the reader.)[6]

[6] I ignore tense, aspect, voice. I often abbreviate "$f(x) = 1$" with "$f(x)$." To a first approximation, $g[i/n]$ is the unique assignment $g'$ that maps $n$ to $i$ and is otherwise identical to $g$; an improved definition of metalanguage expressions of assignment-modification will be provided in §4.

(16) Everything loves it.




$[\![\textbf{loves}]\!] = \lambda w_s.\lambda x_e.\lambda y_e.\lambda g_g\,.\, y(g)$ loves $x(g)$ in $w(g)$

$[\![\textbf{everything}]\!] = \lambda P_{\langle e,t\rangle}.\lambda g_g.\forall x_e\colon P(x)(g)$

$[\![\mathbf{T}^{\langle 1,a\rangle}]\!] = \lambda T_t.\lambda g_g\,.$ for $a = \lambda g_g.g^{-}, T(g[a(g)/1a])$ (*provisional*)

- $g^{-} :=$ the $h \in G$ s.t. for all non-assignment indices $i\tau$, $h(i\tau) = g(i\tau)$

$[\![\mathbf{w}_1\ \mathbf{g}_1]\!] = [\![\mathbf{w}_1]\!]([\![\mathbf{g}_1]\!])$
$= [\lambda a_a.[\lambda g_g\,.\, a(g)(1s)]](\lambda g_g.g(1a))$
$= \lambda g_g.g(1a)(1s)$

$[\![\mathbf{it}_1\ \mathbf{g}_1]\!] = [\![\mathbf{it}_1]\!]([\![\mathbf{g}_1]\!])$
$= [\lambda a_a.[\lambda g_g\,.\, a(g)(1e)]](\lambda g_g.g(1a))$
$= \lambda g_g.g(1a)(1e)$

$[\![\mathrm{S}_1]\!] = [\![\textbf{everything}]\!]\big([\![\textbf{loves}]\!]([\![\mathbf{w}_1]\!]([\![\mathbf{g}_1]\!]))([\![\mathbf{it}_1]\!]([\![\mathbf{g}_1]\!]))\big)$
$= \lambda g_g.\forall x_e\colon x(g)$ loves $g(1a)(1e)$ in $g(1a)(1s)$

$[\![\mathrm{S}]\!] = [\![\mathbf{T}^{\langle 1,a\rangle}]\!]([\![\mathrm{S}_1]\!])$
$= \lambda g_g.$for $a_a = \lambda g_g.g^{-}, \forall x_e\colon x(g[a(g)/1a])$ loves $g[a(g)/1a](1a)(1e)$ in $g[a(g)/1a](1a)(1s)$
$= \lambda g_g.\forall x_e\colon x(g[g^{-}/1a])$ loves $g^{-}(1e)$ in $g^{-}(1s)$

S is true in $c$ iff $[\![S]\!](g_c) = 1$
iff $\forall x_e\colon x(g_c[g_c^-/1a])$ loves $g_c^-(1e)$ in $g_c^-(1s)$

First, pronouns are sister to assignment variables, which determine their interpretation. I assume that sentences have a **topmost assignment-binder** $\mathbf{T}^{\langle i,a\rangle}$, which effectively maps variables sister to assignment variables coindexed with $\mathbf{T}^{\langle i,a\rangle}$ to the values provided by the input assignment. This anchors intuitively free pronouns to the discourse context via the definition of truth-in-a-context (Percus 2000, von Fintel & Heim 2011). In more complex examples, alternative local/global readings will be reflected in different coindexings on assignment variables. A result of §3 will be a derivation of binder expressions, like $\mathbf{T}^{\langle i,a\rangle}$, from an independently defined generalized (cross-categorial, type-flexible) binder-index $^{\langle i,\sigma\rangle}$.

A more complex clausal architecture will be provided in §3. The world argument of a clause's main predicate will be supplied by a world-trace, rather than by a world+assignment-variable complex. For the moment, given the present simpler syntax, one may assume that in the intended interpretation the first-positioned world $g(1s)$ represents the world of the possibility represented by $g$.

Importantly, the outputs of assignments are items in the model. What is loved according to (16) isn't a function $y \in D_e$ but an individual $o \in E$, say Fluffy. Likewise, although the **metalanguage quantification** is over functions $x\colon D_g \to E$, the items in terms of which the condition is stated are *images* of the given assignment $g$ under $x$, i.e. individuals $o \in E$ in the model. The universal quantification over $x_e$ includes functions mapping $g$ to object $o_1 \in E$, functions mapping $g$ to $o_2 \in E$, etc. The metalanguage quantificational condition $\forall x_e\colon \ldots$ in (16) is satisfied iff regardless of which such function we look at, its value $o \in E$ loves the contextually relevant individual (=Fluffy): if there was an $o_i \in E$ that didn't love Fluffy, then any function $x_i \in D_e$ mapping $g_c$ to $o_i$ would be such that $x_i(g_c)$ doesn't love $g_c(1e)$ (=Fluffy), falsifying the condition; and if there was a function $x_j \in D_e$ whose value given $g_c$ doesn't love $g_c(1e)$, then there would be an $o_j \in D_e$, namely $x_j(g_c)$, that doesn't love Fluffy ($=g_c(1e)$). In this way the universal quantification over functions $x \in D_e$ makes a claim about every object $o \in E$ in the set of entities (cf. Kobele 2010).

So, the semantics derives that $S$ is true in $c$ iff in the world of $c$ everything loves the individual $o \in E$ represented by 1.

## 3 Syntax and semantics: Standardizing quantification

Adding assignment-variables to the object language raises non-trivial issues for the syntax and lexical/compositional semantics. This section shows how a theory with

assignment-variables can be integrated into independently motivated treatments of the syntax/semantics interface. The revised account captures phenomena of intensionality and (non-)shifted interpretations of context-sensitive expressions via general mechanisms of movement and variable binding, and affords an elegant standardization of quantification in the syntax and semantics (§1).

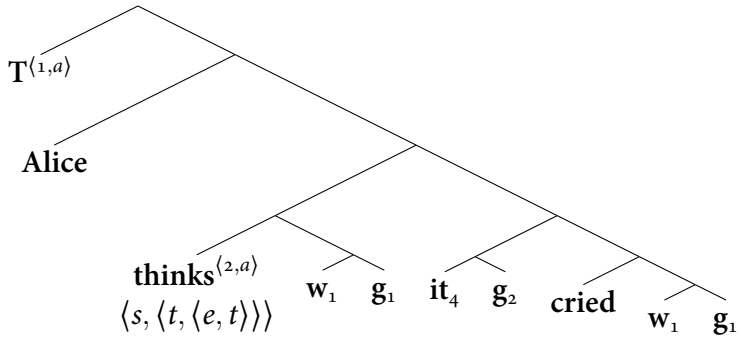
The particular treatments of the syntax and lexical/compositional semantics in the remainder of the paper are of course not the only way of developing an assignment-variable-based theory. I will spare the reader all my other failed attempts. I welcome the development of alternatives with which the account may be compared.[7]

### 3.1 Preamble

A worry with any framework positing object-language variables for worlds/times/etc. is that they have the potential to overgenerate readings. The worry might seem especially pressing for a theory with assignment variables. Absent additional constraints, nothing would seem to exclude a structure/interpretation such as (17), where the embedded pronoun receives a local reading, being sister to an assignment variable coindexed with 'think', and the embedded world variable receives a global reading, being sister to an assignment variable coindexed with the topmost assignment-binder.

(17) Alice thinks it cried.

a.




[7] I want to flag that the general assignment-variable framework, as from §2, doesn't itself require a project of standardizing quantification. One *could* build assignment-binding properties directly into the lexical entries for modals, attitude verbs, etc., as in the Hintikka-style lexical entry in (i) (letting $Dox(o, u)$ be a set of assignments (possibilities) compatible with $o$'s beliefs in $u$).

(i) $[\![\textbf{think}^{\langle i,a\rangle}]\!] = \lambda w_s.\lambda T_t.\lambda x_e.\lambda g_g\,.\,\forall h \in Dox(x(g), w(g))\colon T(g[h/\langle i, a\rangle])$

Such a lexical entry contrasts with lexical entries for determiner quantifiers ((16)), where binding of particular variables results from combining a binder-index with the quantifier, triggered (e.g.) by movement. Methodologically, it is worth examining the prospects for an approach which unifies the treatments of the various shifting phenomena. So I put options such as (i) aside.

b. (17) ≈ for every $h$ representing a possibility compatible with Alice's beliefs in the actual world (=$g_c(1s)$), the individual $o \in E$ represented with 4 by $h$ (=$h(4e)$) cried in the actual world

A proliferation of constraints on readings seems in the offing.

It is important not to overstate the explanatory burdens particular to theories positing object-language variables for worlds, times, assignments, etc. Take 'it'. Suppose for the sake of argument that 'it' cannot receive a shifted (local) reading under e.g. modals/attitude verbs and that this constraint is conventionalized. Following Kaplan and friends, such a constraint could be formally implemented by (say) analyzing 'it' as a variable receiving its interpretation from a contextual parameter on the interpretation function, and disallowing attitude verbs, modals, etc. from shifting such a contextual parameter. An explanatory inquisition isn't far behind. What makes it the case that *that* formalism correctly represents the conventional meaning and use of the string 'i-t' in such-and-such communities? Why would such-and-such contextual parameter be unable to be shifted by attitude verbs, modals, etc., though it can be shifted by other operators such as determiner quantifiers? If 'it' is analyzed as receiving its interpretation from a modally-unshiftable contextual parameter, what explains the fact that other pronouns and context-sensitive expressions *can* receive shifted readings in modal environments? — and by what alternative mechanisms are the different readings compositionally derived? If there is a constraint against local readings of 'it' in English, is the constraint universally associated with analogous pronouns across languages? If so, what general aspects of human cognition, sociality, conversation, etc. explain the cross-linguistic universal?

There is much one might say in response. For instance, with a first-person pronoun there is a natural relation between speaker and attitude subject that may explain the ready retrievability of shifted interpretations in attitude ascriptions, as are indeed attested in various languages (arguably including English). No such general relation seems available with 'it'; addressees don't generally know what the speaker may be presupposing about what some attitude subject takes as relevantly salient. Given the paucity of descriptive content of 'it', shifted readings under attitude verbs, modals, etc. would seem generally unretrievable. For theories using unshiftable (or selectively shiftable) context parameters on the interpretation function, such stories may be understood at the "presemantic"/metasemantic level of what formal objects correctly represent the shifting possibilities for a given string; for a theory positing object-language assignment-variables, at (say) the syntactic or lexical semantic level of why there is a conventionalized locality/globality principle for a given expression. *All* types of theories must ultimately provide an explanation of

the contrasting tendencies — and in some cases conventionalized constraints — for local/global readings among expressions, both in English and cross-linguistically. Where one does is a matter of bookkeeping (cf. Silk 2016, 2017).

Of course not all ways of carving up the explanatory terrain are empirically or theoretically on a par — hence the present project. The traditional approach takes unshiftability for context-sensitive expressions as the default. Though such an approach might seem initially plausible given pronouns such as 'it' or 'I', it is puzzling from the perspective of the broader spectrum of linguistic shifting phenomena — hence the plethora of mechanisms for intensionality, quantification, and context-sensitivity, and epicycles for capturing local readings across context-sensitive expressions. It is time to rethink the foundational assumptions about shifting and context-sensitivity motivating the traditional formalism. What classical theories may gain when it comes to (say) global readings for 'it', they lose when it comes to the spectrum of tendencies for local/global readings across context-sensitive expressions. The project in this paper is to develop a theory which takes the opposite tack: Individual-, world-, and assignment-shifting are given a uniform general analysis. Optionality with respect to local vs. global readings is the default; unshiftability and obligatory shifting on the poles of the spectrum are what call for special explanation (more on which in due course). We will see that proceeding in this way, and introducing assignment variables into the syntax/semantics, affords diverse empirical and theoretical advantages. In semantics as in tailoring (so I'm told), it is often easier to start big and take in.

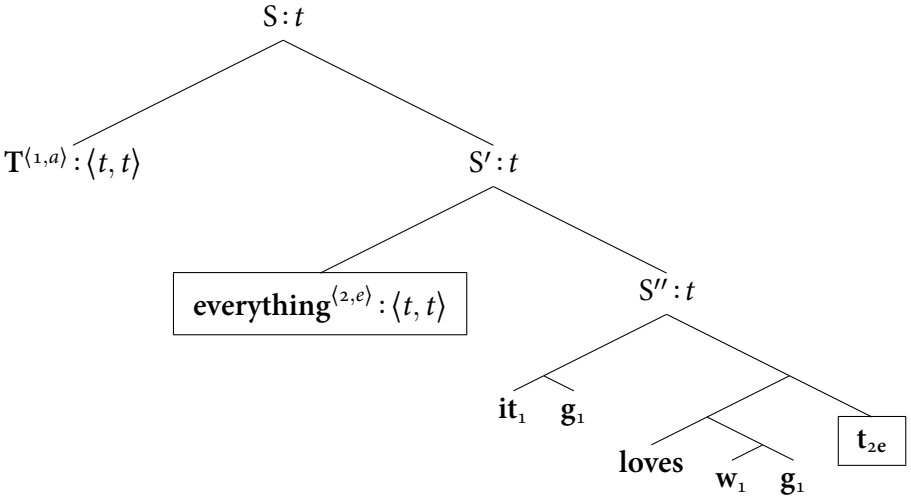
Preamble (=rant) over; the proof of the pudding is in the lambdas and whatnot, so let us proceed.

Some limitations and patterns in available readings may be derived conversationally; not all LFs may be equally likely in representing speakers' intentions in uttering a given string across concrete discourses. Yet some constraints on readings are certainly grammaticalized. In what follows I would like to focus primarily on one constraint on readings, to begin reining in the system's flexibility: the constraint on embedded world-variables. (I revisit obligatory local/global readings of certain pronouns in §4.3.) As Percus 2000 observes, the world argument of a clause's main predicate must be bound by the closest world-binder. In the present framework, the aim is to derive that the main predicate's world argument receives an *obligatory local reading*, and to do so in a way that allows other embedded variables to receive global readings linked to the discourse context. This section develops the preliminary §2-account to capture these points. The revised account derives the binding of specific variables from basic lexical entries and a generalized binder-index (§§1–2).

### 3.2 Type-driven movement

There is a familiar story about what generates binder/bindee relations with object-position quantifiers over individuals: the quantifier moves because of a type mismatch, and a binder-index attaches to the quantifier, leaving a coindexed trace:[8]

(18) It loves everything.




Preliminary type-specific denotation for the binder-index:

$[\![^{\langle i,e\rangle}]\!] = \lambda Q_{\langle et,t\rangle}.\lambda T_t.\lambda g_g\,.\,Q\big(\lambda x_e.\lambda g''_g.T(g[x(g'')/\langle i,e\rangle])\big)(g)$

$[\![\textbf{everything}^{\langle 2,e\rangle}]\!] = [\![^{\langle 2,e\rangle}]\!]([\![\textbf{everything}]\!])$
$= [\lambda T_t.[\lambda g_g.\forall x_e\colon T(g[x(g)/2e])]]$

$[\![\mathbf{t}_{2\mathbf{e}}]\!] = \lambda g_g.g(2e)$

$[\![S'']\!] = [\![\textbf{loves}]\!]([\![\mathbf{w}_1]\!]([\![\mathbf{g}_1]\!]))\,([\![\mathbf{t}_{2\mathbf{e}}]\!])\,([\![\mathbf{it}_1]\!]([\![\mathbf{g}_1]\!]))$
$= \lambda g_g.g(1a)(1e)$ loves $g(2e)$ in $g(1a)(1s)$

$[\![S']\!] = [\![\textbf{everything}^{\langle 2,e\rangle}]\!]([\![S'']\!])$
$= \lambda g_g.\forall x_e\colon g[x(g)/2e](1a)(1e)$ loves $x(g)$ in $g[x(g)/2e](1a)(1s)$

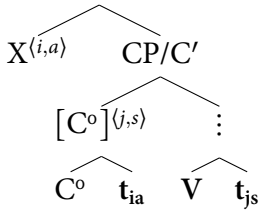
$[\![S]\!] = [\![\mathbf{T}^{\langle 1,a\rangle}]\!]([\![S']\!])$
$= \lambda g_g.\forall x_e\colon g^-(1e)$ loves $x(g[g^-/1a])$ in $g^-(1s)$

[8] When labeling trees I sometimes use prime symbols A′ informally to distinguish different nodes of category A, and sometimes formally for $\overline{\text{A}}$/A-bar in the sense of X-bar theory. Context should disambiguate.

Roughly, the binder-index combines with the quantifier so that the quantifier's scope argument becomes the set of individuals that make the proposition $[\![S'']\!]$ true when returned as value for $2e$.[9]

A natural hypothesis is to treat a parallel mechanism as at play with world- and assignment-quantification. I suggest that we treat the relevant items as quantifiers, and, like determiner quantifiers, as moving because of a type mismatch (cf. Hacquard 2006, 2010, von Stechow 2008). Specifically, I treat the **complementizer** (e.g. 'that') as base-generated at the position of the main predicate's **world argument**; as a higher quantifier type over worlds, it moves, leaving a world-trace. I treat **modals and attitude verbs** as base-generated at the position of a posited **assignment argument** of the C head; as a higher quantifier type over assignments, it moves, leaving an assignment-trace (n. 8):[10]

(19)




The complementizer introduces world-quantification/binding, i.e. intensionality; modals, broadly construed (n. 10), introduce assignment-quantification/binding. Both cases proceed parallel to the case of raised quantifiers: a binder-index attaches to the quantificational expression (quantifier, complementizer, modal) due to type-driven movement, leaving a coindexed (individual, world, assignment) trace.

There are precedents for treating the syntax/semantics interface in the proposed way. Hacquard 2006, 2010 makes such a move for aspect, treating aspect as a quantifier over events and moving from the verb's event-argument position. Similarly, von Stechow 2008, following Heim 2001, treats attitude verbs as quantifiers over worlds and moving from inside the complement (cf. von Fintel & Iatri-

[9]Note that the argument of the raised quantifier is type $t$ (cf. Heim 1982, Kobele 2010, Kennedy 2014), rather than property type (e.g. Heim & Kratzer 1998). The account maintains the traditional view in syntax of representing indices as features on expressions: the binder-index attaches directly to the quantifier, rather than occupying its own node and triggering a special composition rule such as Predicate Abstraction, à la Heim & Kratzer 1998. More on this below.

[10]I often use 'modal' broadly for semantically modal elements of various categories (modal verbs, attitude verbs, T), sometimes narrowly for modal verbs; context should disambiguate. X is a placeholder for the category of the semantically modal item. I label the sister of T at LF as CP; however, officially, I leave open what its specific location is, e.g. whether it raises to SpecCP or heads its own projection, perhaps in some extended projection of the CP-layer such as ForceP.

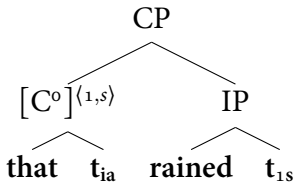
DOU 2009). Though I am bracketing voice, aspect, and tense, an idea would be to generalize the proposal for all functional heads. What will important here is capturing world-quantification/binding (intensionality) via the syntax/semantics of the complementizer, which moves from the verb's world-argument position; and capturing assignment-quantification/binding via the syntax/semantics of modal elements, which move from the complementizer's assignment-argument position.

### 3.3 World-binding: Complementizer

Modifying the clausal architecture as suggested in §3.2 has direct implications for the lexical/compositional semantics. Start with the complementizer. The preliminary §2-implementation adopted a metasemantic constraint that the first world-position of $g_c$, $g_c(1_s)$, pick out the world of $c$. Even if we don't require this, there will be *some* position or other in an assignment that represents the world of the possibility that the assignment represents (§2). Accordingly, it can be useful to define a metalanguage function $@ : G \to W$ that maps an assignment $h$ to the world of the possibility represented by $h$. I offer (20) as a lexical entry for (possibly unpronounced) 'that'.

(20) $[\![\textbf{that}]\!] = \lambda a_a . \lambda p_{\langle s,t\rangle} . \lambda g_g \,.\, \forall w \text{ s.t. } w(g) = @(a(g)), p(w)(g)$

(21)




Roughly put, (20) treats a CP 'that S' as relating the set of S-worlds to some further modal domain; (21) says that it rained in the world identical to the world of the given possibility, $@(a(g))$. The modal element base-generated in the complementizer's assignment-argument position will determine the modal domain. Note that the verb's world argument is now a trace, directly bound by the complementizer.

Although the complementizer's condition in (20) picks out a unique world in the model — namely, the world of the given possibility, $@(a(g))$ — the quantification over $w \in D_s$ is universal. There is a single world $u \in W$ identical to the world of a possibility, but there are many functions $w \in D_s$ such that $w(g) = u$. The functions $w$ quantified over may differ in their values given other possibilities $g'$, yet they agree in mapping (say) $g$ to $u$.

### 3.4 Assignment-binding: T, Modals, Attitude verbs

To fix ideas I focus on the top-level assignment-binder **T**, the attitude verb 'think', and the modal verb 'may'. Consider **T**. We need to ensure two things after it combines with the binder-index: that it interprets the embedded CP with respect to a modified assignment that maps coindexed assignment-variables to the (counterpart of the) input assignment ($g[g^{-}/ia]$ above), and that the modal domain for evaluating the embedded proposition is the actual world. Likewise for modals/attitude verbs, except that the embedded CP is interpreted with respect to a modified assignment mapping coindexed assignment-variables to the assignments being quantified over, and the modal domain is the set of worlds compatible with the modality/attitude. Our metalanguage function @ offers a way of unifying the modals' lexical entries: In each case the modal domain is $\lambda w.\lambda g.w(g) = @(a(g))$; what differs is the quantification over $a$ — for **T** it's over the $a$ such that $a(g) = g^{-}$ for any $g$; with 'may' it's over $a$ such that $a(g)$ is in the set of accessible possibilities; and with 'think' it's over $a$ such that $a(g)$ is compatible with the subject's state of mind:

(22) $[\![\mathbf{T}]\!] = \lambda A_{\langle a,t\rangle}.\lambda g_g$ . for $a_a = \lambda g_g.g^{-}, A(a)(g)$

(23) $[\![\mathbf{may}]\!] = \lambda w_s.\lambda r_{\langle s,at\rangle}.\lambda A_{\langle a,t\rangle}.\lambda g_g$ . for some $a_a$ s.t. $r(w)(a)(g)$: $A(a)(g)$

(24) $[\![\mathbf{think}]\!] = \lambda w_s.\lambda A_{\langle a,t\rangle}.\lambda x_e.\lambda g_g$ . for all $a_a$ s.t. $a(g)$ is compatible with $x(g)$'s state of mind in $w(g)$: $A(a)(g)$

The meaning for the modal verb in (23) can be understood as adapting a familiar Kratzer-style semantics, treating modals as quantifying over a set of contextually relevant possibilities (Kratzer 1977, 1981). For simplicity I use a simple (contextually supplied) accessibility relation $r$ ("modal background"), which maps the verb's world argument to a set of assignments.[11] As usual, the meaning for 'think' in (24) proceeds analogously, yet lexically specifying the set of possibilities being quantified over.

Recall that assignments are understood theoretically as representing possibilities, where "possible ways things might be" may include what world is actual, foci of attention, objects' relative saliences, etc. It is a substantive question what it is for an assignment, thus understood, to be "compatible with" (e.g.) a body of information or a subject's state of mind. For present purposes I simply note that the issue is essentially the same as the issue, generally bracketed in formal semantics, of what it is for an assignment to be the "assignment of the context" $g_c$, or "determine[d]" by the "physical and psychological circumstances" "of the utterance situation" (Heim

[11] I consider an alternative argument structure for modals in §7.6.

& Kratzer 1998: 243). Work on indexical-shift and concept-generators may be helpful here in providing further (gramatical/lexical/metasemantic) resources for reining in the system's flexibility (§3.1).[12]

As we will see in the compositional derivations in §4, the set of worlds at which a clause is evaluated is ultimately determined by the assignment-quantification introduced by the modal. For example, with 'think', the complement is evaluated at a multiplicity of worlds (assuming one isn't maximally opinionated), i.e. the worlds $w(g)$ identical to worlds $@(a(g))$ of assignments representing possibilities compatible with the subject's state of mind. With **T**, the main clause is evaluated at a singleton set, $\{@\,(a(g))\} = \{@\,(g^{-})\}$, i.e. ultimately the world of the assignment representing the discourse context.

### 3.5 Generalized binder-index

The above treatments of the syntax/semantics afford a means of standardizing quantification and defining a generalized binder-index, applying to quantificational expressions of various types. I propose (25) — where $\chi_\tau$ is a variable for the type of what is being quantified over, $\sigma$ is the type of the mother node (i.e. the result of combining the binding expression with its scope argument), and $\gamma^1_{\sigma_1} \ldots \gamma^n_{\sigma_n}$ are variables for any intermediate arguments. Roughly put, the binder-index $^{\langle i,\tau\rangle}$ takes an expression $\alpha$ that quantifies over items of type $\tau$ (e.g. individuals/worlds/assignments), and it lets $\alpha$ combine with its scope $\beta$ by feeding $\alpha$ the set of $\tau$-type items that verify $\beta$ when returned for $\langle i, \tau\rangle$.

(25) *Generalized binder-index*

$$[\![^{\langle i,\tau\rangle}]\!] = \lambda\alpha_{\langle\langle\tau,\langle_1\sigma_1\cdots\sigma_n,t\rangle_1\cdots\rangle_n\rangle,\sigma\rangle}\,.\,\lambda\beta_{\langle_1\sigma_1\cdots\sigma_n,t\rangle_1\cdots\rangle_n}\,.\,\alpha\Big(\lambda\chi.\lambda\gamma^1\cdots\lambda\gamma^n.\lambda g\,.\,\beta(\gamma^1)\cdots(\gamma^n)(g[(^{\downarrow}\chi)(g)/\mathrm{i}\tau])\Big)$$

(26) $[\![[\textbf{everything}]^{\langle i,e\rangle}]\!] = [\![^{\langle i,e\rangle}]\!]([\![\textbf{everything}]\!])$
$= \lambda T_t.\lambda g_g\,.\,\forall x_e\colon T(g[x(g)/\mathrm{i}e])$

(27) $[\![[\textbf{that } \mathbf{t}_{\mathbf{ja}}]^{\langle i,s\rangle}]\!] = [\![^{\langle i,s\rangle}]\!]([\![\textbf{that } \mathbf{t}_{\mathbf{ja}}]\!])$
$= \lambda T_t.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(g(\mathrm{j}a)), T(g[w(g)/\mathrm{i}s])$

(28) $[\![[\textbf{think } \mathbf{t}_{\mathbf{js}}]^{\langle i,a\rangle}]\!] = [\![^{\langle i,a\rangle}]\!]([\![\textbf{think } \mathbf{t}_{\mathbf{js}}]\!])$
$= \lambda T_t.\lambda x_e.\lambda g_g\,.$ for all $a$ s.t. $a(g)$ is compatible with $x(g)$'s state of mind in

[12] For instance, one might require, say, that in the intended interpretation the first-positioned individual in an assignment representing an epistemic possibility determined by $g_c$ be an epistemic counterpart of the first-positioned individual in $g_c$, who is the speaker of $c$. See Percus & Sauerland 2003, Schlenker 2003, Anand & Nevins 2004, Santorio 2010, 2012, Ninan 2012.

$g(js)$: $T(g[a(g)/ia])$

Since the binder-index attaches directly to the expression, the semantic composition proceeds via function application, without recourse to a special composition rule such as Predicate Abstraction as in Heim & Kratzer 1998 (n. 9). The account thus avoids worries with syncategorematic treatments of binding/quantification, as pressed in Rabern 2012, Kennedy 2014. The next section shows how the lexical entries and derived binder denotations in this section capture the requisite binding relationships in sentences' quantifications over individuals/worlds/assignments.

# 4 Examples

## 4.1 Attitude Ascription: Intensionality, local/global readings

Start with a simple attitude ascription such as (29) with a "free" (global) reading of an embedded pronoun. (I use '$\mathbf{C}_{\mathbf{dec}}$' for an unpronounced declarative complementizer, $[\![\mathbf{C}_{\mathbf{dec}}]\!] = [\![\mathbf{that}]\!]$ assumed to head the main clause. To improve readability I abbreviate '$o$'s state of mind in $u$' with '$\mathrm{SOM}_{o,u}$'; I suppress certain irrelevant assignment modifications, indicated with '$\approx$'; and I leave intermediate calculations to the reader (see notes).)[13]

[13]Semantic values for certain relevant lower spinal nodes are given in (i). (See (16), (18), (20)–(28) for relevant lexical entries and derived denotations for the binding expressions.)

(i) $[\![\mathrm{CP}']\!] = \lambda g_g\,.\,\forall w$ s.t. $w(g) =, g[w(g)/2s](1a)(2e)$ cried in $w(g)$

$[\![\mathrm{VP}]\!] = [\![[\mathbf{think}\ \mathbf{t}_{1s}]^{\langle 2,a\rangle}]\!]([\![\mathrm{CP}']\!])$

$= \big[\lambda x_e.[\lambda g_g\,.$ for all $a$ s.t. $a(g)$ is compatible with $\mathrm{SOM}_{x(g),\,g(1s)}$,

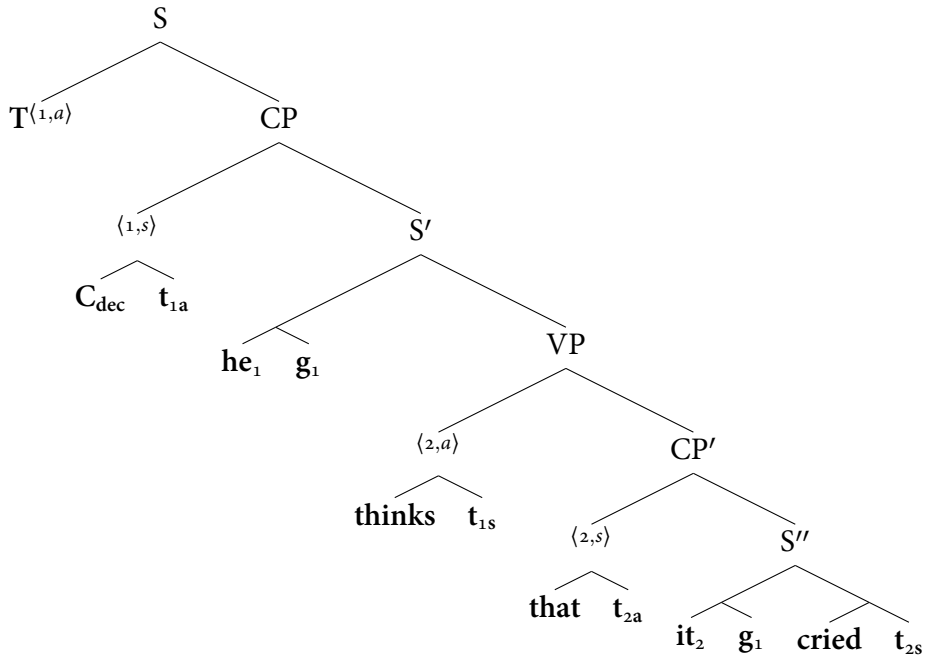
$\forall w$ s.t. $w(g[a(g)/2a]) = @(a(g[a(g)/2a]))$,

$g[a(g)/2a][w(g[a(g)/2a])/2s](1a)(2e)$ cried in $w(g[a(g)/2a])]\big]$

$[\![\mathrm{CP}]\!] = [\![[\mathbf{C}_{\mathbf{dec}}\ \mathbf{t}_{1a}]^{\langle 1,s\rangle}]\!]\big([\![\mathrm{VP}]\!](\lambda g'_g.g'(1a)(1e))\big)$

$= \lambda g_g\,.\,\forall w'$ s.t. $w'(g) = @(g(1a))$, $[\![\mathrm{VP}]\!](\lambda g'_g.g'(1a)(1e))(g[w'(g)/1s])$

(29) He thinks that it cried.




$$
\begin{aligned}
&[\![S]\!] = [\![\mathbf{T}^{\langle 1,a\rangle}]\!]([\![\mathrm{CP}]\!]) \\
&\quad = \lambda g_g \,.\, \text{for } a'_a = \lambda g''_g . g''^{-}, [\![\mathrm{CP}]\!](g[a'(g)/1a]) \\
&\quad \approx \lambda g_g \,.\, \forall w' \text{ s.t. } w'(g) = @(g^-), \\
&\qquad \text{for all } a \text{ s.t. } a(g) \text{ is compatible with } \mathrm{SOM}_{g(1e),\, w'(g)}, \\
&\qquad\quad \forall w \text{ s.t. } w(g) = @(a(g)), \\
&\qquad\qquad g^-(2e) \text{ cried in } w(g)
\end{aligned}
$$

Roughly put: (29) is true in $c$, $[\![S]\!](g_c)$, iff $g_c(2e)$ cried in the world of every possibility compatible with $g_c(1e)$'s state of mind in $@(g_c)$. (For readability I often omit the superscript in '$g_c^-$', though it should be understood (§2.2).)

Parallel to the movement of the object-position quantifier in (18), movement of the complementizer from the embedded predicate's world-argument position leaves a trace, $\mathbf{t}_{2s}$, and the binder-index attaches to the moved expression, $[\mathbf{that}\ \mathbf{t}_{2a}]^{\langle 2,s\rangle}$. This captures **Percus's point** (§3.1): Percus's point is diagnosed as an **obligatory local reading** of the predicate's world argument; it is captured via general mechanisms of movement.

The embedded world argument is obligatorily shifted to the embedding predicate 'think', being supplied directly by a **trace** left from movement of the clause's

complementizer; however, the embedded **pronoun** can still receive a non-shifted reading, receiving its interpretation from an assignment-variable. The intuitively free, or **global reading**, of 'it' is reflected in its being sister to an assignment-variable coindexed with the topmost assignment-binder, anchoring its interpretation to the discourse context (via $g[a'(g)/1a](1a)(2e) = a'(g)(2e) = g(2e)$).[14]

As with individual-quantification (§2.2), although the items quantified over by the complementizer/modal are functions, the conditions concern worlds/assignments in the model. This reflects a philosophical point from Stalnaker (1988, 2014), in his emphasis on understanding shifted "contexts" as *derived*, in the sense of being determined by the discourse. Which features of the subject's state of mind are relevant for interpreting embedded material can depend on context. The formalism represents this in treating the condition placed by the attitude verb as a condition on ways ($a$) of mapping the discourse assignment ($g$) to an assignment ($a(g)$) representing the subject's state of mind.

Likewise, the "…cried in $w(g)$" in the last line shouldn't mislead. The proposed meanings for 'think' and 'that' restrict the quantification to functions $w$ mapping $g$ to worlds $@(a(g))$ of the possibilities compatible with the subject's state of mind. The attitude ascription requires that, for any such $w$, the relevant individual cried in $w(g) \in W$, a world compatible with the subject's state of mind.

### 4.2 De re/de dicto, Specific/non-specific: Global vs. local readings of world arguments

(29) highlights a contrast between **pronouns and traces** in the system.[15] I return to issues with pronominal anaphora, trace-/pronoun-binding, and weak crossover in §§6.2–6.3.1. The trace filling the world argument of a clause's main predicate is coindexed with the nearest c-commanding world-binder due to movement of the complementizer. This captures the obligatory local reading of the main predicate: (30) cannot receive the interpretation in (31).

(30) Alice thinks a friend of mine won.

(31) (30) $\not\approx$

[14] The talk of intuitively free/bound readings of pronouns can be formalized more precisely. Use the label 'pronoun' for the complex expression $[\mathbf{v}_{i\sigma}\ \mathbf{g}_j]$ consisting of the (non-assignment) variable $\mathbf{v}_{i\sigma}$ — call it the "pronoun variable" — and its sister assignment-variable $\mathbf{g}_j$. An intuitively "free" reading of a pronoun is reflected in a tree where (i) the nearest c-commanding assignment-binder $^{\langle j,a\rangle}$, if any, is the topmost assignment-binder, and (ii) there is no $^{\langle i,\sigma\rangle}$-binder c-commanded by the topmost world-/assignment-binders that c-commands it.

[15] Distinguishing traces and pronouns, and trace-binding and pronoun-binding, is desirable for independent reasons, e.g. regarding crossover effects (Büring 2004, 2005). Such distinctions fall out directly from the proposed treatment of the syntax/semantics interface in §3.

a. there is a winner that Alice thinks is a friend of mine
b. for all $u'$ compatible with Alice's beliefs in $u$, some $o$ who won in $u$ is a friend of mine in $u'$

Pronouns, in contrast, receive their interpretation from an assignment-variable (§2.1). This predicts that world-pronoun arguments of embedded non-main predicates — e.g. 'a friend of mine' in (30) — should receive **optional local/global readings**.[16]

(32) $[\![\mathbf{a}]\!] = \lambda P_{\langle e,t\rangle}.\lambda Q_{\langle e,t\rangle}.\lambda g_g\,.\,\exists x_e\colon P(x)(g) \wedge Q(x)(g)$

$[\![\mathbf{FoM}]\!] = \lambda w_s.\lambda x_e\,.\,x(g)$ is a friend of mine in $w(g)$

$[\![\mathbf{a}\ [\mathbf{FoM}\ [\mathbf{w_i}\ \mathbf{g_j}]]]\!] = \lambda Q_{\langle e,t\rangle}.\lambda g_g\,.\,\exists x_e\colon x(g)$ is a friend of mine in $g(ja)(is) \wedge Q(x)(g)$

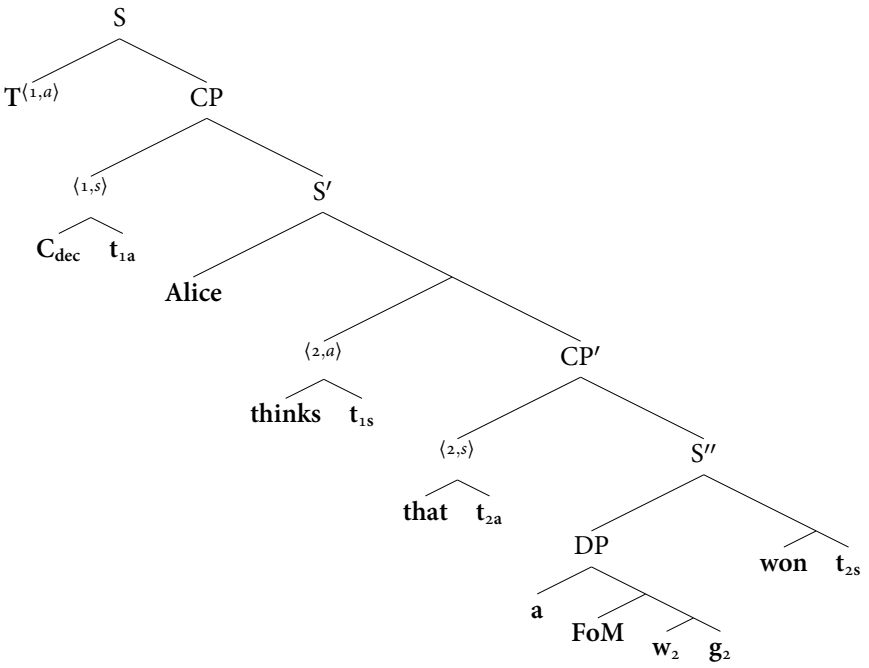
Binding configurations with world-pronouns afford a locus for capturing classic contrasts between **de re/de dicto** and **specific/non-specific** readings.

Non-specific de dicto readings are captured via structures involving *local binding* of the embedded world-pronoun, as in (33). Specific de re readings are captured via structures where the DP is *raised*, hence local = global binding, as in (34):[17]

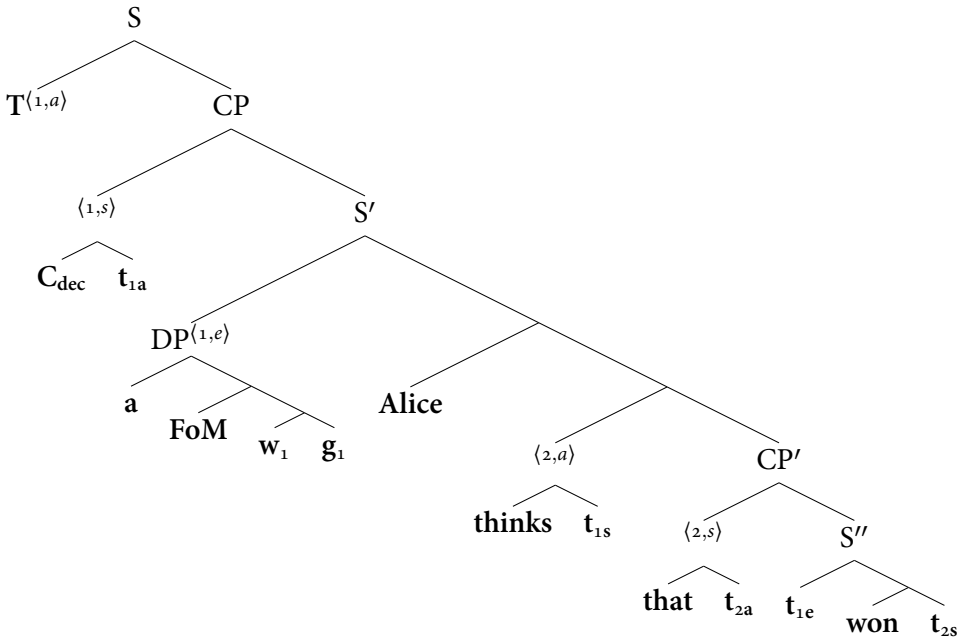
[16] I bracket potential additional structure from quantifier domain variables (von Fintel 1994, Stanley & Szabó 2000, Stanley 2002).

[17] See 6 for discussion of alternative treatments of specific readings with indefinites.

(33) *De dicto, Non-specific:*
≈ Alice thinks there is some individual or other who is friend of mine that won

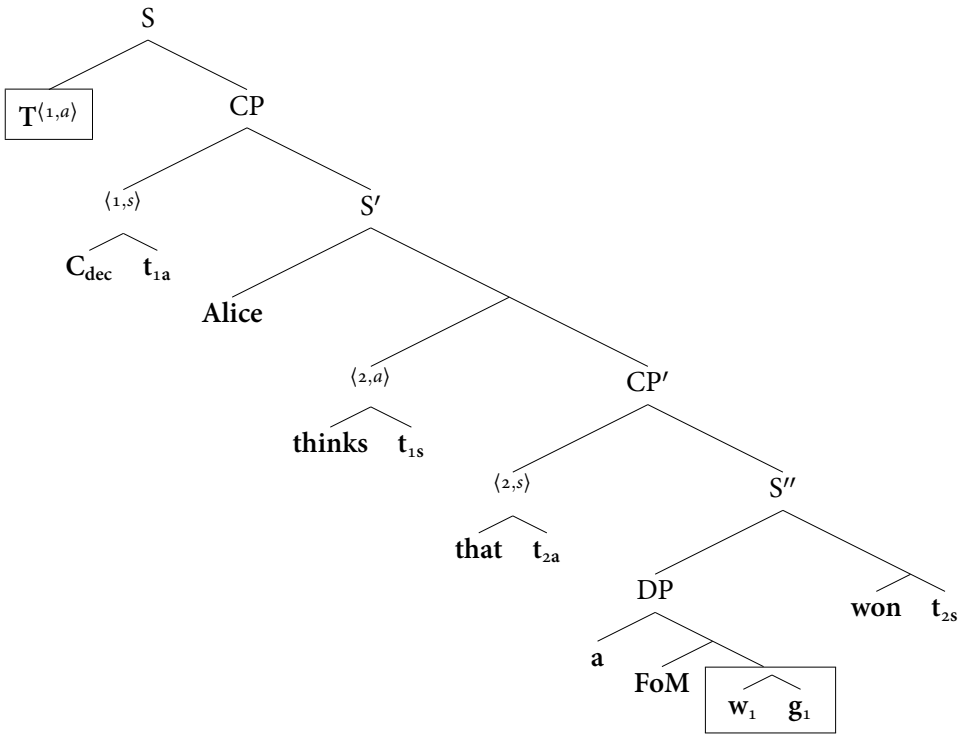


(34) *De re, Specific:*
≈ there is some particular individual who is a friend of mine such that Alice thinks (s)he won




As observed in Fodor 1970, DPs such as 'a friend of mine' in (30) can also have a so-called *non-specific* de re reading — informally, a reading ascribing a belief that is "de re" in the sense that it's about actual-world friends-of-mine, yet "non-specific" in the sense that it isn't about any particular individual. Fodor's non-specific de re readings can be captured via structures involving *long-distance binding* of the predicate's world-pronoun:

(35) *De re, Non-specific:*
≈ there is some group of individuals who are friends of mine (say, the Sharks) such that Alice thinks some or other of them won

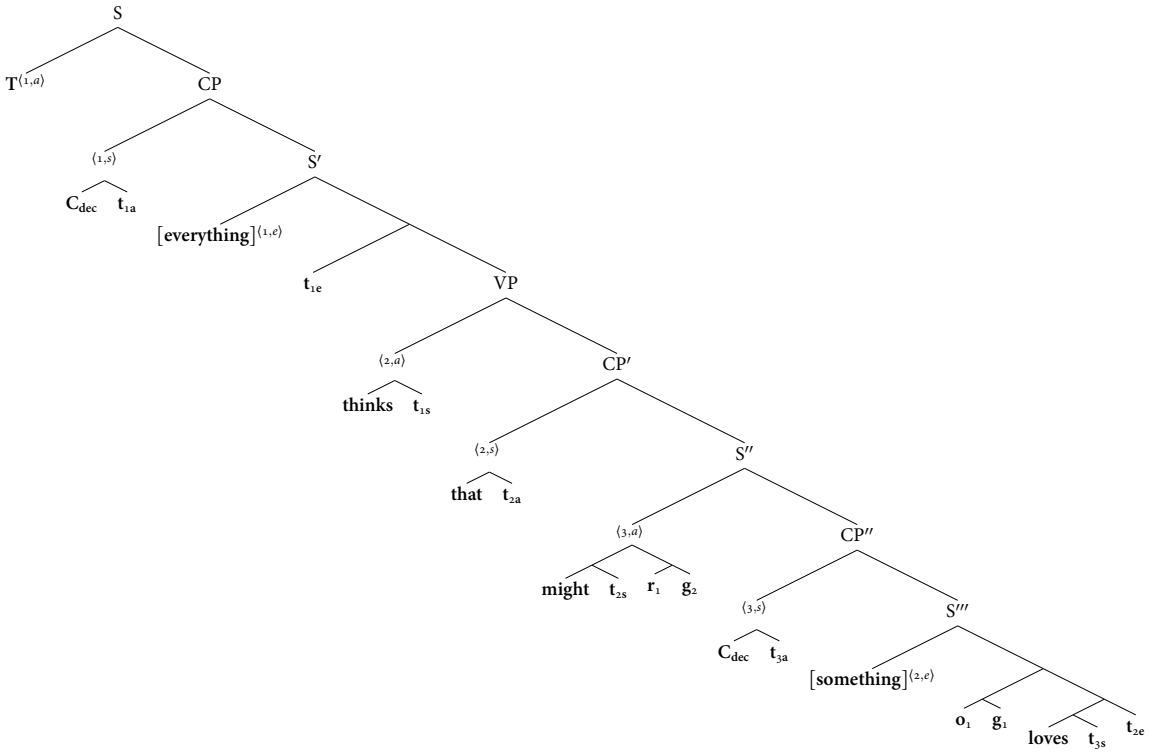



Like other accounts with covert world-variables, the present account has a resource for capturing Fodor's "third reading" in terms of long-distance/local binding. What is particular to the present account is how the binding is implemented — via coindexing involving the world-variable's sister assignment-variable — and what gives rise to the potential, or lack thereof, for the alternative readings with different predicate positions. **Intensionality** is diagnosed as local context-sensitivity of embedded world-variables, and it is captured via general mechanisms for capturing (possibly obligatory) local interpretation. Distinctions among readings are diagnosed in terms of movement and the general phenomenon of **optional local/global readings** of pronouns, here world-pronouns. Constraints on possible readings are explained in terms of the treatment of **pronouns vs. traces**.

### 4.3 Quantified modal attitude ascription

This section applies the proposed syntax/semantics to a more complex example such as (36) with a quantified modal ascription. Working through this example will help illustrate a range of features of the account, as concerning free/bound pronouns, modality, and local/global readings with context-sensitive expressions. (Hereafter, to improve readability I omit explicit reference to the quantification over $w \in D_s$ when the modal domain has been derived. As above I suppress certain irrelevant assignment modifications, indicated with '$\approx$'. Certain equivalences from assignment modification are highlighted for comment below. I use '$r$' in indices for type $\langle s, at \rangle$.)[18]

(36) Everything thinks that it might love something.




[18] I consider an alternative argument structure for the modal in §7.6. For space purposes further intermediate calculations must again be left to the reader:

$[\![\text{S}'''[\!]\!] = \lambda g_g.\exists x{:}\, g[x(g)/2e](1a)(1e)$ loves $x(g)$ in $g(3s)$

$[\![\text{CP}''[\!]\!] = [\![[\textbf{that } \textbf{t}_{3a}]^{\langle 3,s\rangle}[\!]\!]([\![\text{S}'''[\!]\!])$

$[\![S]\!] \approx \lambda g_g$ . for $a'' = \lambda g_g.g^{\frown}$,
$\forall y$: $\forall a_a$ s.t. $a(g)$ is compatible with $\text{SOM}_{y(g),\,@(a''(g))}$,
$\exists a'_a$ s.t. $a(g)(1r)(@(a(g)))(a'(g))$,
$\exists x$: $\underline{g[a''(g)/1a][y(g)/1e](1a)(1e)}$ loves $x(g)$ in $@(a'(g))$
$= \lambda g_g. \ldots$ $\exists x$: $\underline{g[a''(g[y(g)/1e])/1a](1a)(1e)}$ loves $x(g)$ in $@(a'(g))$
$= \lambda g_g. \ldots$ $\exists x$: $\underline{a''(g[y(g)/1e])(1e)}$ loves $x(g)$ in $@(a'(g))$
$= \lambda g_g. \ldots$ $\exists x$: $\underline{g[y(g)/1e]^{\frown}(1e)}$ loves $x(g)$ in $@(a'(g))$
$= \lambda g_g$ . $\forall y$: $\forall a_a$ s.t. $a(g)$ is compatible with $\text{SOM}_{y(g),\,@(g^{\frown})}$,
$\exists a'_a$ s.t. $a(g)(1r)(@(a(g)))(a'(g))$, $\exists x$: $\underline{y(g)}$ loves $x(g)$ in $@(a'(g))$

Roughly put: (36) is true iff for every individual $o$, for every possibility $h$ compatible with $o$'s beliefs, there is some possibility $h'$ accessible from $h$ such that there is some individual $o'$ whom $o$ loves in the world of $h'$.

### *4.3.1 Standardizing quantification. Binding with pronouns and traces*

As discussed previously, bound readings of pronouns, intensionality, shifting under modals, and context-sensitivity are captured via uniform syntactic/semantic mechanisms introducing quantification over individuals, worlds, and assignments.

Obligatory binding relationships may be established by (type-driven) movement. Movement generates a cross-categorial binder-index attaching to moved expressions, combining via function application. Notably, the complementizer moves from the main predicate's world-argument position, leaving a coindexed world-trace, fol-

---

$= \lambda g_g$ . $\exists x$: $g[w(g)/3s][x(g)/2e](1a)(1e)$ loves $x(g[w(g)/3s])$ in $@(g(3a))$

$[\![[\mathbf{r}_1\ \mathbf{g}_2]]\!] = [\![\mathbf{r}_1]\!]([\![\mathbf{g}_2]\!])$
$= [\lambda a'_a.[\lambda w_s.[\lambda a_a.[\lambda g_g\,.\,a'(g)(1r)(w(g))(a(g))]]]](\lambda g_g.g(2a))$
$= [\lambda w_s.[\lambda a_a.[\lambda g_g\,.\,g(2a)(1r)(w(g))(a(g))]]]$

$[\![S'']\!] = [\![[[\mathbf{might}\ \mathbf{t}_{2s}][\mathbf{r}_1\ \mathbf{g}_2]]^{\langle 3,a\rangle}]\!]([\![CP'']\!])$
$\approx \lambda g_g$ . $\exists a_a$ s.t. $g(2a)(1r)(g(2s))(a(g))$, $\exists x$: $g(1a)(1e)$ loves $x(g)$ in $@(a(g))$

$[\![VP]\!] = [\![[\mathbf{think}\ \mathbf{t}_{1s}]^{\langle 2,a\rangle}]\!]([\![CP']\!])$
$\approx \lambda y_e.\lambda g_g$ . $\forall a_a$ s.t. $a(g)$ is compatible with $\text{SOM}_{y(g),\,g(1s)}$,
$\exists a'_a$ s.t. $a(g)(1r)(@(a(g)))(a'(g))$, $\exists x$ s.t. $g(1a)(1e)$ loves $x(g)$ in $@(a'(g))$

$[\![S']\!] = [\![[\mathbf{everything}]^{\langle 1,e\rangle}]\!]\big([\![VP]\!](\lambda g_g.g(1e))\big)$
$\approx \lambda g_g$ . $\forall y$: $\forall a_a$ s.t. $a(g)$ is compatible with $\text{SOM}_{y(g),\,g(1s)}$,
$\exists a'_a$ s.t. $a(g)(1r)(@(a(g)))(a'(g))$, $\exists x$: $g[y(g)/1e](1a)(1e)$ loves $x(g)$ in $@(a'(g))$

$[\![S]\!] = [\![\mathbf{T}^{\langle 1,a\rangle}]\!]\,\big([\![[\mathbf{that}\ \mathbf{t}_{1a}]^{\langle 1,s\rangle}]\!]([\![S']\!])\big)$

lowed by the modal element's movement from the complementizer's assignment-argument position, leaving a coindexed assignment-trace. This coindexing-via-movement generates the local reading of each clause's main predicate: the "loving" occurs in worlds $u'$ ($=@(a'(g))$) compatible with the relevant information; the relevant information is determined relative to the worlds $u$ ($=@(a(g))$) compatible with the subject's attitude state; the subject's attitude state is assessed at the world $u''$ ($=@(g^{-})$) of the discourse context.

In contrast, the optional bound reading of 'it' is implemented via coindexing configurations with the pronoun-complex $[\mathbf{o}_1\ \mathbf{g}_1]$. The binder-index on $\textbf{everything}^{\langle 1,e\rangle}$ says to interpret $\mathbf{o}_1$ with respect to the input assignment modified to take $\langle 1, e\rangle$ to (in this case) $y(g)$. Although embedded under several assignment-shifters, the pronoun can be linked to the main-clause quantifier via its assignment-variable $\mathbf{g}_1$ coindexed with the topmost assignment-binder.

Analogous points hold with the modal's epistemic modal-background pronoun $[\mathbf{r}_1\ \mathbf{g}_2]$. The variable $\mathbf{r}_1$ is interpreted with respect to (takes as argument) the assignment variable $\mathbf{g}_2$ coindexed with the assignment-binder attaching to the attitude verb. This captures how the set of accessible possibilities is determined by the possibilities $a(g)$ compatible with the subject's state of mind. The generalized semantics for variables/traces (§2.1) derives how, although the lexical entry for the modal specifies an argument of type $\langle s, at\rangle$ and the modal quantifies over functions $a' : D_g \to G$, the value returned by $a(g)(1r)$ is a function from worlds $u \in W$ to (the characteristic function of) a set of assignments (possibilities) $h' \in G$, and the quantified condition is a condition on a possibility $h' \in G$ in this set $a(g)(1r)(u)$ (see n. 18). (I return to issues about local/bound readings of modal background variables below.)

### *4.3.2 Assignment modification and bound pronouns*

Capturing the bound interpretation of 'it' raises interesting general issues about assignment modification. The notion of a modified assignment is standardly introduced by saying something to the effect that $g[x/i]$ is the unique assignment which is just like $g$ except that $i$ is mapped to $x$. A question rarely (if ever) addressed is how to interpret expressions "$g[\ldots g\ldots/i]$" in our metalanguage, where the description of what $i$ gets mapped to uses the same letter as the letter used for the original assignment (here '$g$'). This question becomes pressing in derivations involving repeated assignment modifications — in particular, when encountering assignment-descriptions of the form "$g[\ldots g\ldots/i][\cdots]$."

The final steps in (36) provide such a case when $g[y(g)/1e]$ is to be modified to $g[a''(g)/1a][y(g)/1e]$. Given the standard characterization of modified assign-

ments, $g[y(g)/1e]$ is the assignment $g'$ that is just like $g$ except that $1e$ is mapped to $y(g)$; this modified assignment is modified to the assignment $g''$ that is just like $g'$ except that $1a$ is mapped to $a''(g)$. So, feeding $1a$ to $g''$ would seem to return $a''(g)$. Since $a''$ is (roughly) the identity function, $a''(g) = g^{-}$, and so, it would seem, $g''(1a) = g^{-}$. The critical question is what this resulting assignment returns for $1e$. What we want isn't whatever happens to be returned by the (counterpart in $G$ of the) original assignment $g$, i.e $g^{-}(1e)$, but what is returned by $g$ as modified by the initial modification, i.e. $g[y(g)/1e](1e) = y(g)$. What we need — and as yet fail to have — is a way of ensuring a sort of dynamic updating in repeated assignment modifications, so that references to "$g$" in later modifications refer to the assignments *as modified* in earlier steps.[19]

To capture this, I propose that we treat assignment modifiers as operators on assignments, and repeated modifications as proceeding via function composition.

(37) *Assignment modification*

a. $[z/\mathrm{i}\tau] := \lambda g_g \,.\, \iota m_g\colon m(\mathrm{i}\tau) = z \wedge m(\mathrm{j}\sigma) = g(\mathrm{j}\sigma)$, for all $\mathrm{j}\sigma \neq \mathrm{i}\tau$

b. $[\cdots][\ldots] := [\cdots] \circ [\ldots]$

c. $g_g[\cdots]_1 \ldots [\cdots]_n := [\cdots]_1 \circ \ldots \circ [\cdots]_n(g)$

These definitions derive the crucial equivalence step in (36), reproduced in (38); the modifier $[a''(g)/1a]$ is correctly treated as mapping $m = g[y(g)/1e]$ to an assign-

[19] The only place I've seen this issue addressed is Sternefeld 1998: 16–17. He cheats in the way mentioned in the main text.

ment $m'$ that is just like $m$ except that it maps $1a$ to *its* image under $a''$.[20]

(38) $g[a''(g)/1a][y(g)/1e](1a)(1e) = g\big[a''\big(g[y(g)/1e]\big)/1a\big](1a)(1e)$
$g[\dots g\dots][\cdots] = g\big[\dots g[\cdots]\dots\big]$

The remainder of the derivation proceeds straightforwardly: Given $1a$, the resulting assignment $g\big[a''\big(g[y(g)/1e]\big)/1a\big]$ returns $a''(g[y(g)/1e])$. Since $a'' = \lambda g_g.g^-$, this reduces to $g[y(g)/1e]^-$, which, given $1e$, returns $y(g)$, capturing the bound reading of the pronoun by the quantifier, as desired.

### *4.3.3 Epistemic modals: Locality and binding*

Paradigm context-sensitive expressions are at least optionally (if not obligatorily) interpreted with respect to the context of utterance when embedded in attitude ascriptions (§1). A principal challenge for contextualists has been to capture the contrasting behavior of epistemic modals, which seem obligatorily linked to the subject (§1). Likewise with quantificational subjects, as in (36), seeming to reflect a kind of binding. There is apparently no reading of (39) which ascribes to every contestant $o$ the belief that it's compatible with Alice's/Bert's evidence that $o$ is the winner.

---

[20]For readability I abbreviate the right conjunct in (37a) as $m(\mathrm{j}\sigma, \neq \mathrm{i}\tau) = g(\mathrm{j}\sigma, \neq \mathrm{i}\tau)$; and I use large parentheses to enclose descriptions of assignments when prefixed to an argument, e.g. $\big(\iota g\colon \dots\big)(4s)$:

(i) $[a''(g)/1a] = \lambda g_g\,.\,\iota m\colon m(1a) = a''(g) \wedge m(\mathrm{j}\sigma, \neq 1a) = g(\mathrm{j}\sigma, \neq 1a)$
$[y(g)/1e] = \lambda g_g\,.\,\iota m\colon m(1e) = y(g) \wedge m(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)$

$g[a''(g)/1a][y(g)/1e]$
$= \big([a''(g)/1a] \circ [y(g)/1e]\big)(g)$
$= \big[\lambda g'_g\,.\,[a''(g)/1a]([y(g)/1e](g'))\big](g)$
$= \Big[\lambda g'_g\,.\,\big[\lambda g''_g\,.\,\iota m\colon m(1a) = a''(g'') \wedge m(\mathrm{j}\sigma, \neq 1a) = g''(\mathrm{j}\sigma, \neq 1a)\big]$
$\big(\iota m'\colon m'(1e) = y(g') \wedge m'(\mathrm{j}\sigma, \neq 1e) = g'(\mathrm{j}\sigma, \neq 1e)\big)\Big](g)$
$= \big[\lambda g'_g\,.\,\iota m_g\colon m(1a) = a''\big(\iota m'\colon m'(1e) = y(g') \wedge m'(\mathrm{j}\sigma, \neq 1e) = g'(\mathrm{j}\sigma, \neq 1e)\big)$
$\wedge\, m(\mathrm{j}\sigma, \neq 1a) = \big(\iota m'\colon m'(1e) = y(g') \wedge m'(\mathrm{j}\sigma, \neq 1e) = g'(\mathrm{j}\sigma, \neq 1e)\big)(\mathrm{j}\sigma, \neq 1a)\big](g)$
$= \iota m_g\colon m(1a) = a''\big(\iota m'\colon m'(1e) = y(g) \wedge m'(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)\big)$
$\wedge\, m(\mathrm{j}\sigma, \neq 1a) = \big(\iota m'\colon m'(1e) = y(g) \wedge m'(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)\big)(\mathrm{j}\sigma, \neq 1a)$
$= \big[a''\big(\iota h'\colon h'(1e) = y(g) \;\wedge\; h'(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)\big)/1a\big](g)$
$= \big[a''\big([y(g)/1e](g)\big)/1a\big](g)$
$= g\big[a''\big(g[y(g)/1e]\big)/1a\big]$

(39) *Alice:* Bert thinks that [every contestant]$_i$ thinks she$_i$ might$_i$ be the winner.
(cf. Stephenson 2007: ex. 5b)

Relativist/expressivist theories offer general shifting mechanisms to capture this.[21] No rigorous compositional semantic account of the shifting and binding properties of epistemic modals has been attempted by contextualists.

The syntax/semantics in this paper **compositionally derives local and bound readings** of embedded epistemic modals, as in (36). Moreover it does so in a framework which maintains the **core contextualist idea** of modeling the context-sensitivity of recalcitrant expressions such as epistemic modals in the same kind of way as the context-sensitivity of paradigm context-sensitive expressions such as pronouns, namely via quantification/binding with assignment-variables.[22] The account may thus be of interest to theorists who are compelled by the thought that the interpretation of (e.g.) epistemic modals depends, in some sense, on context, but have reservations about innovations introduced by relativism/expressivism.

A general assignment-variable-based framework also provides a framework for theorizing about differences among expressions in **tendencies for local vs. global readings** (Silk 2016). For epistemic modals a locality principle might be given which excludes LFs in which the modal-background pronoun's assignment-variable isn't coindexed with the closest c-commanding assignment-binder.[23] Such a principle would be no more ad hoc than a globality principle for (e.g.) gendered pronouns excluding LFs in which the individual pronoun's assignment-variable is bound by an element other than **T**. For expressions permitting local and global readings, conversational explanations may be given regarding the expressions' tendencies for different readings. Such explanations would be understood at the "presemantic" level (Perry 2001) of what LFs are (not) determined by token utterances.

## 5 Recap. Next steps

Let's take stock. Independent linguistic phenomena have led various theorists to introduce assignments into the model, and to posit variables in the syntax for (e.g.) worlds, times, and elements interpreting referential expressions. This paper begins

[21] E.g., an informational parameter in the index coordinate on the interpretation function, which is shifted by attitude verbs (cf. Stephenson 2007, Yalcin 2007, Hacquard 2010):

(i) $[\![x \text{ thinks } S]\!]^{c;\,w,s} = 1$ iff $\forall u \in s'\colon [\![S]\!]^{c;\,u,s'} = 1$, where $s' = Dox(x, w)$

[22] There may of course be other differences among them (Tonhauser et al. 2013, Silk 2016).

[23] X c-commands Y iff neither node dominates the other, and the lowest branching node that dominates X dominates Y.

developing a linguistic theory which posits object-language variables for assignment functions — variables for the sort of item responsible for interpreting quantifiers and context-sensitive language generally — and treats compositional semantic values systematically in terms of sets of assignments. Principal features of the account are that it standardizes quantification across domains (e.g. individuals, worlds, assignments); and it systematizes a range of linguistic shifting phenomena, as with quantifiers, intensionality, and local/global readings of context-sensitive expressions.

A particular version of an assignment-variable-based account has been developed. The syntax and lexical/compositional semantics delineate the sources of intensionality and assignment-shifting: world-quantification/binding arises from the complementizer, which moves from the world-argument position of the clause's main predicate; assignment-quantification/binding arises from modals (broadly construed), which move from the assignment-argument position of the C head. Binding with individuals/worlds/assignments is derived uniformly from a generalized binder-index resulting from type-driven movement. This binder-index attaches directly to moved expressions. The account avoids quantification-specific composition rules or added parameters of interpretation. A distinction between trace-binding and pronoun-binding — something arguably desirable for independent reasons (Büring 2004, 2005) — falls out directly (more on which in §6.3.1). An improved formalization of assignment modification was provided, which helps capture binding relations in examples with repeated modifications.

Philosophically, the account can be understood as providing a precise formal implementation of Stalnaker's "multiple context" approach to attitude ascriptions. The syntax/semantics affords a unified analysis of the context-sensitivity of pronouns, epistemic modals, etc., in the spirit of contextualist theories. Yet it improves in compositionally deriving certain distinctive shifting phenomena (e.g. with epistemic modals), and providing a framework for theorizing about expressions' different tendencies for local/global readings. Further (grammatical, lexical, metasemantic, conversational) constraints on readings call for more thorough investigation.

§§2–4 focused on applying the assignment-variable-based framework and particular treatment of the syntax/semantics interface to certain phenomena with quantifiers, attitude verbs, and modal verbs. The remainder of the paper begins to examine how the account may be extended to other types of constructions. I focus on phenomena with local/global readings in questions and conditionals.

Extending an assignment-variable-based account to a particular expression or construction isn't as straightforward as taking one's favorite style of analysis and adding assignment-variables to interpret any other variables or context-sensitive

elements. The treatments of intensionality and modals in §3 relied on particular assumptions about the syntax and semantics to motivate a basis for introducing the relevant world- and assignment-binders, traces, and variables. Whatever style of analysis one assumes for a given further expression, one needs to ensure that any binder indices and sources of shifting phenomena can be derived from features of the syntax/semantics that are independently attested and continuous with the theory developed thus far — e.g., base-generating complementizers in the world argument position of the clause's main predicate, and base-generating assignment-shifters, such as certain semantically modal expressions, in a relevant assignment-argument position. §6 draws on prominent head-raising and D-complement analyses of relative clauses to develop an assignment-variable approach to relativization and donkey anaphora, with determiner quantifiers now introducing quantification over assignments. §7 turns to local/global readings in conditionals, drawing on developments on 'if'-clauses as free relatives, now construed as definite descriptions of possibilities, i.e. assignments. The approach to pronominal anaphora from §6 is generalized to proforms in correlatives and 'then' conditionals. §8 examines local/global readings in interrogative sentences, drawing on developments from Heim of an approach to questions as sets of possible answers, with answers now construed as sets of assignments. The proposed syntax/semantics afford uniform analyses of *wh*-words, indefinites, and relative determiners as choice-function pronouns, and of interrogative sentences, 'if'-clauses, and non-modal correlative clauses; and they capture a spectrum of shifting phenomena with 'if'-clauses in sentence-initial, sentence-internal, and sentence-final positions (adjoined to NP/VP/IP/CP), and conditionals with modalized/non-modalized and declarative/interrogative main clauses.

## 6 Relative clauses. Donkey anaphora

The following sections examine applications of the assignment-variable framework to various types of non-declarative clauses and linguistic anaphora. I begin with relative clauses. §6.1 motivates a treatment of determiner quantifiers in headed relative clauses as quantifying over assignments. §6.2 applies the treatment of relative clauses from §6.1 to several types of donkey anaphora. Speculative extensions to further phenomena with pronominal anaphora — including reflexives, inverse linking, genitive binding, and weak crossover — are briefly considered in §6.3. Principal features of the proposed assignment-variable-based account are as follows:

- the syntax/semantics of relative clauses derives individual- and assignment-binders from independently motivated **D-complement and raising analyses**;
- the semantics is **fully compositional**: the account doesn't require additional

composition rules such as Predicate Abstraction, Predicate Modification, or Hamblin Function Application, and it avoids introducing independent principles for interpreting reconstructed phrases or traces vs. pronouns; a limited role for function composition is briefly considered;

- the semantics of determiner quantifiers and treatment of donkey pronouns as copies of their linguistic antecedents allow for existential readings of donkey sentences, capture **specific and nonspecific readings** of donkey pronouns in **intensional contexts**, and avoid the **proportion problem**.

## 6.1 Relative clauses

I focus primarily on headed restrictive relative clauses such as (40) — to a first approximation, constructions in which a head constituent ('baby') is modified by a subordinate relative construction by means of a (possibly implicit) relative pronoun ('which') or complementizer ('that').

(40) a. Every [baby which __ laughed] is cute.
b. Every [baby which Alice likes __] is cute.

(Terminology: I use 'relative clause' for expressions such as the bracketed material; I use 'relative pronoun/determiner' for (possibly implicit) 'which' in relative clauses; I use 'relative phrase' for the combination of the relative determiner and a nominal, e.g. 'which baby'. I use such terminology more-or-less theory-neutrally — e.g., my usage doesn't presuppose particular views on the syntactic category or semantic type of the matrix determiner's restrictor argument, the relation between relative determiners and interrogative *wh*-words, the semantic type of relative words such as 'which', or the syntactic presence and semantic type of the intuitive "gap" position. We will address these issues in due course.)

### *6.1.1 Syntax: Head raising + D-complement*

It is standard following Quine 1960 to treat restrictive relatives as supplying an additional restriction to the domain of the matrix determiner — e.g., treating 'baby which laughed' in (40a) as restricting the domain of 'every' to the set of babies *o* such that *o* laughed. How to derive this intuitive interpretation in the syntax and compositional semantics is controversial. A familiar idea is that the relative word triggers Predicate Abstraction, and the head NP and relative clause CP combine by Predicate Modification (Heim & Kratzer 1998):

(41) a. $[_{\text{NP}}$ baby $[_{\text{CP}_{\text{rel}}}$ which$_i$ t$_i$ laughed $]]$

b. $[\![\text{CP}_{\text{rel}}]\!] \approx \{o : o \text{ laughed}\}$
$[\![\text{NP}]\!] \approx \{o : o \text{ is a baby}\} \cap \{o : o \text{ laughed}\} = \{o : o \text{ is a baby} \wedge o \text{ laughed}\}$

The syntax/semantics of relative clauses might necessitate additional composition rules such as Predicate Abstraction. Yet assuming such rules would be theoretically awkward at this stage, given the emphasis throughout the paper on avoiding syncategorematic treatments of binding and quantification. I will suggest that alternative **head raising analyses** provide a more attractive syntactic basis for developing an assignment-variable-based account of relative clauses.

It isn't uncommon in semantics to assume a "head external" syntax for relative clauses, e.g. in which the head NP is base-generated external to the relative clause CP, which is adjoined to/complement of the NP (Montague 1970, Chomsky 1977, Heim & Kratzer 1998).

(42) "Head-external" analysis:
$[_{\text{DP}}\ [_{\text{D}^{\text{o}}}\ \text{every}\ [_{\text{NP}}\ [\ \text{baby}\ [_{\text{CP}_{\text{rel}}}\ \text{which}_i\ [_{\overline{\text{C}}}\ [\ \text{C}_{\text{rel}}\ [_{\text{IP}}\ \text{t}_i\ \text{laughed}\ ]]]]]]]]$

Yet more common in contemporary syntax is to treat the head NP as having a representation *internal* to the relative clause. On arguably the most prominent version of this approach, the **head-raising analysis**, the head NP is base-generated inside the relative clause CP (Kayne 1994, Bianchi 1999, Bhatt 2002, de Vries 2002). One compelling source of evidence comes from languages with circumnominal relatives — relative constructions which overtly realize the sort of LF proposed by raising analyses, where the head NP is pronounced inside the relative clause (de Vries 2002). Theories differ on what syntactic mechanism triggers the movement of the head NP (e.g. case, agreement), and what position the NP occupies at LF. What is important in what follows is simply that the head NP can be reconstructed internal to the relative clause at LF. To fix ideas I assume that the relative clause CP is the complement of the matrix determiner (Kayne 1994, Schmitt 2000, de Vries 2002), as reflected in the preliminary LF in (43). (I consider the position of the relative phrase and the nature of the gap position shortly.)[24]

[24]An alternative "matching" analysis treats the head NP as having representations internal *and* external to the relative CP (Sauerland 2003; cf. Citko 2001). The matching analysis adopts more controversial assumptions about the syntax/phonology interface; I put it aside. What is important in what follows is simply that the nominal head can be interpreted internal to the relative CP. That the relative CP is a complement rather than an adjunct is accepted by theorists in head-external and head-internal camps (see also Partee 1975, Fabb 1990). For discussion of the syntax of relative constructions cross-linguistically, see Chomsky 1977, Dayal 1996, de Vries 2002.

(43) "Head-raising" analysis (preliminary)

$[_{DP}\ D^{o}\ [_{CP_{rel}}\ wh_{rel}\ NP\ [_{\overline{C}}\ C_{rel}\ IP\ ]]]]$

- NP reconstructs into the relative clause $CP_{rel}$ at LF
- relative clause $CP_{rel}$ is complement of D

Treating the head NP as interpreted internal to the relative clause raises prima facie challenges for the compositional semantics. Consider the DP 'every baby which laughed' in (40a). The predicate 'laughed' requires a sister of type $e$ or $\langle et, t\rangle$, yet 'baby' is type $\langle e, t\rangle$; hence simply reconstructing the head NP to the gap position in the IP would create a type mismatch. Reconstructing 'which' along with 'baby' could yield an argument of individual/generalized quantifier type to combine with 'laughed', given some suitable semantics for 'which'. However, proceeding in this way seems to predict that the relative clause is sentence type, although the matrix determiner 'every' presumably requires an argument of type $\langle e, t\rangle$. The compositional challenge is to capture both (i) that the IP-internal predicate ('laughed') can combine with whatever fills the gap position, e.g. yielding a type $t$ denotation for the IP, and (ii) that the relative clause CP is predicate type so that it can combine with the matrix determiner ('every').

Perhaps the only serious attempt to address this compositional semantic challenge for head-internal analyses comes from Bhatt 2002 (cf. Elbourne 2005), which resorts to non-compositional mechanisms for interpreting reconstructed phrases — notably (i) a principle of Trace Conversion from Fox (2000, 2002), which converts a relative phrase such as 'which baby' to a definite description ≈ "the baby identical to $x$," where (ii) the variable $x$ is bound by a binder index in SpecCP, which (for some unexplained reason) arises from the non-type-driven reconstruction of the relative phrase, and (iii) all copies of the relative phrase are deleted except the lowest copy reconstructed into the IP.[25] Other things equal it would be preferable to provide a

[25] Bhatt's account proceeds from a full chain such as (i-a) to (i-b), where deleting the non-lowest copies is assumed to leave a binder index in the position of the highest copy; and from (i-b) to (i-c) by Trace Conversion, where the relative phrase is replaced by a variable-bound definite description.

(i) a. every [[wh baby] Alice thinks [[wh baby] that Bert likes [wh baby]]]
b. every $\lambda x$ [Alice thinks [that Bert likes [*wh baby*]]]
c. every $\lambda x$ [Alice thinks [that Bert likes [**the baby identical to** $x$]]]

(cf. Bhatt 2002: exs. 35–38)

Compare Safir 1999, which analyzes certain lower copies like pronouns, and Sportiche 2006, which analyzes the lower copies as demonstratives. Safir appeals to Fiengo & May's (1994) mechanism of "vehicle change" to motivate treating copies of names and definite descriptions as potentially "evaluated as pronouns with respect to interpretive principles" (Safir 1999: 587); however, crucial

semantics for the head-raising analysis without needing to invoke independent (ad hoc?) principles of interpretation such as these.

The goal is to compositionally derive an interpretation of the relative clause from the lexical semantics of the relative determiner and relative complementizer, function application, and binding relations arising from type-driven movement. An attractive strategy is to treat the syntax/semantics of DPs in headed relative constructions parallel to the syntax/semantics of assignment-quantifiers such as modals from §§3, 7: Just as modal quantifiers raise for type reasons from inside their clausal complement, i.e. from an internal argument of the declarative/interrogative complementizer, **determiner quantifiers raise for type reasons from inside the relative clause complement** in headed relative constructions, i.e. from an internal argument of the relative complementizer.

There are various ways of implementing this approach in the syntax and lexical/compositional semantics. Choice points include (i) the position of the relative phrase at LF; (ii) the interactions among the relative complementizer, relative phrase, and (possibly gappy) IP in deriving a suitable argument for the matrix determiner; and (iii) the relation between relative words and interrogative *wh* words. To fix ideas: (i) I assume, following e.g. Sternefeld 2001, that the relative phrase is interpreted in $\text{SpecCP}_{\text{rel}}$. (ii) Just as the declarative complementizer raises for type reasons from a world-argument position inside the complement IP, a natural hypothesis is to treat the relative complementizer $\mathbf{C}_{\mathbf{rel}}$ as raising for type reasons from the individual-type gap position in the IP. (iii) I suggest a unified analysis of relative pronouns, *wh*-words, and (at least some) indefinites as choice-function pronouns. (More on indefinites in §6.2 and *wh*-words in §8.)

In sum, the core components of the account of (headed restrictive) relative clauses are as follows:

- *Head raising:* the head NP is interpreted inside in the relative clause at LF, specifically as sister to the relative determiner in $\text{SpecCP}_{\text{rel}}$
- *D-complement:* the relative clause $\text{CP}_{\text{rel}}$ is the complement of the matrix determiner
- *Syntax/semantics interface:*
  - the relative complementizer raises for type reasons from its IP complement, specifically from the (individual) gap position;

to Safir's general account is that quantified expressions, which include relative clause heads, "do not permit their variables to undergo vehicle change" (1999: 615). Given their purposes, neither Safir nor Sportiche provide derivations for their posited interpretations in the compositional semantics. (See also §7.7.1.)

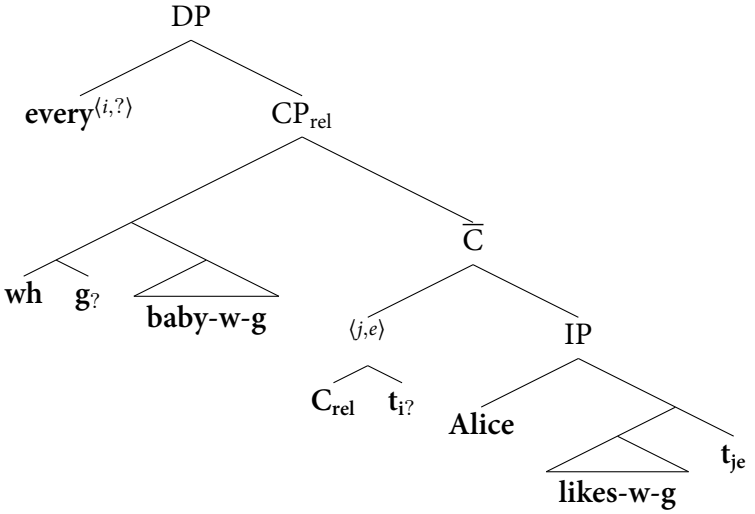
  - the matrix determiner raises for type reasons from its $CP_{rel}$ complement, specifically from an internal argument of the relative complementizer
- *Semantics:* relative determiners denote choice-function pronouns

A simplified LF (I address the question marks shortly):

(44) LF: *Headed relative DP: D $CP_{rel}$* (preliminary)

a. 'every baby which Alice likes'

b.

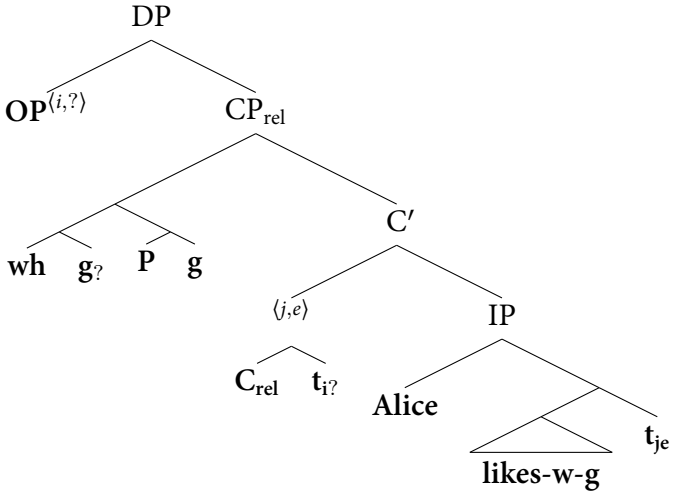



In headed relatives the matrix determiner raises from an internal argument of the complementizer to head the DP and the overt relative phrase restricts the determiner's restrictor argument. Free (non-headed) relatives with distributions of DPs — roughly, tensed free relatives in argument/adjunct positions — may be treated analogously. Adapting Comp accounts of free relatives (Groos & van Riemsdijk 1981, Grosu 1996, Caponigro 2002), the relative phrase is in SpecCP and what raises from $C^{o}_{rel}$ is the implicit definite determiner picking out the unique (possibly plural) individual satisfying the property denoted by the relative clause, as reflected in (45). (Bare free relative 'what' may be glossed informally as "which relevant thing(s)"; cf. e.g. Dayal 1996: 196.)

(45) LF: *Free relative as DP: $D_{\varnothing}$ $CP_{rel}$* (preliminary)

a. '(Bert likes) what Alice likes'

b.




*6.1.2 Semantics: Assignment-quantification with determiners*

Principal issues for the lexical/compositional semantics are the nature of the quantification introduced by the matrix determiner, and the binding relations among the matrix determiner, relative complementizer, and choice-function pronoun representing 'which'. To motivate answers to these questions, I take a brief detour to examine indefinites.

Indefinites in embedded contexts raise notorious challenges for compositional semantics. What is relevant here is simply the observation that the interpretation of indefinites can vary with a quantificational subject. First, certain indefinites can exhibit apparent intermediate readings in embedded contexts — readings "intermediate" between ordinary nonspecific readings, as in (46), and specific readings about a particular individual, as in (47), where the indefinite is specific relative to an attitude subject, supposition, or quantificational subject (Abusch 1994, Kratzer 1998), as in (48)–(50). The intermediate reading of (49) says that for every baby *o* there is some specific toy of mine that scared *o*, though which toy did the scaring may vary across babies (for Joe it was the clown, for Annie the jack-in-the-box, etc.).

(46) Alice thinks a friend of mine died in the fire.

a. Nonspecific reading: ≈ Alice thinks I had some friend or other who died in the fire

(47) If a friend of mine from Texas had died in the fire, I would have inherited a

fortune. (Fodor & Sag 1982: ex. 60)

a. Specific reading: ≈ there is some particular friend of mine, say Tex, such that I would have inherited a fortune if he had died in the fire

(48) Bert might think some stalker is out to get him.

a. Intermediate reading: ≈ it's possible that there is some particular stalker *o* such that Bert thinks *o* is out to get him (*might* > *indef* > *think*)

(49) Every baby cried because a (certain) toy of mine scared them.
(*every* > *indef* > *because*)

(50) Every professor rewarded every student who read a/some book he had recommended. (*every prof* > *indef* > *every student*)
(Abusch 1994: ex. 10; Kratzer 1998: ex. 16)

Second, in donkey sentences the interpretation of the pronoun varies as a function of the indefinite and supposed circumstance or quantificational subject:

(51) If a farmer owns a donkey, he beats it.

(52) Most farmers who own a shovel use it.

(52) isn't true simply if most farmer-shovel pairs $\langle x, y \rangle$ are such that $x$ uses $y$, or if most shovel-owning farmers use some stolen shovel or other; the truth of (52) requires that most farmers $x$ use some shovel owned by $x$. The quantificational force and content of the donkey pronoun varies with the subject and value for the indefinite in the quantifier's restriction.

The interpretation of certain indefinites and expressions linguistically dependent on them can *shift*, not only in "shifty" contexts such as conditionals and attitude ascriptions, but also under ordinary quantifiers. A hypothesis is that just as modal quantifiers can shift the interpretations of pronouns, so too, at least in some cases, with determiner quantifiers. This section develops a syntax/semantics of determiner quantifiers as involving quantification over assignments. §§6.2–6.3 apply the account to several types of pronominal anaphora. I leave applications to specific indefinites and other linguistic/discourse anaphora for future work.

I suggest that we treat **determiner quantifiers in headed relative clauses as quantifying over assignments**, and raising for type reasons from an internal assignment-argument of the relative complementizer. Intuitively put, a DP 'D wh-NP VP' such as 'every baby which Alice likes' quantifies over those individuals which could be chosen from among the NPs (babies) and would correctly answer the question of what VPs (what Alice likes). I offer the following lexical entry for the relative com-

plementizer $\mathbf{C_{rel}}$:[26]

(53) $[\![\mathbf{C_{rel}}]\!] = \lambda a_a.\lambda P_{et}.\lambda y_e.\lambda x_e.\lambda g_g\,.\,x(g) = y(g) \wedge P(x)(g)$

A relative CP denotes a singleton set of individuals — the singleton of individuals $x(g) \in E$ which have property $P$ and are identical to a given individual. The individual is supplied by the relative pronoun, analyzed as a **choice-function pronoun**.

(54) A function $F\colon [[X \to T] \to X]$ is a **choice function** iff $\forall P\colon X \to T \neq \varnothing\colon P(F(P))$.

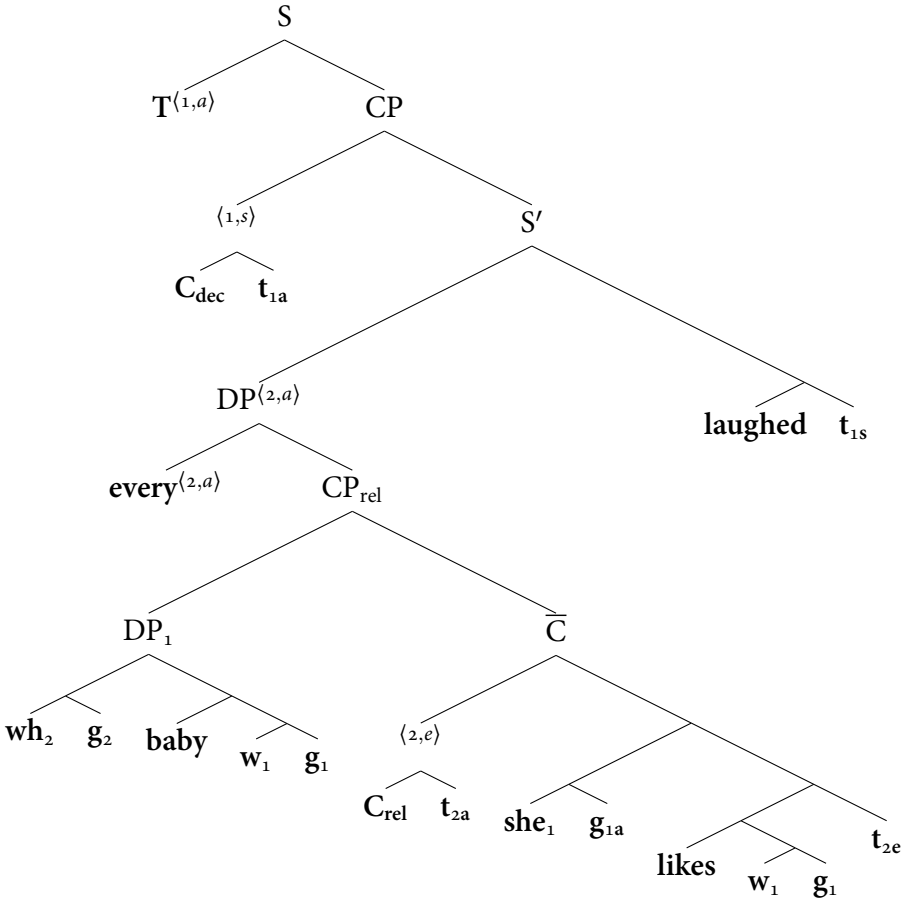
A choice function $F_{\text{cf}}$ of individuals selects a particular individual $o \in E$ from a non-empty set of individuals. The assignment-quantification introduced by the determiner shifts what individual is selected and thereby determines the domain. A first-pass entry for 'every' base-generated internal to a relative clause is in (55). The derived semantic value of a simple sentence with a free pronoun and headed relative follows in (56). (I will use 'cf' and '$F_{\text{cf}}$' specifically for indices/variables of type $\langle et, e\rangle$ that are choice functions. Recall $^{\downarrow}$ which "lowers" an item in a domain to an item composed out of associated elements of the model (§2). I use (e.g.) '$baby_u$' for the characteristic function of the set of individuals $o \in E$ such that $o$ is a baby in $u$. Hereafter for space purposes I omit many intermediate steps in derivations, and I often continue to omit explicit reference to the quantification over $w \in D_s$ when the modal domain has been derived; further calculations are left to the reader.)[27]

[26] Dayal (1996: 191–193) also proposes a substantive semantic value for the relative complementizer. Roughly speaking, Dayal treats the relative complementizer as type $\langle et, \langle et, \langle et, t\rangle\rangle\rangle$, returning for a relative clause 'wh-NP VP' the set of properties of the unique maximal plural individual which is NP and VP; the relative CP is itself a type-$\langle et, t\rangle$ plural definite description. Though such a semantics may be suitable for free relatives combining with a property-type or individual-taking argument, it doesn't apply to relatives combining with a determiner quantifier. Dayal is thus forced to treat relative expressions as ambiguous. By contrast, the entry in (53) and assignment-variable-based treatment of relative determiners generalizes to headed and free relative clauses. The distinctive definiteness effects associated with free relatives are captured, not via a distinct determiner-like relative complementizer, but via an implicit maximalizing operator (**ID** in (45)), analogous to the matrix determiner in restrictive relatives. In both cases the relative CP denotes a set of individuals. This clause is suitable to combine with a determiner quantifier, as in headed relatives, or maximalizing operator, as in free relatives. (Cf. Gajewski 2008 which captures the maximalization via a [DEF] feature on the relative complementizer.)

[27] In the general definition of the binder-index: with **every**, $\tau = a, \sigma = \langle\langle a, et\rangle, t\rangle, \sigma_1 = e$; with DP: D $\text{CP}_{\text{rel}}$, $\tau = a, \sigma = t, \sigma_1 = e$. I assume that the relative pronoun must have the same assignment-variable as the local relative complementizer, as due to agreement. As with other determiners, there may be reasons for incorporating domain variables to further restrict the domains of relative determiners. In (56) the domain variable may be treated as sister to 'baby' or as an additional argument of 'which', restricting the domain of the choice-function pronoun to a set of contextually

(55) $[\![\textbf{every}]\!] = \lambda P^{+}_{\langle a,et\rangle}.\lambda Q^{+}_{\langle a,et\rangle}.\lambda g_g\,.\,\big[\forall x_e \exists a_a\colon P^{+}(a)(x)(g)\big]\; Q^{+}(a)(x)(g)$

(56) 'Every baby which she likes laughed'




$[\![\textbf{wh}_2\ \textbf{g}_2]\!] = \lambda P_{et}.\lambda g_g\,.\,g(2a)(2\text{cf})((^{\downarrow}P)(g))$

$[\![\text{DP}_1]\!] = \lambda g_g\,.\,g(2a)(2\text{cf})\big([\lambda g_g.\text{the function } f \text{ s.t. for all } y_e, f(y(g)) \text{ iff } y(g) \text{ is a baby in } g(1a)(1s)](g)\big)$

$= \lambda g_g\,.\,g(2a)(2\text{cf})\big(\iota f \text{ s.t. for all } y_e, f(y(g)) \text{ iff } y(g) \text{ is a baby in } g(1a)(1s)\big)$

$\approx \lambda g_g\,.\,g(2a)(2\text{cf})(baby_{g(1a)(1s)})$

$[\![\text{CP}_{\text{rel}}]\!] \approx \lambda x_e.\lambda g_g\,.\,x(g) = g(2a)(2\text{cf})(baby_{g(1a)(1s)}) \wedge g(1a)(1e) \text{ likes } x(g) \text{ in } g(1a)(1s)$

$[\![\text{DP}^{\langle 2,a\rangle}]\!] \approx \lambda Q_{et}.\lambda g_g\,.\,\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(baby_{g(1a)(1s)})$

relevant babies. Compare von Fintel 1994, Büring 2004 invoking domain variables sister to the determiner, and Stanley & Szabó 2000, Stanley 2002 invoking domain variables sister to the noun phrase. For simplicity I continue to bracket such additional structure.

$$\wedge\, g(1a)(1e) \text{ likes } x(g) \text{ in } g(1a)(1s)\big]\; Q(x)(g[a(g)/2a])$$

$$[\![\text{S}]\!] \approx \lambda g_g\,.\,\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(baby_{g^-(1s)}) \wedge g^-(1e) \text{ likes } x(g) \text{ in } g^-(1s)\big]$$
$$x(g) \text{ laughed in } @(g^-)$$

Roughly put, the DP 'every baby which she likes' quantifies over those individuals $o \in E$ that are chosen by some choice function or other ($a(g)(2\text{cf})$) from among the babies ($baby_{g^-(1s)}$) and are liked by the contextually relevant individual ($g^-(1e)$). The sentence (56) is true iff every such individual $o$ laughed.

Several remarks: First, the preliminary implementation in §2 assumed that in the intended interpretation a certain world-index, say $g(1s)$, represents the world of the possibility represented by the assignment $g$. This assumption was dropped in §3 by invoking the metalanguage operator @. Examples with presuppositional predicates may motivate reintroducing the above metasemantic assumption. The quantification in (56) is over individuals that are babies in the actual (evaluation) world. Every account must adopt some metasemantic assumptions — general or specific to particular discourses — about the intended interpretations of different syntactic indices and about the relations among values assigned to shifted assignments (e.g., perhaps treating $1e$ as representing the speaker or an epistemic counterpart of the speaker (§3.4)). For simplicity I will retain our metalanguage @ operator while also assuming that the first-positioned world $1s$ represents the world of the possibility represented by the assignment, i.e. $g(1s) = @(g)$, for any $g_g$.

The above syntax/semantics compositionally derives the intuitive interpretation delivered by familiar semantics with Predicate Abstraction and intersective modification, and does so without positing additional composition rules or principles for interpreting reconstructed phrases (e.g. Trace Conversion). The syntax is coopted from prominent head-raising and D-complement analyses of headed relatives. The compositional semantics parallels the treatment of type-driven binding/quantification with verbal quantifiers and the declarative complementizer: Just as complementizers in matrix clauses raise from VP as quantifiers over worlds, capturing the obligatory local reading of the main predicate's world argument, analogously the relative complementizer $\mathbf{C}_{\mathbf{rel}}$ raises from the gap position in the relative clause, capturing the obligatory link between the gap and the nominal head. Just as modal quantifiers raise from inside their complement clause as quantifiers over assignments, determining the relevant modal domain, analogously the determiner quantifier 'every' in (56) raises from inside its complement $\text{CP}_{\text{rel}}$, determining the relevant domain of individuals.

It is standard in syntax to treat features on a head X as projecting to the XP.

Given the treatment of binder-indices as features on expressions, the assignment binder-index on 'every' projects to the DP. In what follows I will suggest that this assignment binder affords a resource for capturing shifted interpretations of pronouns and various phenomena with donkey anaphora.

## 6.2 Donkey anaphora

### *6.2.1 Indefinites and anaphors. Universal, existential, and asymmetric readings*

Consider (57), schematically represented in (58) (ignoring worlds).

(57) 'Every baby which got a toy liked it'

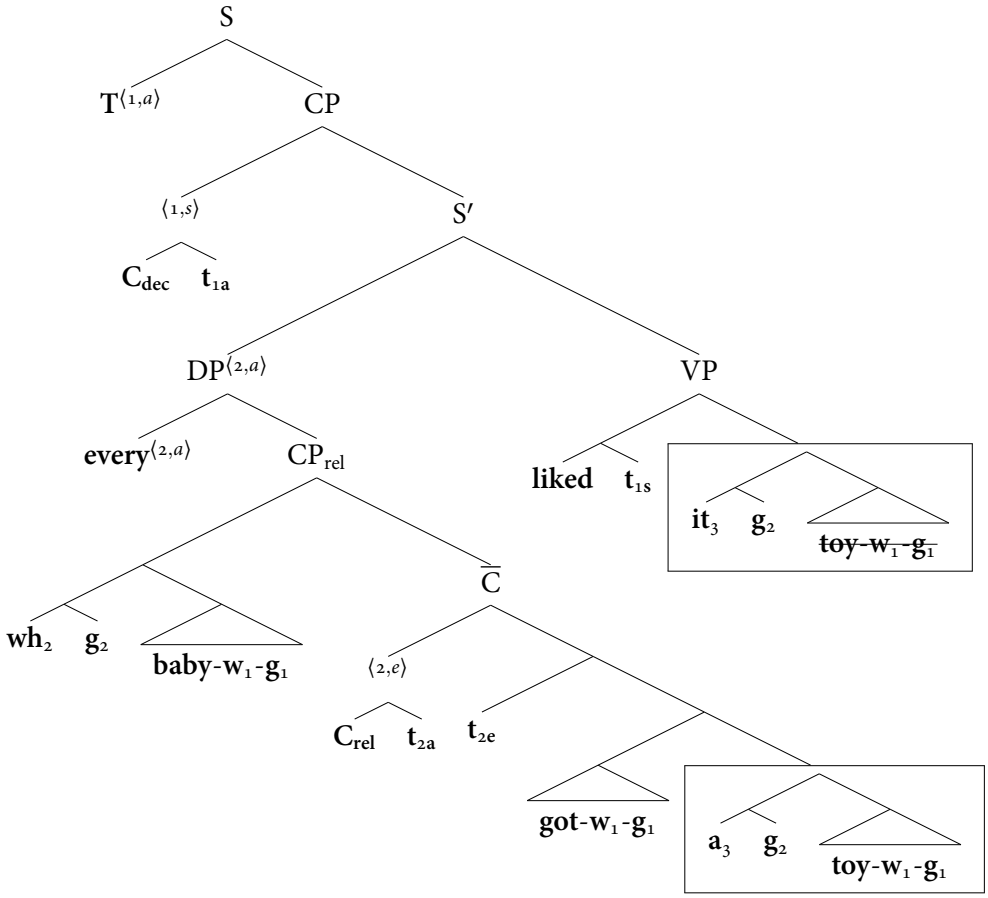
(58) $[_{S}\ \ldots[[_{DP}\ \text{every}^{\langle 2,a\rangle}\ [_{CP_{rel}}\ \text{wh}_2\ g_2\ \text{baby}\ [[\mathbf{C_{rel}}\ t_{2a}]^{\langle 2,e\rangle}\ [t_{2e}\ \text{got}\ \underline{???\text{-toy}}]]]]\ \text{liked}\ \underline{???}\ ]]$

As is familiar, the donkey pronoun 'it' isn't c-commanded by its apparent linguistic antecedent, the indefinite 'a toy'. Simply representing 'it' with some individual pronoun $[\mathbf{it}_3\ \mathbf{g_i}]$ doesn't capture the intuitive anaphoric interpretation: coindexing the assignment-variable with the topmost assignment-binder yields a claim about $g_c(3e)$, and coindexing it with $\mathbf{every}^{\langle 2,a\rangle}$ yields a claim about $g_c(2a)(3e)$. Approaches to donkey anaphora are diverse. One might layer resources from one's preferred theory into an assignment-variable-based framework — e.g., adding unselective binders and revising the treatment of indefinites (Kamp 1981, Heim 1982), or treating donkey pronouns as E-type descriptions and introducing mechanisms for recovering the relevant descriptive content (Heim 1990, Büring 2004, Elbourne 2005). However, it is worth exploring whether the assignment-quantification with determiners could be exploited for developing an account of apparent non-c-command anaphora such as donkey anaphora.

A common approach in both dynamic and non-dynamic theories is to treat indefinites as introducing a (new) variable, as for an individual (Kamp 1981, Heim 1982) or choice function (Reinhart 1997, Kratzer 1998). Given the above treatment of relative pronouns, suppose we treat (at least some) indefinite determiners, such as 'a', likewise as choice-function pronouns. To a first approximation, I suggest representing donkey pronouns in sentences such as (57) as **copies of their linguistic antecedent**. There are various ways of implementing this idea. One option is to treat the anaphoric pronoun DPs as coindexed choice-function pronouns with an elided copy of the antecedent complement NP, as reflected in (59). (Such an approach might be understood as an assignment-variable-based analogue of the NP-deletion E-type theory in Elbourne 2005.)[28]

[28]Alternatively, the pronouns could be treated as denoting identity functions and taking the

(59) ‘Every baby which got a toy liked it’




unpronounced representation of the antecedent DP as argument. In what follows I often use ‘$\mathbf{o_i}$’ short for ‘$\mathbf{o_{icf}}$’ in the representations of individual pronouns and choice-function variables. Free readings could be represented with simple type *e* pronouns, or uniformly with choice-function pronouns; the choice-function pronoun would be coindexed with the topmost assignment-binder, and the complement would be trivial (≈ “which thing”) or supplied by a property-type pronoun.

I focus exclusively on instances of donkey anaphora where the pronoun has a linguistic antecedent. I leave open how exactly the account may be extended to “paycheck” pronouns, as in (i)–(ii), where the pronoun’s covarying interpretation is (at least partly) contextually determined.

(i) [Context: A new faculty member picks up her first paycheck from her mailbox. Waving it in the air, she says to a colleague:]
Do most faculty members deposit it in the Credit Union?

(ii) John gave his paycheck to his mistress. Everybody else put it in the bank.
(Elbourne 2005: exs. 43–44)

$$[\![\mathrm{DP}^{\langle 2,a\rangle}]\!] \approx \lambda Q_{et}.\lambda g_g\,.\,\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(baby_{g(1a)(1s)})$$
$$\wedge\, x(g) \text{ got } a(g)(3\mathrm{cf})(toy_{g(1a)(1s)}) \text{ in } g(1a)(1s)\big]\; Q(x)(g[a(g)/2a])$$
$$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(baby_{g^-(1s)}) \wedge x(g) \text{ got } \underline{a(g)(3\mathrm{cf})(toy_{g^-(1s)})} \text{ in } g^-(1s)\big]$$
$$x(g) \text{ liked } \underline{a(g)(3\mathrm{cf})(toy_{g^-(1s)})} \text{ in } @(g^-)$$

$\mathrm{CP}_{\mathrm{rel}}$ denotes a singleton set of individuals that are selected by some particular choice function and got a toy selected by some particular choice function. The determiner's assignment-binder binds the assignment-variables in the choice-function pronouns representing the indefinite 'a toy' and relative phrase 'which baby'. Roughly, the DP 'every baby which got a toy' quantifies over those individuals $o \in E$ such that there are choice functions $F, F'$ s.t. $F$ $(=a(g)(2\mathrm{cf}))$ selects $o$ from among the babies, $F'$ $(=a(g)(3\mathrm{cf}))$ selects some $o'$ $(=a(g)(3\mathrm{cf})(toy_{g(1s)}))$ from among the toys, and $o$ got $o'$ — babies $o$ that got some toy or other $o'$. The sentence is true iff for every such individual $o$, $o$ liked $o'$. The apparent anaphoric connection between 'a toy' and 'it' is captured by (i) the syntactic identification of the donkey pronoun with its linguistic antecedent $[\mathbf{a}_3\text{-}\mathbf{g}_2\ \mathbf{toy}\text{-}\mathbf{w}_1\text{-}\mathbf{g}_1]$, and (ii) the assignment-quantification/binding introduced by the determiner.

Although the entry in (55) introduces quantification over assignments, the determiner's semantics is still a selective quantification that relates sets of individuals. The account avoids the **proportion problem** (Heim 1990) facing unselective binder approaches, which fundamentally relate sets of assignments (Lewis 1975, Kamp 1981, Heim 1982). Consider an asymmetric reading with 'most' in (60), assuming an LF parallel to (59).

(60) 'Most babies which got a toy liked it'
$$\approx \lambda g_g\,.\,\big[MOST\, x_e\colon \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(baby_{g(1s)}) \wedge x(g) \text{ got } a(g)(3\mathrm{cf})(toy_{g(1s)}) \text{ in } g(1s)\big]$$
$$x(g) \text{ liked } a(g)(3\mathrm{cf})(toy_{g(1s)}) \text{ in } @(g)$$

(60) is correctly predicted false in a scenario where one baby $b_1$ got four toys and liked them, and two babies $b_2, b_3$ didn't like the unique toy they got: $b_2/b_3$ satisfy the restriction that there are choice functions which select them from among the babies and select a toy they got; however, $b_2/b_3$ fail to satisfy the scope condition since they don't like the selected toy, i.e. $a(g)(3\mathrm{cf})(toy_{g(1s)})$. The semantics avoids giving symmetric construals of asymmetric readings.

The semantics for 'every' in (55) derives a so-called "universal reading" for donkey sentences: (59) requires that for every baby $o$ s.t. there is some choice function $F'$ that selects a toy $o$ got, $o$ likes the toy selected by $F'$. Although many theo-

ries predict only universal readings for donkey sentences (Kamp 1981, Heim 1982, Groenendijk & Stockhof 1991, Elbourne 2005), it has been observed that some donkey sentences have existential readings. (61b) is intuitively true as long as every person who has a dime will put *some* dime that she has in the meter.

(61) a. Yesterday, every person who had a credit card paid his bill with it.
(R. Cooper)
b. Every person who has a dime will put it in the meter.
(Pelletier and Schubert 1989)
c. Every person who submitted a paper had it rejected once.
(Chierchia 1995: ex. 3)

One way of capturing existential readings is to weaken the semantics of the determiner. Consider the following alternative entry and semantic value for (59):

(62) $[\![\textbf{every}]\!] = \lambda P^{+}_{\langle a,et\rangle}.\lambda Q^{+}_{\langle a,et\rangle}.\lambda g_g\,.\,\big[\forall x_e \exists a_a\colon P^{+}(a)(x)(g)\big]$
$\exists a'_a\colon P^{+}(a')(x)(g) \wedge Q^{+}(a')(x)(g)$

(63) $[\![(59)]\!] \approx \lambda g_g\,.\,\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(baby_{g(1s)}) \wedge x(g)$ got $a(g)(3\text{cf})(toy_{g(1s)})$ in $g(1s)\big]$
$\exists a'_a\colon x(g) = a'(g)(2\text{cf})(baby_{g(1s)}) \wedge x(g)$ got $a'(g)(3\text{cf})(toy_{g(1s)})$ in $g(1s)$
$\wedge\, x(g)$ liked $a'(g)(3\text{cf})(toy_{g(1s)})$ in $@(g)$

The semantics in (62) requires that, for every individual satisfying the restriction given some assignment $a$, there is some assignment — not necessarily $a$ — that verifies both the restriction and scope. The derived semantic value for (59) represents the existential reading: (63) says, roughly, that for every $o \in E$ s.t. [there are choice functions $F, F'$ s.t. $o = F(baby)$ and $o$ got $F'(toy) = o'$], there is a choice function $F''$ s.t. $o$ got $F''(toy) = o''$ and $o$ liked $o''$. There is universal quantification over the subject-babies $o$, but existential quantification in the scope over toys liked by $o$ — more precisely, over assignments which determine choice functions that select a toy $o$ liked from among the toys $o$ received. The condition "$P^{+}(a')(x)(g)$" in (62) ensures that the choice function $F''$ relative to which the individuals $o$ satisfy the scope condition — that $o$ likes $F''(toy)$ — selects a toy received by $o$. (57) is still correctly predicted false in a scenario where a baby $b$ liked some toys or other but hated all the toys it received.

It is contentious whether (at least some) donkey sentences conventionally have both existential and universal readings, or whether they conventionally have one type of reading (e.g. existential) and the other type of reading is conversationally derived. I leave open whether all universal readings can be derived conversationally,

or positing some sort of ambiguity is ultimately necessary (see Kanazawa 1994, Chierchia 1995, King 2004, Brasoveanu 2007). (Hereafter for simplicity assume the "universal reading" entries such as (55), unless indicated otherwise.)

### *6.2.2 Donkey pronouns in attitude ascriptions*

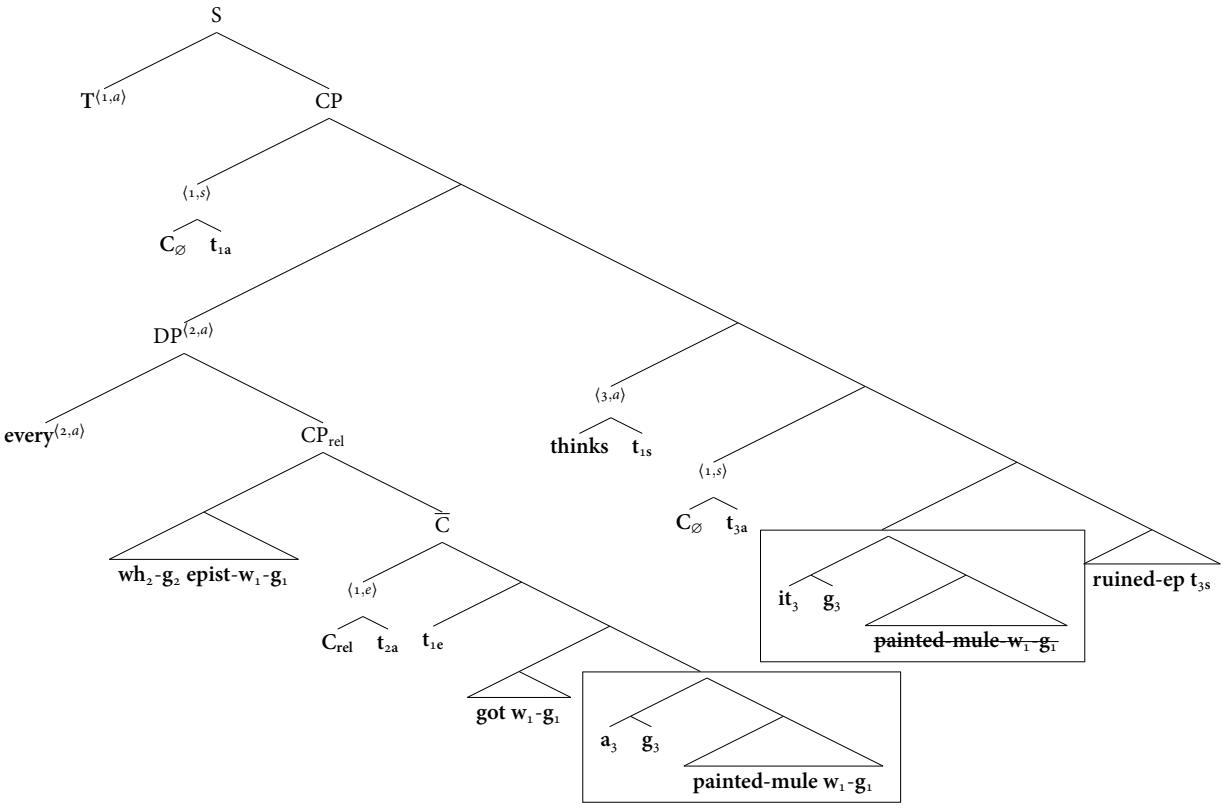
Consider (64) where a donkey pronoun is embedded under an attitude verb.

(64) Every woman who has a secret admirer thinks he is stalking her.
(King 2004: ex. 18)

King 2004 argues that such examples are problematic for main approaches to donkey pronouns such as DRT and dynamic theories. Insofar as these approaches treat donkey pronouns as semantically bound variables, they predict a specific reading for 'he', i.e. a reading which attributes to each relevant woman a belief about a particular individual. However, the attitude ascription can also receive a nonspecific reading which "can be true even though the women in question don't know who their secret admirers are" (2004: 105).

The account in this section provides a unified analysis of specific and nonspecific readings of donkey pronouns in intensional contexts. Consider the following LF and derived semantic value for (65) on a nonspecific reading, where which mule did the ruining may vary across the subject's doxastic alternatives. (Imagine that a trickster sent each zoo-owning epistemologist a letter with the latest delivery of animals that some or other of the zebra-looking animals was a cleverly painted mule.)

(65) 'Every epistemologist who got a painted-mule thinks it ruined-epistemology.'




$$\begin{aligned}[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\big[&\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(\mathit{epist}_{g^-(1s)})\\ &\wedge x(g)\text{ got } a(g)(3\mathrm{cf})(\mathit{painted\text{-}mule}_{g^-(1s)})\text{ in } g^-(1s)\big]\\ &\quad \forall a'_a\colon a''(g)\text{ is compatible with SOM}_{x(g),@(g^-)},\\ &\qquad a'(g)(3\mathrm{cf})(\mathit{painted\text{-}mule}_{g^-(1s)})\text{ ruined-epistemology in } @(a'(g))\end{aligned}$$

The subject DP quantifies over individuals $o \in E$ s.t. there are choice functions $F, F'$ s.t. $F$ selects $o$ from among the epistemologists and $o$ got $F'(\mathit{painted\text{-}mule})$. (65) says that for every such $o$, for every possibility $g'$ compatible with $o$'s state of mind, $g'(3\mathrm{cf})(\mathit{painted\text{-}mule})$ ruined epistemology. Which choice function is assigned to 3cf, and hence which individual is selected, may vary across the subject's doxastic alternatives. This represents the nonspecific reading.

Coindexing the donkey pronoun's assignment-variable with the subject DP's binder-index would represent a specific reading: the scope condition would require that a particular individual selected by $a(g)(3\mathrm{cf})$ ruined epistemology in every pos-

sibility compatible with the subject's state of mind. Nonspecific readings such as (65) may thus motivate allowing the anaphoric pronouns' assignment-variables to be locally bound by an intervening assignment-binder.

In contrast, the world-pronoun in the donkey pronoun's elided NP is *not* locally bound. King (2004) characterizes the nonspecific reading of sentences such as (64) as follows:

> These sentences certainly appear to have readings on which they attribute *de dicto* beliefs to the women in question. That is, they have readings on which they attribute to the women in question *general* beliefs to the effect that they are being stalked by secret admirers. This is why these sentences can be true even though the women in question don't know who their secret admirers are, and so have no beliefs about *particular* persons stalking them. (King 2004: 105; underline added)

King's gloss in the underlined portion is misleading. We saw in §4.2 that the de re/de dicto distinction cannot be assimilated to the specific/general distinction. The fact that the subject's beliefs are nonspecific — that the beliefs aren't about a particular individual — doesn't imply that the beliefs are de dicto in the sense that the subject represent the stalkers in question *as secret admirers*. The long-distance binding of the embedded world-pronoun in (65) captures this: The attitude ascription requires that, for some group of actual painted mules, each epistemologist in question thinks some or other of *them* ruined epistemology.

Examples such as (67) reinforce the de re reading of the donkey pronoun.

(66) Every boy who has a nickel in his pocket thinks it should go in the meter.

(67) [Context: The meter only takes quarters, and the boys know this. However, the boys confuse their coins and think that the nickels they have are quarters.]
Every boy who has a nickel in his pocket thinks it should go in the meter.
   a. *Nonspecific de re:* ≈ every boy who has some coins *o* that are nickels thinks that some *o* or other should go in the meter
   b. 'it' ≈ "a nickel$_{@}$"

(66) *might* be true because every nickel-owning boy correctly thinks that there are nickels in his pocket, and thinks that some or other of them should go in the meter. Yet as the context in (67) indicates, the quantified attitude ascription can be true even if the boys don't think that the coins in their pocket are nickels. What must be the case, however, is that each boy thinks, of a certain collection of coins (=actual nickels) he has, that some or other of them should go in the meter.

The above examples indicate that embedded donkey pronouns can have de re readings — readings where the NP's world-pronoun is coindexed with its antecedent and is bound long-distance. The stronger claim that the pronouns must have de re readings seems plausible as well. Contrast the infelicitous use of the donkey pronoun 'it' in (68) with the felicitous use of the explicitly spelled-out 'a dime', reflected in the informal indexing in (69).

(68) [Context: Each of the boys has dimes and nickels in his pocket. They are all confused about which coins are which: they think the dimes are nickels and the nickels are dimes. They would each say 'the meter only takes dimes', but since they are confused they would try to use a nickel.]

a. #Every boy who has a dime in his pocket thinks it should go in the meter
b. Every boy who has a dime in his pocket thinks a dime should go in the meter

(69) a. #Every boy who has a dime$_{@}$ in his pocket thinks$^{i}$ it$_{i}$ should go in the meter.
b. Every boy who has a dime$_{@}$ in his pocket thinks$^{i}$ a dime$_{i}$ should go in the meter.

'It' is anomalous in (68) where the boys don't think, of the *actual* dimes in their pocket, that some or other of *them* should go in the meter.

Nonspecific readings of donkey pronouns in attitude ascriptions may thus constitute a systematic case of the **nonspecific de re**. This point is arguably an instance of a general idea about donkey pronouns: that "there is a pairing of indefinite antecedents with donkey-pronouns that is purely syntactic (as expected under the unselective binding approach, but not available under the E-type approach)" (von Fintel 1994: 176, drawing on Kratzer 1995; underline added; cf. e.g. Heim 1990, Ward et al. 1991, Elbourne 2005, Patel-Grosz & Grosz 2010). Treating instances of donkey anaphora as copies of their linguistic antecedent (modulo possible differences in the pronounced D-head's assignment-variable) captures this.

King's (2004) own "Context-Dependent Quantifier" (CDQ) account also treats donkey pronouns as representing material from the linguistic context. Donkey pronouns are analyzed as quantifiers which inherit their force and restriction from their linguistic antecedent and other features of the sentence. Yet, first, absent additional mechanisms for capturing de re readings with narrow scope quantifiers, simply saying that the donkey pronoun "has the same quantificational force as its antecedent" (2004: 105) fails to capture the above nonsepecific de re readings — readings where the pronoun's intuitive descriptive content is anchored to the world of the antecedent.

Whatever mechanisms are provided, a pressing challenge is to explain the contrasts in available readings between donkey pronouns and explicit quantifier phrases, as in (68)–(69) (see Büring 2004, Elbourne 2005).

Second, King diagnoses specific vs. nonspecific readings of donkey pronouns in intensional contexts in terms of differences in scope: insofar as the pronoun is quantificational, it may take varying scopes with respect to attitude verbs. This diagnosis is problematic. Donkey pronouns can receive specific readings even when embedded in scope islands such as 'if'-clauses, as in (70).

(70) Every star who has a/some secret admirer thinks that if he is a stalker, he is evil.

  a. *Specific de re:* ≈ every star who has a certain secret admirer *o* thinks that if *o* is a stalker, *o* is evil

By contrast, the account in this section diagnoses the distinction between specific vs. nonspecific readings of donkey pronouns in terms of coindexing on the choice-function pronoun's assignment-variable (see (65)).

Third, King must ensure that the donkey pronoun-quantifier's restriction isn't identified with the restriction of its linguistic antecedent, but is rather "determined by the predicative material in the sentence in which the antecedent occurs" (2004: 106). For instance, the restriction in (71) must be recovered from 'donkey' and some combination with 'farmer' and 'owns', so that 'it' quantifies over donkeys owned by the quantificational subject; (71) isn't equivalent to (72).

(71) Every farmer who owns a donkey beats it.

(72) Every farmer who owns a donkey beats a donkey.

In other work King identifies the restriction of a discourse anaphoric pronoun (with antecedent headed by a symmetric monotone increasing determiner such as 'a') with "the intersection of the denotation of its antecedent's N-bar constituent, the denotation of the set term the antecedent attaches to, and the denotation of any predicative material occurring in a sentence intervening between S and the antecedent which contains a cdq [anaphoric pronoun] with the same antecedent" (King 1994: 224). It isn't immediately obvious how to implement this idea in the case of donkey sentences. There is no syntactic constituent in e.g. (71) corresponding to the intuitive restriction 'is owned by *x*' or 'is a donkey owned by *x*'. The relation in more complex examples can be even more indirect:

(73) Every farmer who beats a donkey that loves a donkey hates it.

The syntax/semantics in this section avoids such issues. Instances of donkey anaphora are represented syntactically as copies of their linguistic antecedents. The semantic restriction in interpreting the donkey pronoun is captured by the assignment-quantification introduced by the matrix determiner, which requires that the assignment verifying the determiner's scope argument verifies the restrictor argument.

## 6.3 Extensions: DPs and pronoun binding

### *6.3.1 Determiners and assignment-quantification?*

The semantics in (55)/(62) treat determiners such as 'every' in headed relative clauses as type $\langle\langle a, et\rangle, \langle\langle a, et\rangle, t\rangle\rangle$. The assignment binder-index resulting from the movement from $\mathbf{C_{rel}}$ and projecting to the DP helped capture the obligatory link between the relative phrase and gap position in the relative clause, and certain anaphoric dependencies between the determiner's restrictor and scope. A pressing question is how this syntax/semantics in relative constructions relates to the quantifiers' familiar $\langle et, \langle et, t\rangle\rangle$ lexical entries.

A conservative response would be to treat determiner quantifiers as systematically ambiguous between items taking arguments of type $\langle e, t\rangle$ vs. $\langle a, et\rangle$, or to introduce a general lexical rule which converts the basic familiar lexical entry into an "assignment-lifted" entry. Such moves are familiar from type-shifting and flexible-type approaches to quantifiers, connectives, etc. (Partee & Rooth 1983, Hendriks 1993, Jacobson 1999; cf. Heim & Kratzer 1998). LFs with the "wrong" homonym or entry could be semantically excluded due to incurring a type-mismatch, as when the determiner is generated inside a relative clause.

An alternative more revisionary option is to analyze determiner quantifiers as in general taking CP complements, and to say that apparent NP complements have covert structure corresponding to that in a relative clause, as reflected in (74).

(74) $[_{\text{DP}}\ [_{\text{D}}$ Every $[_{\text{CP}}\ \ldots\ [_{\text{NP}}$ baby $]\ \ldots]]]$ laughed

Though such a response may seem outlandish, it is perhaps not entirely without precedent. For instance, headed relative clauses aren't the only case of determiners taking CP complements cross-linguistically (Caponigro 2002, de Vries 2002, Hankamer & Mikkelsen 2012). Unifying the structure of DPs would afford a simple hypothesis. Second, in order to capture how the temporal interpretation of presuppositional noun phrases can be independent of the temporal interpretation of a clause's main predicate, Kusumoto 2005 raises the type of determiners to include extra quantification over times; the complement is effectively given the structure of a TP. As we have seen, the assignment(s) relevant for interpreting presuppositional

noun phrases can differ from the assignment(s) for interpreting the clause's main predicate as well. The above DP: D CP, type $\langle aet, \langle aet, t\rangle\rangle$ implementation is an instance of the general approach to the syntax/semantics interface throughout the paper.

The extra structure afforded by a general D CP analysis may provide a locus for implicit domain restriction in simple examples such as (75) (n. 27). The domain variable providing the contextually relevant restriction in (75b) is represented analogously to the explicit restriction in a headed relative (again ignoring worlds).

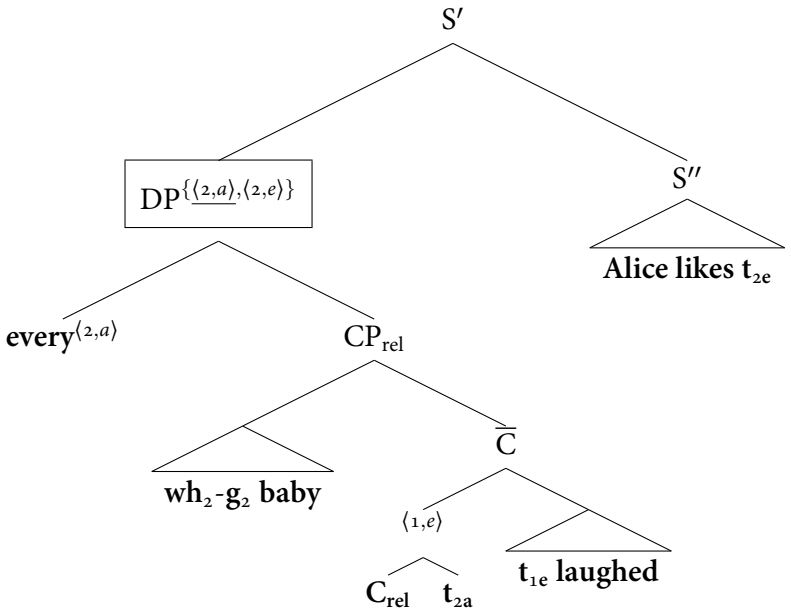
(75) a. Every baby laughed.
b. $[_{S} \ldots [[_{DP}\ \text{every}^{\langle 2,a\rangle}\ [_{CP}\ F_{2cf}\text{-}g_2\ \text{baby}\ [_{\overline{C}}\ [C\ t_{2a}]^{\langle 1,e\rangle}\ [t_{1e}\ [\underline{P_{1et}\ g_1}]]]]]]^{\langle 2,a\rangle}\ \text{laughed}]]$
c. $[\![S]\!] \approx \lambda g_g\,.\,\left[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(baby) \wedge g(1et)(\overline{x(g)})\right]\ x(g)\ \text{laughed}$

Second, the assignment-binding introduced by the determiner may help capture reflexives and bound readings of pronouns without needing to posit non-type-driven QR of the subject quantifier, as in Heim & Kratzer 1998 (§4.3). The pronoun in (76) is represented, like donkey pronouns, as a copy of its linguistic antecedent.

(76) a. Every cat petted itself.
b. $[_{S} \ldots [[_{DP}\ \text{every}^{\langle 2,a\rangle}\ [_{CP}\ F_{2cf}\text{-}g_2\ \text{cat}\ [_{\overline{C}}\ \ldots]]]^{\langle 2,a\rangle}\ [\text{petted}\ [\text{itself}_2\text{-}g_2\ \sout{\text{cat}}]]]]$
c. $[\![S]\!] \approx \lambda g_g\,.\,\left[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(cat)\ldots\right]\ x(g)\ \text{petted}\ a(g)(2\text{cf})(cat)$

One issue concerns object-position quantifier phrases with relative clauses. In (77) the determiner 'every' raises from $CP_{rel}$ as a quantifier over assignments to take its type $\langle e, t\rangle$ restrictor argument, and the object-position DP QRs, binding an individual-trace (again ignoring intensionality).

(77) Alice likes every baby which laughed.




In principle one could treat the determiner's scope argument in such examples fundamentally as type $\langle e, t\rangle$. Yet such a move has an air of "multiplying senses beyond necessity." One would also need to stipulate that the assignment binder-index feature on the D head fails to project to the DP. A methodologically more attractive approach is to maintain the uniform type $\langle aet, \langle aet, t\rangle\rangle$. As in the subject-position examples, the assignment binder-index feature on D projects to the DP, and an individual binder-index attaches to the QR'd DP, as reflected in the feature set on the DP in (77). However, a prima facie worry may come from crossover…

### *6.3.2 Donkey crossings: Donkey crossover, inverse linking, genitive binding*

Following Reinhart 1983 a prominent generalization of **weak crossover** is that an expression $\beta$ can bind a pronoun only if $\beta$ is in an A-position (argument position) that c-commands the pronoun at LF. This generalization allows trace-binding but excludes pronoun-binding from $\overline{\text{A}}$-positions (non-argument positions), such as positions derived from QR or *wh*-movement, as reflected in (78).

(78) a. Who$_i$ ($t_i$) likes her$_i$ child?
b. Who$_i$ does her$_{j/*i}$ child like $t_i$?

Reinhart's generalization has been applied to donkey pronouns in cases of "donkey crossover" as well (Reinhart 1987, Chierchia 1995, Büring 2004):

(79) a. Every farmer who beat *a donkey*$_i$ killed *its*$_i$ lawyer.
b. ≈ "every farmer $x$ who beat a donkey killed the lawyer of the donkey beaten by $x$"

(80) a. **Its*$_i$ lawyer sued every farmer who beat *a donkey*$_i$. (Büring 2004: ex. 8b)
b. ≉ "every farmer $x$ who beat a donkey is such that the lawyer of the donkey beaten by $x$ sued $x$"

The object DP 'every farmer who beat a donkey' in (80) can bind its trace but, unlike the subject DP in (79), it cannot provide an antecedent for the donkey pronoun 'it'.

Absent additional constraints, nothing would seem to exclude the following rough LF and semantic value for (80):

(81) 'Its lawyer sued every farmer who beat a donkey'
a. $[_{S'}[_{DP}\ \text{every}^{\langle 2,a\rangle}\ [_{CP}\ \text{wh}_{2\text{cf}}\text{-g}_2\text{-farmer}\ [_{\overline{C}}\ [\text{C}\ \text{t}_{2a}]^{\langle 1,e\rangle}\ [\text{t}_{1e}\ \text{beat}\ \text{a}_3\text{-g}_2\text{-donkey}]]]]^{\underline{\{\langle 2,a\rangle,\langle 3,e\rangle\}}}$ $[_{S''}\ \text{the-lawyer-of-}\underline{\text{it}_3\text{-g}_2\text{-}\sout{\text{donkey}}}\ \text{sued}\ \mathbf{t}_{3e}]]$
b. $[\![(81a)]\!] \approx \lambda g_g.\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(\textit{farmer}) \wedge x(g)\ \text{beat}\ a(g)(3\text{cf})(\textit{donkey})\big]$ the-lawyer-of-$\underline{a(g)(3\text{cf})(\textit{donkey})}$ sued $x(g)$

This represents the unattested bound reading where the interpretation of the donkey pronoun covaries with the raised DP.

One *could* treat Reinhart's generalization as a basic principle in the grammar. LFs such as (81a) would be excluded because they violate Reinhart's generalization: the assignment-variable in the pronoun $[\mathbf{it}_{3\text{cf}}\ \mathbf{g}_2]$ (underlined in (81a)) is bound by the assignment-binder from the DP's $\overline{\text{A}}$-position.

It would be theoretically preferable to derive generalizations such as Reinhart's from more basic features of the syntax/semantics. A more explanatory approach might be to allow expressions to have multiple binder-indices, but include a constraint that no expression may bind distinct variables, in some relevant sense of binding — call it "s-binding." A first approximation is as follows. (I will often be sloppy about distinguishing expressions/variables (qua types) from occurrences.)

(82) *Variable Binding Constraint:* An occurrence of an expression in a tree $\gamma$ may s-bind occurrences of at most one variable.
a. An occurrence of an expression $\beta$ *s-binds* an occurrence of a variable $\mathbf{v}_{i\sigma}$ in $\gamma$ iff the sister of $\beta$ is the largest subtree of $\gamma$ in which $\mathbf{v}_{i\sigma}$ is s-free.
b. $\mathbf{v}_{i\sigma}$ is *s-free* in $\gamma$ iff there is no occurrence in $\gamma$ of an expression with binder-index feature $^{\langle i,\sigma\rangle}$ that c-commands $\mathbf{v}_{i\sigma}$.

An explanation of donkey crossover falls out directly: The raised object DP in (81a) has the set of binder-index features $^{\{\langle 2,a\rangle,\langle 3,e\rangle\}}$. Like all movement, QR leaves a coindexed trace. On the unattested reading, the assignment binder-index binds the assignment-variable in $[\mathbf{it}_3\ \mathbf{g}_2]$ and the individual binder-index binding the trace $\mathbf{t}_{3e}$. This violates the constraint in (82). The donkey pronoun cannot be bound by the raised DP because the DP's binding capacities are exhausted from binding the trace derived from QR. Hence a string such as in (81) can have an acceptable reading but only with an intuitively free reading of 'its'. No analogous constraint excludes an intuitively bound reading of 'its' in (79) where the DP is in an A-position: the subject DP doesn't bind a trace and is free to bind the donkey pronoun.

Adopting the general type-$\langle aet, \langle aet, t\rangle\rangle$ syntax/semantics of determiner quantifiers from §6.3.1 would provide a means of generalizing the above approach to weak crossover to examples without relative clause restrictor arguments, as in (83)–(84).

(83) *Every dog*$_i$ likes *its*$_i$ owner.

a. $[_S \ldots [_{S'}[_{DP}\ \text{every}^{\langle 2,a\rangle}\ [_{CP}\ F_{2cf}\text{-}g_2\text{-dog}\ [_{\overline{C}}\ [C\ t_{2a}]^{\langle 1,e\rangle}\ [t_{1e}\ P_{1et}\text{-}g_1]]]]]^{\underline{\langle 2,a\rangle}}$
$[_{VP}$ likes the-owner-of-$\underline{it_2\text{-}g_2\text{-}\sout{dog}}$]]]

(84) **Its*$_i$ owner likes *every dog*$_i$.

a. $[_S \ldots [_{S'}[_{DP}\ \text{every}^{\langle 2,a\rangle}\ [_{CP}\ F_{2cf}\text{-}g_2\text{-dog}\ [_{\overline{C}}\ [C\ t_{2a}]^{\langle 1,e\rangle}\ [t_{1e}\ P_{1et}\text{-}g_1]]]]]^{\underline{\{\langle 2,a\rangle,\langle 3,e\rangle\}}}$
$[_{S''}$ the-owner-of-$\underline{it_2\text{-}g_2\text{-}\sout{dog}}$ likes $\underline{t_{3e}}$]]]

The pronominal anaphors are represented as copies of their linguistic antecedents (§6.3.1). In (84) the trace $\mathbf{t}_{3e}$ must be bound by the individual binder-index on the QR'd DP. This excludes the assignment-variable in the representation of the pronoun 'its' from being bound by the assignment binder-index projecting from D to the DP.

The foregoing approach carries over to other recalcitrant cases of apparent binding out of DPs (see esp. Büring 2004). The remainder of the section considers two such cases: *genitive binding* and *inverse linking*.

Consider donkey-style anaphora and crossover with **genitives**:

(85) a. *Every boy*$_i$'s cat likes *him*$_i$.
b. ≈ "for every boy *b*, the cat owned by *b* likes *b*"

(86) a. *Every boy*$_i$'s *sister*$_j$'s cat likes *him*$_i$/*her*$_j$
b. ≈ "for every boy *b*, the cat of the *s* s.t. *s* is the sister of *b* likes *b*/*s*"

(87) a. **His*$_i$ dog likes *every boy*$_i$'s cat.
b. ≉ "for every boy *b*, the cat owned by *b* is liked by the dog owned by *b*"

In (85) the embedded DP 'every boy' can provide an antecedent for 'him' even

though it doesn't c-command the pronoun at LF, being in a specifier position of the main DP headed by the genitive **'s**. In (86) the pronoun can be linked either to the embedded DP 'every boy's sister' or to the DP 'every boy' embedded in it. Yet the interpretation of the pronoun cannot vary when the main genitive DP QRs in (87).

As is standard following Partee 1984, I assume that the interpretation of a genitive 'X's N' is determined relative to a contextually supplied relation-pronoun **R**. Adapting the D CP analyses above, suppose we treat the head determiner **'s** as originating in the CP complement; the nominal N is then sister to the choice-function pronoun in SpecCP, and the possessor X originates in $\overline{\text{C}}$ sister to **R**, as reflected in (88). (I assume that the genitive **'s** has the same semantics as 'the'.)

(88) 'Alice's cat'

a. $[_{\text{DP}}\ [_{\text{D}^0}\ \text{'s}^{\langle 2,a\rangle}\ [_{\text{CP}}\ \text{F}_{2\text{cf}}\text{-g}_2\text{-cat}\ [_{\overline{\text{C}}}\ [\text{C}\ \text{t}_{2\text{a}}]^{\langle 2,e\rangle}\ [_{\text{IP}}\ \text{t}_{2\text{e}}\ \text{R}_{1\text{eet}}\text{-g}_1\ \text{Alice}]]]]]^{\langle 2,a\rangle}$

b. $[\![(88\text{a})]\!] = \lambda P_{et}.\lambda g_g\,.\,\big[\iota x_e(g)\exists a_a\colon x(g) = a(g)(2\text{cf})(cat) \wedge g(1a)(1eet)(A)(x(g))\big]$
$P(x)(g[a(g)/2a])$

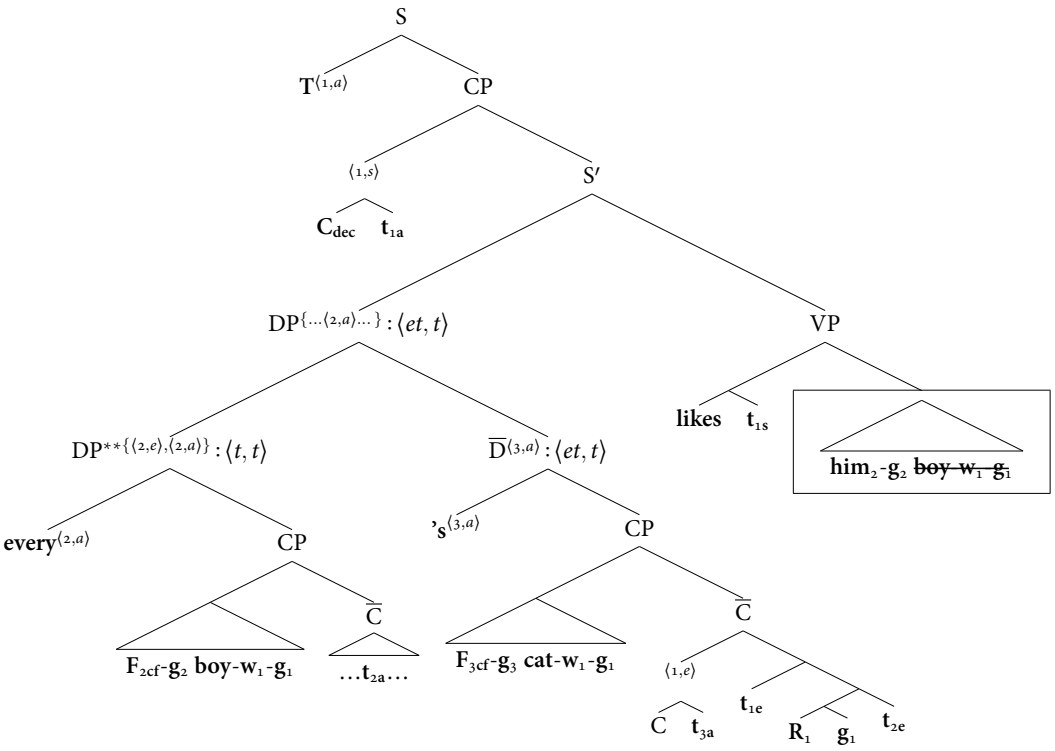
c. ≈ "the unique *o* s.t. there is a choice function that selects *o* from among the cats, and *o* bears the relevant relation *R* (e.g. "is owned by") to Alice"

In examples such as (85) with complex genitive DPs, the embedded DP 'every boy' raises to a specifier position of the main subject DP, and binds its trace in $\overline{\text{D}}$. The QR'd 'every boy' (type $\langle t, t\rangle$) must be able to combine with its sister ''s cat' (type $\langle et, t\rangle$) to form the subject DP (type $\langle et, t\rangle$). Thus far our compositional semantics has proceeded solely via function application; however, adapting the treatment of inverse linking in Kobele 2010, suppose that we allow a role for **function composition** in deriving the semantic values of certain adjunction structures, such as complex DPs formed from DP-internal QR/movement.[29] Combining $\overline{\text{D}}$ and the raised DP by function composition yields the subject DP of generalized quantifier type $\langle et, t\rangle$. as reflected in (89). The assignment binder-index feature projected to the DP binds the donkey pronoun.[30]

[29] Kobele 2010 also introduces assignments into the model and type system. Kobele doesn't go the further step of incorporating assignment-variables into the syntax, and doesn't examine how the analyses of assignments and the binder-index may be generalized for types other than *e*. I consider additional applications of function composition inverse linking below and with 'if'-clauses in §7.

[30] I assume that binder-index features projecting from the head D in the internally QR'd DP also project, and more generally that binder-index features c-commanding a head X in an XP project to the XP.

(89) *Every boy$_i$*'s cat likes *him$_i$*.

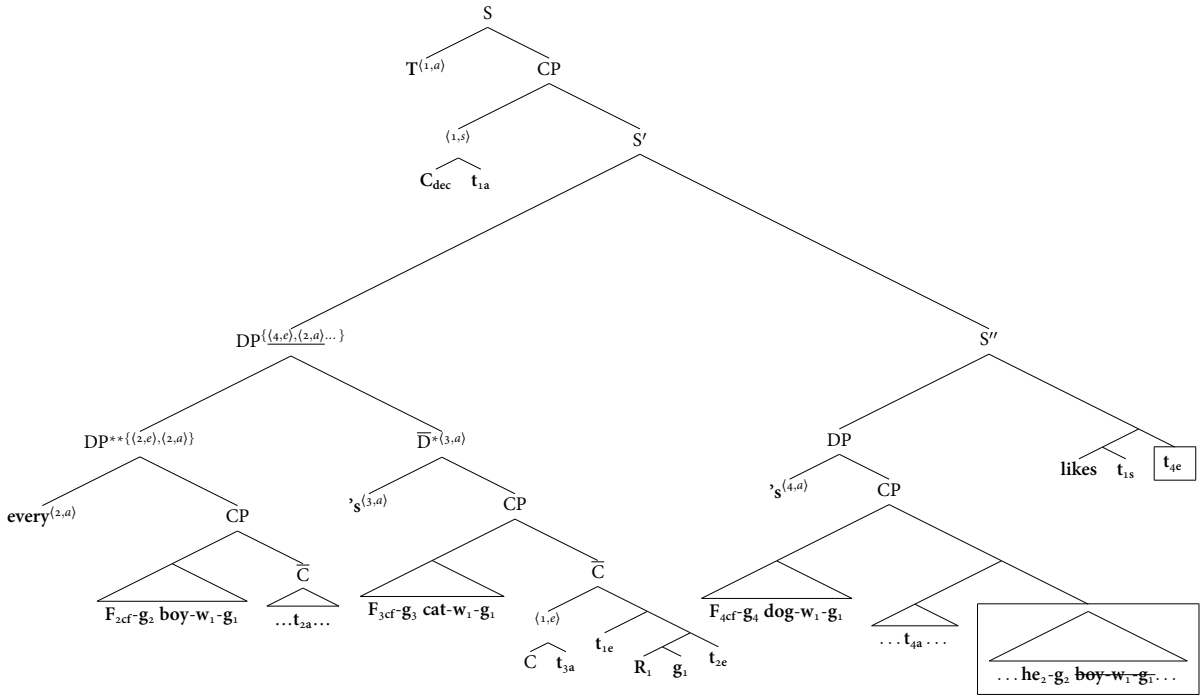



$$[\![\mathrm{DP}]\!] = [\![\mathrm{DP}^{**}]\!] \circ [\![\overline{\mathrm{D}}]\!] = \lambda P_{et}.[\![\mathrm{DP}^{**}]\!]([\![\overline{\mathrm{D}}]\!](P))$$
$$\approx \lambda P_{et}.\big[\lambda T_t.[\lambda g_g.\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(boy_{g(1a)(1s)}),\, T(g[x(g)/2e][a(g)/2a])]\big]$$
$$\big(\lambda g_g.\iota y_e \exists a'_a\colon y(g) = a'(g)(3\mathrm{cf})(cat_{g(1a)(1s))}) \wedge g(1a)(1\mathrm{eet})(g(2e))(y(g)),\, P(y)(g[a'(g)/3a])\big)$$
$$\approx \lambda P_{et}.\lambda g_g\,.\,\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(boy_{g(1a)(1s)}),$$
$$\iota y_e(g) \exists a'_a\colon y(g) = a'(g)(3\mathrm{cf})(cat_{g(1a)(1s)}) \wedge g(1a)(1\mathrm{eet})(x(g))(y(g)),$$
$$P(y)(g[x(g)/2e][a(g)/2a][a'(g)/3a])$$
$$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(boy_{g^-(1s)}),$$
$$\iota y_e(g) \exists a'_a\colon y(g) = a'(g)(3\mathrm{cf})(cat_{g^-(1s)}) \wedge g(1\mathrm{eet})(x(g))(y(g)),$$
$$y(g) \text{ likes } a(g)(2\mathrm{cf})(boy_{g^-(1s)}) \text{ in } @(g^-)$$

This says, roughly, that for every $o \in E$ s.t. there is a choice function that selects $o$ from among the boys, the unique $o' \in E$ s.t. $o'$ is selected by some choice function from among the cats and bears the relevant relation $R$ ("is owned by," "is a pet of") $o$, is such that $o'$ likes $o$ — i.e., for every $o$ in the set of boys, the unique $o'$ among the cats which bears $R$ to $o$ likes $o$.

The above account of weak crossover/"donkey crossover" carries over to "genitive crossover" violations such as (87):

(90) **His dog*$_i$ likes *every boy*$_i$'s cat.




The object DP 'every boy's cat' has a set of binder-index features including an individual binder-index resulting from QR, and an assignment binder-index projecting from DP**. The individual binder-index binds the DP's coindexed trace $\mathbf{t}_{4e}$. In order for the interpretation of the pronoun to covary with the DP, the assignment binder-index must bind the assignment-variable in $[\mathbf{he}_2\ \mathbf{g}_2]$. This violates the binding constraint in (82) which excludes a single expression from binding distinct variables.

**Inverse linking** readings, as in (91), raise well-known challenges for compositional semantics.

(91) a. Some child of *every parent* loves *her*.
b. ≈ "for every parent *o*, some child *o′* of *o* loves *o*"

The embedded DP 'every parent' in (91) is a constituent of the subject DP (e.g. May 1985, Heim & Kratzer 1998). So, first, 'every parent' must be able to combine with its sister 'some child of t' to form the subject DP. Second, the interpretation

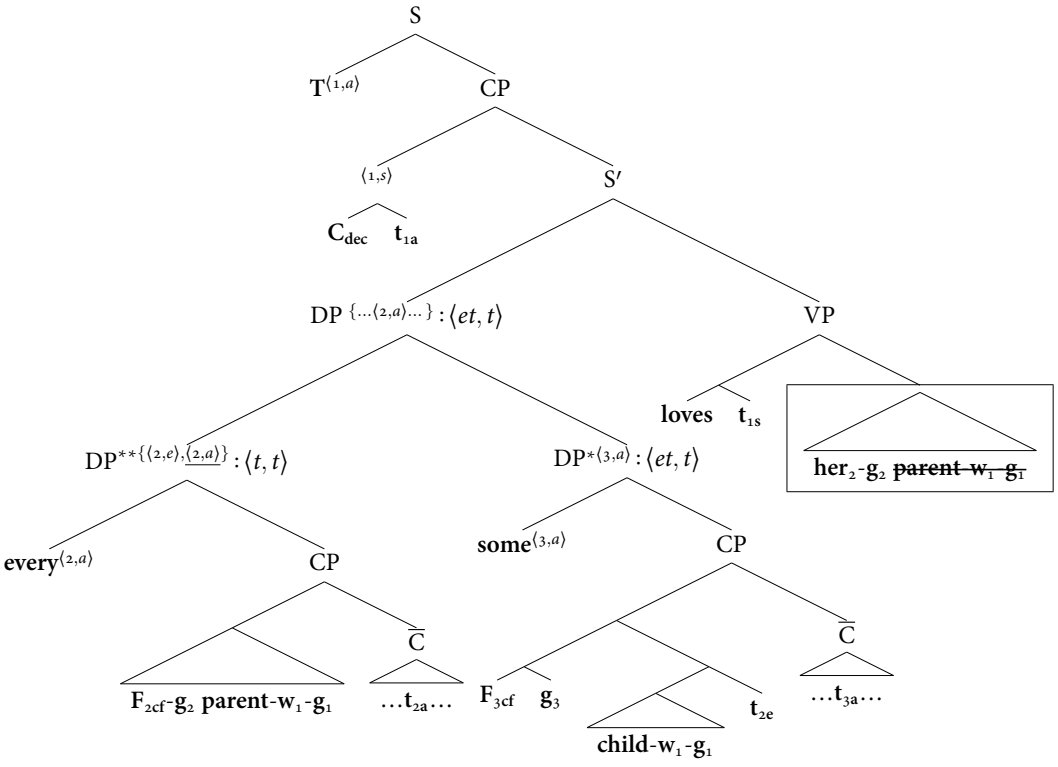
of 'her' covaries with the quantificational subject even though the pronoun isn't c-commanded by 'every parent'. Third, as with donkey pronouns, pronouns in inverse linking examples are subject to weak crossover effects:

(92) a. **Her* book is loved by some child of *every parent*.
b. ≉ "for every parent $o$, there is some child $o'$ of $o$ such that $o$'s book is loved by $o'$"

The raised 'every parent' can bind its trace in (91)–(92); but it can provide a linguistic antecedent for the pronoun only in (91) when embedded in the subject DP, and not in (92) when embedded in the QR'd object DP.

The compositional semantics proceeds analogously to examples with complex genitives, as reflected in (93). DP$^{**}$ and D$^{*}$ of types of types $\langle t, t\rangle$ and $\langle et, t\rangle$, respectively, combine by function composition to yield the main DP of generalized quantifier type $\langle et, t\rangle$. The assignment binder-index feature projected from DP$^{**}$ to the DP binds the donkey pronoun.

(93) Some child of *every parent* loves *her*.



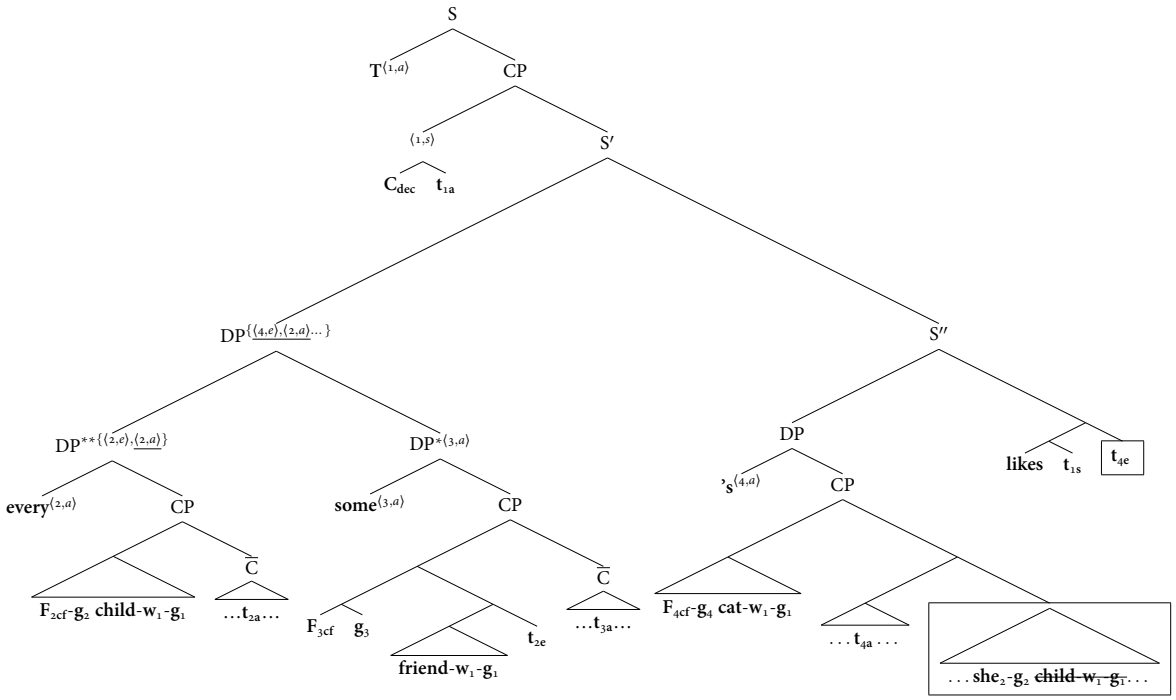
$$
\begin{aligned}
&[\![\mathrm{DP}]\!] = [\![\mathrm{DP}^{**}]\!] \circ [\![\mathrm{DP}^{*}]\!] \\
&\quad \approx \lambda P_{et}.\lambda g_g\,.\,\forall x_e \exists a_a\colon x(g) = a(g)(\mathrm{2cf})(\mathit{parent}_{g(1a)(1s)}), \\
&\qquad \exists y_e \exists a'_a\colon y(g) = a'(g)(\mathrm{3cf})(\mathit{child\text{-}of\text{-}x}(g)_{g(1a)(1s)}), \\
&\qquad\quad P(y)(g[x(g)/2e][a(g)/2a][a'(g)/3a]) \\
&[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\forall x_e \exists a_a\colon x(g) = a(g)(\mathrm{2cf})(\mathit{parent}_{g^-(1s)}), \\
&\qquad \exists y_e \exists a'_a\colon y(g) = a'(g)(\mathrm{3cf})(\mathit{child\text{-}of\text{-}x}(g)_{g^-(1s)}), \\
&\qquad\quad y(g) \text{ loves } a(g)(\mathrm{2cf})(\mathit{parent}_{g^-(1s)}) \text{ in } @(g^-)
\end{aligned}
$$

The derived semantic value captures the inverse linking reading: (93) says that for every $o \in E$ s.t. there is a choice function that selects $o$ from among the parents, there is an $o' \in E$ selected by some choice function from among $o$'s children s.t. $o'$ loves $o$ — i.e., for every parent $o$, there is an $o'$ among the children of $o$ s.t. $o'$ loves $o$.

The above account of weak crossover carries over to "inverse crossover" examples such as (92) or (94):

(94) **Her cat*$_i$ likes some friend of *every child*$_i$.

a. ≉ "for every child $o$, there is some friend of $o$ that is liked by $o$'s cat"




The QR'd object DP binds its coindexed trace $\mathbf{t}_{4e}$. Given the constraint that an

expression cannot semantically bind distinct variables, the assignment-variable $\mathbf{g}_2$ in the representation of 'her' cannot be bound by the DP, and the intuitively bound reading is excluded.

Let's recap. This section has speculated about how the assignment-quantificational approach to donkey anaphora from §6.2 might be extended to other recalcitrant phenomena with pronominal anaphora — e.g., regarding **weak crossover** effects and apparent binding out of DPs with **inverse linking** and **genitive binding**. The D CP syntax for inverse linking and genitives captures how expressions such as 'some child of every parent' and 'every boy's cat' form constituent DPs (contrast Hornstein 1995). The intuitively bound readings of pronouns in the DPs' scope follow from (i) the treatment of pronominal anaphors as copies of their linguistic antecedents, (ii) the generalized assignment-quantificational syntax/semantics for determiner quantifiers, and (iii) the use of function composition in the compositional semantics of (e.g.) complex DPs formed from DP-internal movement. I suggested potentially explaining weak crossover data such as Reinhart's generalization via a general principle that no expression can bind distinct variables. Since a moved expression must bind its trace, the assignment-variable in a subject pronoun cannot be bound by a QR'd object DP — in examples with simple DPs ((84)), donkey sentences ((80)–(81)), inverse linking ((92)/(94)), and genitive binding ((87)/(90)) alike. There is no analogous obstacle to bound readings when the DP is in subject position — hence Reinhart's generalization that bound pronouns, unlike traces, must be bound from A-positions.[31]

A worry with many accounts of (donkey) crossover is that they end up formalizing what needs to be explained — the distinction between trace-binding and pronoun-binding. Contrasts such as in (79)–(80) may be captured via stipulations on admissible indexings (e.g. Reinhart 1987) or ad hoc syntactic/semantic dis-

[31] Yes, the last inference was too quick. For instance, the above discussion applied specifically to DPs with assignment binder-indices. Nothing has been said about weak crossover effects with *wh* interrogatives, as in (78). (Though see e.g. Safir 1999 on contrasts between *wh* chains and QR chains regarding the interpretation of traces/pronouns.) There are also well-known exceptions where weak crossover configurations are acceptable, both in English and cross-linguistically; e.g., the German sentence corresponding to (ii) is grammatical.

(i) a. *Who* will be easy for us to get *his* mother to talk to __? (Lasnik & Stowell 1991: ex. 20a)
b. *Which baby* did Alice give *its* bottle to __?
c. Which mother gave *its* bottle to *which baby*?

(ii) **Which parent*$_i$ does *her*$_i$ *child* like?

How to develop the approach to weak crossover in this section will depend on one's views on the syntactic/semantic status of *wh* movement, reconstruction, pied piping, etc. A more general binding theory is needed. (I return to *wh* interrogatives in §8.)

tinctions between traces and pronouns (e.g. Büring 2004; cf. Elbourne 2005). For instance, Büring 2004 — arguably the most extensively developed account — introduces distinct syntactic categories for traces and pronouns (including, crucially, individual-variables in E-type representations), distinct binding operators and domains for assignments corresponding to the two categories, and distinct principles regarding admissible LFs for traces/pronouns and their respective binding operators. At minimum the present assignment-variable-based framework offers independent grounds for formally distinguishing pronouns and traces (§§2, 4.3). Pronouns $[\mathbf{v}_{i\tau}\ \mathbf{g}_j]$ include an assignment-variable from which the element receives its interpretation; no assignment-variable is included in the representation of a trace $\mathbf{t}_{i\tau}$ since the binder-index attaching to the moved expression binds the variable directly. This independent distinction may be exploited in an account of weak crossover. No additional binder operators or constraints on admissible indexings are required. Assignment functions and the generalized binder index make no distinction between traces and pronouns as such.

I hope the preliminary discussion in this section may provide a basis for a more explanatory treatment of weak crossover. The prospects for the specific assignment-variable-based approaches in this section to determiner quantification, relativization, and trace-/pronoun-binding remain to be seen. Ellipsis, "sloppy identity" readings, and discourse anaphora may offer fruitful additional applications to explore.

# 7 Conditionals

## 7.1 Local and global readings

Conditionals provide diverse sources of local and global readings of variables and context-sensitive expressions. For instance, there are (i) global readings in both 'if'-clause and consequent clause, as in (95); (ii) local readings in the 'if'-clause, as in (96); and (iii) local readings in the main clause, as in (97).

(95) If $\underline{\text{it}_i}$ breaks, $\underline{\text{he}_j}$ will cry.
- ≈ If $g_c(i)$ breaks, $g_c(j)$ will cry. (*global readings, both clauses*)

(96) a. [Giving to Charity X wouldn't maximize overall utility.]
If we $\underline{\text{should}_i}$ give to Charity X, classical utilitarianism must be incorrect.
- ≈ If the correct norms are *i* and *i* requires us to give to Charity X, then classical utilitarianism must be incorrect.

b. If it's $\underline{\text{raining}_i}$, we should bring an umbrella.

c. [We know how much everyone's income is. Rita is getting a tax break. We

haven't settled ourselves about what income should count as "rich."]
If Rita is rich$_i$, then Miguel is rich. So Miguel should get the tax break too.
(*local reading, 'if'-clause*)

(97) a. [If John wasn't invited,]$_i$ everyone$_i$ will come.
- ≈ [If John wasn't invited,]$_i$ everyone who is relevant given *i* will come.

b. [If it rained,]$_i$ John brought$_i$ an umbrella.
c. [If the intersection is clear,]$_i$ we should$_i$ speed through.
(*local reading, main clause*)

Semantic work on conditionals has focused nearly exclusively on examples where the 'if'-clause combines with a complete clause. Yet there are also conditionals where the 'if'-clause appears sentence-finally and modifies the verb, or appears sentence-internally and modifies a nominal subject, as in "adnominal" conditionals. Syntactic tests confirm that the 'if'-clauses in such examples cannot be construed as scoping over the rest of the sentence, but rather combine with the VP/NP, as reflected in the VP-ellipsis and Condition C evidence in (98) and coordination evidence in (99) (Iatridou 1991, Lasersohn 1996, Bhatt & Pancheva 2006).

(98) *Sentence-final 'if'-clause. VP-adjunction*
a. I will leave if you do and John will ~~[$_{VP}$ leave if you do]~~ too.
b. *She$_i$ yells at Bill if Mary$_i$ is hungry.
(Bhatt & Pancheva 2006: exs. 19a, 21a)

(99) *Adnominal 'if'-clause. NP-adjunction*
[[The [$_{NP}$ location if it rains]] and [the [$_{NP}$ location if it doesn't rain]]] are within five miles of each other. (Lasersohn 1996: ex. 10)

Shifted readings can be observed in each of these positions, as in (101)–(102) as well. For instance, Santorio 2012 argues that examples such as (100) involve a shifted (i.e. local) reading of 'I', referring to epistemic counterparts of the speaker (see 2012: 363n.2 for precedents). Shifted readings of 'I' are no less possible when the 'if'-clause combines with the VP, as in (101d)–(101e); likewise for the shifted readings of 'my' in (102b) when the 'if'-clause combines with an NP.

(100) [Context: Lingens and Lauben know they are kidnapped amnesiacs. They are informed that they will be anesthetized, and a coin will be flipped: if it lands tails, Lingens will be released in the Stanford library and Lauben will be killed; if it lands heads, Lauben will be released in the Harvard library and Lingens

will be killed. After the experiment, one of them wakes up and says:]
If the coin landed heads, I am in Widener Library, Harvard.

(Santorio 2012: ex. 6)

(101) a. John brought$_i$ an umbrella [if it rained]$_i$ (…and Alice did ~~[bring$_j$ an umbrella [if it rained]$_j$]~~ too).
b. Everyone$_i$ will come [if John wasn't invited]$_i$.
c. We should$_i$ block Shaft A [if the miners are in Shaft A]$_i$.

(cf. Kolodny & MacFarlane 2010)

d. I$_i$ [$_{VP}$ am in Widmore Library [if the coin landed heads]$_i$].
e. Bert is in Widmore Library if the coin landed heads, and I$_i$ am ~~in Widmore Library [if the coin landed heads]$_i$~~ too).

(102) a. The [$_{NP}$ right$_i$ thing [if utilitarianism is correct]$_i$] is to donate.
b. [[$_{DP}$ My$_i$ location [if the coin landed heads]$_i$] and [$_{DP}$ my$_j$ location [if the coin landed tails]$_j$]] are on opposite coasts.

Most existing semantics for (sentence-initial) conditionals are inapplicable as they stand to VP-/NP-adjunction examples. For instance, on a standard restrictor semantics (Kratzer 1981, 1991), the 'if'-clause combines with a (possibly implicit) operator/modal and restricts its modal base, or domain of quantification. It isn't immediately obvious how such an analysis might be generalized to compositionally derive the relevant range of shifted/non-shifted interpretations in examples such as (98)–(99) or (101)–(102) where the 'if'-clause combines with a VP or subject NP.

Historically, work on the semantics of conditionals has proceeded largely in isolation from syntax literatures on 'if'-clauses and other types of conditional constructions. To some extent this is to be expected. Many questions regarding the semantics of conditional can be addressed without taking a stand on, say, whether 'if' is in C or SpecCP in different languages, possibilities for reconstruction, etc. But if our project is to provide a genuine compositional semantics, we must ensure that whatever type of semantics we go in for will generalize across the spectrum of environments in which 'if'-clauses (and other markers of conditionality) appear.

Whatever syntactic/semantic package we take on board must (i) derive local readings in the consequent *and* in the antecedent — shifting in the scope of a supposition as well as in the supposition itself, as in (96)–(97); (ii) must do so in a way that still allows for global readings in both clauses, as in (95); and (iii) must capture how 'if'-clauses can combine directly with a VP/NP and shift the interpretation of material within the VP/NP they modify, as in e.g. (101a)/(102a), as well as of external material in the sentence, as in e.g. (101d). The type of the 'if'-clause must be

suitable to combine with and modify expressions of multiple types. The remainder of this section shows how we can satisfy these desiderata, drawing on independent syntactic work on 'if'-clauses as free relatives/correlatives. The compositional semantics affords a uniform analysis of 'if'-clauses in diverse types of conditionals — conditionals with sentence-initial/-internal/-final 'if'-clauses, and in conditionals with/without an overt modal or a proform such as 'then'. As we will see further in §8, the account affords uniform treatments of conditional and individual proforms, and of conditional, correlative, and interrogative clauses.

## 7.2 'If' and conditionality

### *7.2.1 Syntax: Free relatives + Clause-internal operator movement*

A standard story following Lewis (1975) and Kratzer (1981, 1991) is that 'if'-clauses restrict the domain of a modal or other operator. Yet as von Fintel notes, "it is very probable… that tripartite structures are merely a convenient meta-level notation" (1994: 77), and that movement operations don't literally generate tripartite LFs for conditionals like (103) parallel to determiner quantifiers (cf. Partee 1995).

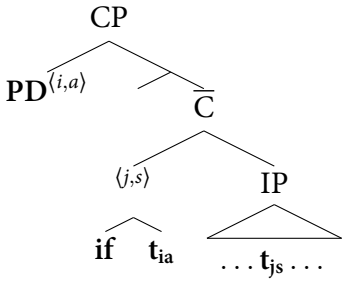
(103) $[_S\ [\text{MOD}^i\ [\text{if-clause}]^j]\ [_{CP}\ t_j\ [\ldots t_i \ldots]]]$

So I assume that our best syntactic story for conditionals will involve some other way of capturing the idea that 'if'-clauses function to modify a domain. In §6 we drew on D-complement and head-raising analyses to motivate treatments of individual- and assignment-quantification in headed relative clauses — a relative complementizer $\mathbf{C_{rel}}$, and a determiner which moves for type reasons from an internal assignment argument. I suggest that prominent syntactic theories of **'if'-clauses as free relatives** (Iatridou 1991, Lycan 2001, von Fintel 1994, Bittner 2001, Schlenker 2004, Bhatt & Pancheva 2006) provide analogous motivations for sources of world- and assignment-quantification in conditionals. Like other free relatives (Jacobson 1995, Dayal 1996, Caponigro 2003, Caponigro 2012), 'if'-clauses are interpreted as definite descriptions. However, rather than treating the variable relativized over as a variable over worlds or events (as in Schein 2003, Schlenker 2004, Bhatt & Pancheva 2006, Haegeman 2010), we can treat it as a variable over *assignments*: 'if'-clauses denote **definite descriptions of possibilities**, represented via assignments (cf. Bittner 2001).

Given the variable means of expressing conditionality, both in English and cross-linguistically, it is common to treat conditional interpretations as arising independent of particular complementizers such as 'if' (e.g. Bhatt & Pancheva 2006, Rawlins 2008). A prominent approach is to treat the conditional element as moving to

a specifier position from within the clause (Bhatt & Pancheva 2006, Haegeman 2010; cf. Larson 1985). Movement analyses of conditional clauses provide independently motivated resources for implementing an analysis of 'if'-clauses into the §3-framework — notably, a complementizer such as 'if', and clause-internal movement of an operator responsible for conditional interpretations: Just as determiner quantifiers raise from the internal assignment argument of the relative complementizer in relatives of individuals (§6), the conditional operator raises from an internal assignment argument of complementizers such as 'if'.[32] A schematic LF is as follows, where **PD** is the implicit operator (for Plural Description), parallel to the definiteness operator in free relatives.

(104)




*7.2.2 Semantics: 'if'-clauses as plural definite descriptions of assignments*

Consider the following preliminary lexical entries for 'if' and the general conditionalization/definiteness operator **PD** (to be revised).

(105) $[\![\textbf{if}]\!] = \lambda a_a.\lambda p_{st}.\lambda w_s.\lambda g_g\,.\,@(a(g)) \leq w(g) \wedge \forall w' \text{ s.t. } w'(g) = @(a(g)), p(w')(g)$
(*to be revised*)

(106) $[\![\textbf{PD}]\!] = \lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,\left[\iota a(g)^*\colon A(a)(g)\right]\ A'(a)(g)$
$= \lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,\left[\exists a_a\colon A(a)(g) \wedge \forall a'' \text{ s.t. } A(a'')(g), a''(g) \leq a(g)\right] A'(a)(g)$
$= \lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,\left[\iota a(g)^*\colon a(g) \text{ is the unique maximal } h^* \in G \text{ s.t. } (\downarrow A)(g)(h)\right] A'(a)(g)$

The lexical entry for 'if' in (105) is a rough intensional analogue of the entry for the relative complementizer $\mathbf{C_{rel}}$. The world argument in the specifier position determines the relevant restricted domain of possibilities. **PD** converts the set of possi-

[32] I assume that 'if' is in C°. Although Bhatt & Pancheva 2006 don't specify the generation site of the conditional operator, Haegeman 2010 argues against treating it as moving from within the VP. Haegeman treats the operator as semantically modal and as sharing properties specifically with syntactically high (broadly epistemic) modals. Such a view may provide further support for the present treatment of the operator as moving from above the VP.

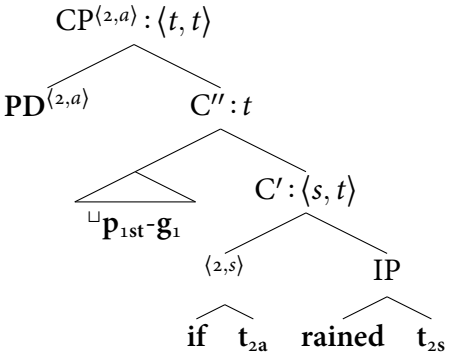
bilities into a definite description of the maximal plural possibility in the set. Let's take these components in turn.

There is typically more than one $p$-possibility for a given 'if'-clause *if p*. First, following general treatments of free relatives as plural definite descriptions, the assignment described by the 'if'-clause may be a plural assignment representing a **plural possibility** (cf. Jacobson 1995, Dayal 1996, Grosu & Landman 1998, Schein 2003, Bhatt & Pancheva 2006). The components of the model $E, W, G$ are structured to include plural objects — objects which contain atomic objects as parts (Link 1983, Schwarzschild 1996). The metalanguage $\iota$ operator in (106) can be understood along the lines of Link's (1983) $\sigma$ operator, which returns the *maximal* entity of a set — the element of the set that isn't a proper part of any other element of the set (formally, the $m$ in the set $S$ such that $\forall m' \in S: m' \leq m$). The uniqueness implication applies to the items in the model. Just as there may be many functions $x: G \to E$ mapping $g$ to the unique individual $o \in E$ intuitively picked out by a definite description, there may be many functions $a': G \to G$ mapping $g$ to the relevant unique possibility $h \in G$ described by an 'if'-clause. (I often use an asterisk $^*$ when introducing a variable to flag that its value may be a plurality ("$\iota o^*: o\ldots$"). I won't distinguish between singular vs. plural predicates; my saying that a property holds of an object leaves open whether the predication is of an atomic object, a plural object, or every (atomic) part of a plurality.)

Even after incorporating plurality, our analysis should reflect some way of restricting the quantification to relevant (salient/live/remote) assignments satisfying the antecedent. The external argument of 'if' supplies a relevant modal possibility which further restricts the domain of the definiteness operator **PD**, as reflected in (107).[33] ($\sqcup S$ is the maximal element of a set $S$ — e.g., if $S = \{a, b, c\}$, $\sqcup S = a \sqcup b \sqcup c$. For readability I continue to omit explicit reference to the quantification over $w \in D_s$ when the modal domain has been derived.)

[33] In the definition of the binder-index (§3.5): with **if**, $\tau = s$; $\sigma = \langle s, t\rangle$; with **PD**, $\tau = a$; $\sigma = \langle at, t\rangle$.

(107)




$[\![\text{C}']\!] = \lambda w_s.\lambda g_g\,.\,@(g(2a)) \leq w(g) \wedge \forall w'$ s.t. $w'(g) = @(g(2a))$, it rained in $w(g)$

$[\![\text{CP}^{\langle 2,a\rangle}]\!] \approx \lambda T_t.\lambda g_g\,.\,\big[\iota a_a(g)^*\colon @(a(g)) \leq (\sqcup g(1a)(1st))$
$\wedge$ it rained in $@(a(g))\big]\ T(g[a(g)/2a])$
$\approx \lambda T.\lambda g_g\,.\,\big[\exists a_a\colon a(g)^*$ is the unique maximal $h^* \in G$ s.t. $@(h) \leq (\sqcup g(1a)(1st))$
$\wedge$ it rained in $@(h)\big]\ T(g[a(g)/2a])$

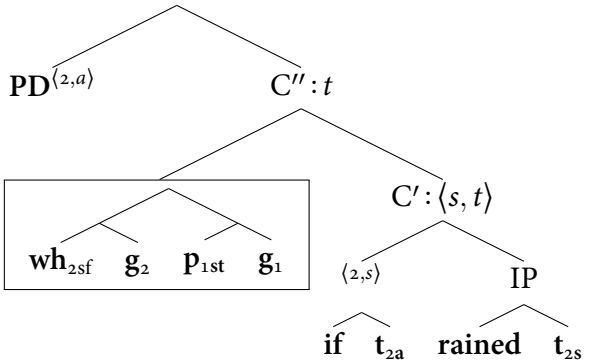
Like the declarative complementizer, the complementizer 'if' is base-generated in the world argument position of the clause's main predicate, and moves for type reasons as a quantifier over worlds. This captures how the main predicate in the 'if'-clause receives an obligatory local reading under the supposition. Like determiner quantifiers in relative constructions and modal quantifiers, the conditionalization element **PD** is base-generated in the complementizer's assignment argument position, and moves for type reasons (here clause-internally), introducing an assignment binder. Intuitively put, the specifier argument in the conditional clause supplies a topical possibility which provides the backdrop for the supposition. The conditional clause picks out the sum of relevant possibilities in which it rained. (Recall that I'm not distinguishing between singular/plural predicates; so, saying e.g. that it rained in $@(h^*)$ can be understood as saying that it rained in the world of every possibility that is a part of $h^*$.)

The preliminary structure in (107) treats the external argument of 'if' as a relevant plurality of worlds, and the semantics for 'if' requires the world of the internal assignment-argument to be a part of that plurality. The analysis of relative clauses in §6.1, in contrast, treated the external argument of $\mathbf{C_{rel}}$ as a selected individual $o \in E$ supplied by the relative phrase, and the semantics required the individual in the gap position to be identical to $o$. Given the proposal that 'if'-clauses are free relatives of possibilities, it is worth exploring how we might unify our analyses of relative clauses and 'if'-clauses.

I offer the following revised lexical entry for 'if' and structure for an 'if'-clause. The analysis of (109) is parallel to the analysis of free relatives of individuals from (45), reproduced below.

(108) $[\![\textbf{if}]\!] = \lambda a_a.\lambda p_{st}.\lambda w_s.\lambda g_g\,.\,@(a(g)) = w(g) \wedge \forall w'$ s.t. $w'(g) = @(a(g)), p(w')(g)$

(109)




$[\![C'']\!] = \lambda g_g\,.\,@(g(2a)) = g(2a)(2\text{sf})(g(1a)(1st))$
$\wedge \forall w$ s.t. $w(g) = @(g(2a))$, it rained in $w(g)$

$[\![CP^{\langle 2,a\rangle}]\!] \approx \lambda T_t.\lambda g_g\,.\,\big[\iota a_a(g)^*\!: @(a(g)) = a(g)(2\text{sf})(g(1a)(1st))$
$\wedge$ it rained in $@(a(g))\big]\ T(g[a(g)/2a])$

(45) a. '(Bert likes) what Alice likes'
b. [DEF$^{\langle i,a\rangle}$ [$_{\text{CP}_{\text{rel}}}$ wh-g$_i$ P-g [$_{\overline{\text{C}}}$ [C$_{\text{rel}}$ t$_{ia}$]$^{\langle j,e\rangle}$ [$_{\text{IP}}$ Alice likes t$_{je}$]]]]

In an individual relative clause (see §6.1): The relative phrase 'what' supplies the external individual argument of $\mathbf{C_{rel}}$ and is analyzed intuitively as "which relevant thing(s)." The relative choice-function pronoun is (obligatorily) coindexed with the relative complementizer's assignment argument, e.g. due to agreement, and the property-type argument of the relative pronoun supplies a set of contextually relevant individuals. The assignment-quantification introduced by the raised determiner then binds the choice-function pronoun, and the determiner quantifies over individuals that satisfy the property denoted by the relative clause $\overline{\text{C}}$ and are identical to some or other relevant individual $o \in g_c(1et) \in E$. The compositional semantics derives that the free relative (45) 'what Alice likes' picks out the sum of relevant things that Alice likes.

Analogously: Just as the relative phrase 'what' in (45) is analyzed intuitively as "which relevant thing(s)," the external argument of 'if' is analyzed intuitively as "which relevant world(s)." Indeed the specifier-position argument could be under-

stood as an implicit 'whether' analogous to the relative phrase in SpecCP$_{\text{rel}}$ (see e.g. Larson 1985, Kayne 1991 on 'whether' being in SpecCP). Roughly put, the relative complementizer $\mathbf{C}_{\text{rel}}$ (e.g. 'that') is to 'if', as an individual relative phrase (e.g. 'what') is to 'whether', as reflected in (110).

(110) a. Every baby {which, that, *which that} laughed is happy.
b. Alice knows {whether, if, *whether if} it rained.

In §6 I suggested analyzing relative pronouns as **choice-function pronouns**. A natural move is to analyze the 'whether'-like element in an 'if'-clause likewise as a *choice function pronoun of worlds* — a function $s \in D_{\langle st,t\rangle}$ s.t. $p(s(p))$ for any $p_{st}$ ((54)). (For clarity I distinguish 'sf' for choice-function indices/variables of type $\langle st, s\rangle$; I continue to use 'cf' with choice functions of type $\langle et, e\rangle$.) As above, the pronoun is (obligatorily) coindexed with the conditional complementizer's assignment argument, and the external 'whether'-like argument supplies a particular world from among the set of contextually relevant worlds (=$h^*(2\text{sf})(g_c(1st))$). The assignment-quantification introduced by the raised pluralization operator $\mathbf{PD}^{\langle 2,a\rangle}$ binds the choice-function pronoun, here $[\mathbf{wh}_{2\text{sf}}\ \mathbf{g}_2]$, and quantifies over possibilities in the restricted set that satisfy the property denoted by the 'if'-clause $\overline{\text{C}}$. The compositional semantics derives that the conditional free relative (109) 'if it rained' picks out (roughly) the sum of relevant possibilities in which it rained — the unique maximal possibility $h^* \in G$ s.t. it rained in $@(h)$, where $@(h)$ is identical to some or other selected relevant $u \in g_c(1st) \in W$.[34]

The revised syntax/semantics for 'if'-clauses affords a unified assignment-variable-based analysis of relativization. Free relative 'if'-clauses are analyzed as intensional analogues of free relatives of individuals. (I return to the extent of the similarities in §§7.7, 8.)

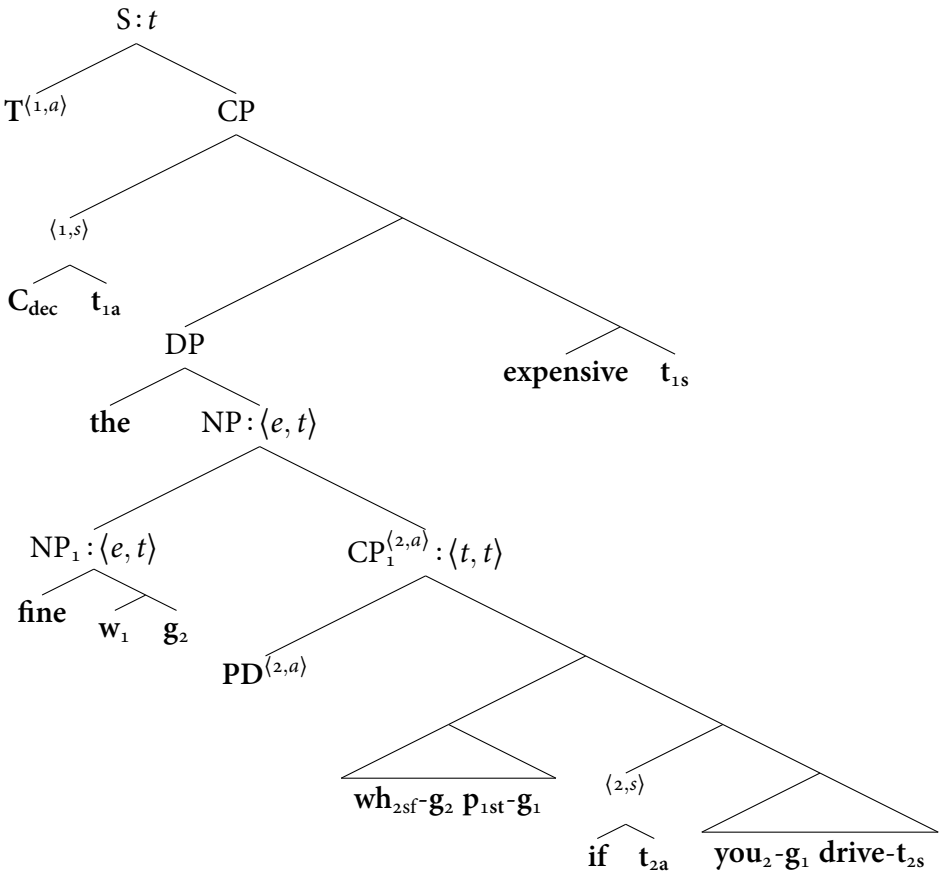
Note that the semantic type of the 'if'-clause CP is derived to be type $\langle t, t\rangle$ — the same type of the adjoined DPs in our examples with inverse linking and genitive binding from §6.3.2 (n. 30). We will see that function composition and the $\langle t, t\rangle$-type of the 'if'-clause can similarly be exploited to help satisfy our desiderata from §7.1 — e.g., capturing the spectrum of (non-)shifted readings with sentence-initial 'if'-clauses as well as with sentence-final 'if'-clauses adjoined to VP and with NP-adjoined 'if'-clauses in adnominal conditionals.

[34]Strict conditional and material conditional interpretations could be understood as cases where the semantic value for $[\mathbf{p}\ \mathbf{g}]$ in the specifier argument is ultimately identified with $W$ vs. $@(g_c)$, respectively. Extensions to aspect, mood, tense may afford resources for an assignment-variable-based treatment of counterfactuals.

## 7.3 Adnominal conditionals

Though rarely considered in semantics literatures on conditionals, let's start with adnominal conditionals such as (111), where the 'if'-clause adjoins to the subject NP (Lasersohn 1996). (For simplicity assume that 'the' has a standard $\langle et, \langle et, t\rangle\rangle$ type, and treat 'expensive' as a simple predicate.)

(111) *Adnominal conditional* (NP-adjunction)
'The fine if you drive is expensive.'




$$[\![\mathrm{CP}_1^{\langle 2,a\rangle}]\!] \approx \lambda T_t.\lambda g.\,\big[\iota a(g)^*\!:\! g(1a)(2e) \text{ drives in } @(a(g))$$
$$\wedge\, @(a(g)) = a(g)(2\mathrm{sf})(g(1a)(1st))\big]\; T(g[a(g)/2a])$$

$$[\![\mathrm{NP}]\!] = [\![\mathrm{CP}_1^{\langle 2,a\rangle}]\!] \circ [\![\mathrm{NP}_1]\!]$$
$$= \lambda x_e.[\![\mathrm{CP}_1^{\langle 2,a\rangle}]\!]([\![\mathrm{NP}_1]\!](x))$$
$$\approx \lambda x_e.\lambda g_g.\,\big[\iota a(g)^*\!:\! g(1a)(2e) \text{ drives in } @(a(g))$$

$$\wedge\, @(a(g)) = a(g)(2\mathrm{sf})(g(1a)(1st))\big]\ x(g[a(g)/2a]) \text{ is a fine in } a(g)(1s)$$

$$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\big[\iota x(g)\colon [\iota a(g)^*\colon g^-(2e) \text{ drives in } @(a(g))$$
$$\wedge\, @(a(g)) = a(g)(2\mathrm{sf})(g^-(1st))]\ x(g) \text{ is a fine in } a(g)(1s)\big]$$
$$x(g) \text{ is expensive in } @(g^-)$$

This says, roughly, that the fine in the maximal relevant possibility $h^*$ where you drive is expensive in the actual world $@(g_c)$. The modified subject DP picks out the unique $o \in E$ s.t. $o$ is the fine in the world ($=h(1s)$) of the maximal relevant possibility where you $g_c(2e)$ drive — i.e., the maximal possibility in which you drive and which is identical to some or other possibility $h(2\mathrm{sf})(g_c(1st))$ in the contextually relevant domain $g_c(1st)$. The sentence is true iff $o$ is expensive in the world of the discourse $@(g_c)$.

As in simple sentences, the main clause complementizer raises from the world-argument position of 'expensive'; and the topmost assignment-binder raises from the assignment-argument position, linking the modal domain for the main clause to the world of the discourse via the definition of truth-in-a-context. The world argument of the subject predicate 'fine' is supplied by a world pronoun. However, the assignment binder-index on the 'if'-clause shifts the coindexed world pronoun $[\mathbf{w}_1\ \mathbf{g}_2]$ to the world of the assignment representing the hypothetical possibility, i.e. the maximal relevant possibility $a(g)^*$ where you drive. The 'if'-clause CP is type $\langle t, t\rangle$, the predicate is type $\langle e, t\rangle$, and they combine via function composition to yield the modified subject NP of type $\langle e, t\rangle$.

The §7.2-semantics compositionally derives the local reading of the subject NP's world pronoun in (111). Yet nothing said thus far excludes an LF where the world pronoun is coindexed with the topmost assignment-binder, e.g. $[_{\mathrm{NP}_1}$ **fine** $\mathbf{w}_1\ \mathbf{g}_1]$, representing an unattested reading implying that the fine in the actual world is expensive. Although the complex subject NP needn't receive a local reading in an embedded adnominal conditional, as reflected in (112), the interpretation of the world pronoun must still shift, it seems, with the adjoined 'if'-clause.

(112) Alice thinks that the venue if it rains is going to close before the party.
   a. *de dicto* ≈ Alice thinks there is some venue or other that will be the venue in the possibility where it rains, and it, whatever it is, is going to close before the party
   b. *de re* ≈ the venue in the possibility where it rains is such that Alice thinks it is going to close before the party

It would be implausible to derive the (apparent) obligatory shifted reading by

treating the 'if'-clause as moving from the NP's world argument, since the 'if'-clause is base-generated in an adjoined position. A more promising approach may be to understand LFs representing global readings as generally excluded for conversational reasons, failing to represent cooperative uses. For instance, in an LF for (111) where $NP_1$'s world pronoun is bound by $\mathbf{T}^{\langle 1,a\rangle}$, the 'if'-clause would be trivial in the interpretation of the complex subject and the sentence. An interpretive principle against such semantically trivial modifications might be represented roughly as follows:[35]

(113) *Non-triviality principle:*

Let $i$ be a set of binder-index features $\{\langle i_1, \tau_1\rangle, \langle i_2, \tau_2\rangle, \dots\}$, and $\gamma$ be a branching node in the domain of $[\![\cdot]\!]$ whose daughters are $\alpha$ and $\beta^i$, where $\beta^i$ occupies an $\overline{\text{A}}$-position. For any binder-index feature $k \in i$ that is semantically necessary in $\gamma$, there are $g' \approx_k g''$ such that $[\![\alpha]\!](\cdots)(g') \neq [\![\alpha]\!](\cdots)(g'')$.

a. $h \approx_k h'$ iff $h$ and $h'$ are otherwise identical except that $h(k) \neq h'(k)$

[35] An interpretive principle along the lines in (113) needn't be an exceptionless grammatical constraint. For instance, there are *wh*-ever adjuncts such as in (i) which don't antecede a pronoun.

(i) Whatever Bert did/does, Chip was/is/will be happy.

Though the adjuncts in (i) arguably still modify some other operator (temporal, generic, modal) in the main clause, there are likely other exceptions. Indeed relevance conditionals may provide precisely such a case. Though it is contentious how relevance conditionals ought to be analyzed, a natural approach in the present framework might be as follows:

(ii) *Biscuit conditional* (CP-adjunction)

a. 'If you're hungry, I baked'

b. $[_{\text{S}}\ \text{T}^{\langle 1,a\rangle}\ [_{\text{CP}}\ [\text{PD}^{\langle 2,a\rangle}\ [\text{wh}_{2\text{sf}}\text{-g}_2\ \text{p}_{1\text{st}}\text{-g}_1\ [[\text{if}\ \text{t}_{2a}]^{\langle 2,s\rangle}\ \text{you}_2\text{-g}_1\ \text{hungry-t}_{2s}]]]^{\langle 2,a\rangle}$
$[_{\text{CP}}\ [\mathbf{C_{dec}}\ \text{t}_{1a}]^{\langle 1,s\rangle}\ \text{I}_1\text{-g}_1\ \text{baked-t}_{1s}]]]$

c. $[\![\text{S}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*\!:\! g^-(2e)$ is hungry in $@(a(g)) \wedge @(a(g)) = a(g)(2\text{sf})(1st)\big]$
$g^-(1e)$ baked in $@(g^-)$

$\approx$ S is true in $c$ iff the maximal relevant possibility where you $g_c^-(2e)$ are hungry — the maximal possibility where you're hungry and which is included in the contextually relevant domain $g_c^-(1st)$ — is s.t. I $g_c^-(1e)$ baked in the actual world $@(g_c^-)$

Like in simple sentences the topmost assignment-binder raises from the assignment-argument position of the main clause complementizer, linking the modal domain for the main clause to the world of the discourse via the definition of truth-in-a-context. The LF and semantic value in (ii) thus derive common intuitions about relevance conditionals, such as that they involve an *assertion of the consequent*, and *independence* of the antecedent and consequent: The 'if'-clause introduces a modal topic — the possibility that you $g_c(2e)$ are hungry — but then fails to comment on it in the main clause; S implies that I $g_c(1e)$ actually baked. For present purposes I simply assume that (113) provides a sufficiently robust interpretive principle as to capture the modifying function of 'if'-clauses in adnominal conditionals.

b. *k* is *semantically necessary* in $\gamma$ iff, for $\gamma^*$ a branching node whose daughters are $\alpha$ and $\beta^{i\setminus\{k\}}$, $\gamma^*$ is not in the domain of $[\![\cdot]\!]$.

Intuitively put, this says that binder-indices necessary for interpretability in a given step in a derivation must do non-trivial semantic work in that step in the derivation. (113) is of course directly satisfied in cases of QR or *wh*-movement, where the moved expression necessarily binds its trace. With base-generated adjuncts such as 'if'-clauses, (113) amounts to a norm that the modifier genuinely *modify* the expression to which it is adjoined.[36] In an adnominal conditional such as (111) the 'if'-clause's assignment-binder is "semantically necessary" in the sense of (113); without it, CP and $\text{NP}_1$ would be types $\langle at, t\rangle$ and $\langle e, t\rangle$, respectively, and hence the complex NP node would be uninterpretable. So, lest the non-triviality principle be violated, the world-pronoun must be coindexed with the 'if'-clause's assignment-binder, representing the shifted reading.

### 7.4 Sentence-final 'if'-clauses

The account of 'if'-clauses combining with subject predicates carries over to conditionals with sentence-final 'if'-clauses that adjoin to verbal predicates. First, note that treating the world argument of the main predicate as supplied by a world trace coindexed with the higher complementizer would fail to capture the role of the 'if'-clause in shifting the modal domain:

(114) a. $[_{\text{S}}\ \mathbf{T}^{\langle 1,a\rangle}\ [_{\text{CP}}\ [\mathbf{C_{dec}}\ \text{t}_{1a}]^{\langle 1,s\rangle}\ [\ \text{Alice}\ [_{\text{VP}}\ [_{\text{VP}_1}\ \text{won}\ \text{t}_{1s}]\ [_{\text{CP}_1}\ \textsc{if-clause}]^{\langle 2,a\rangle}\ ]]]]$

b. $[\![\text{VP}_1]\!] = \lambda x_e.\lambda g_g\,.\,x(g)$ won in $g(1s)$

$[\![\text{VP}]\!] = \lambda x_e.\lambda g_g\,.\,\big[\iota a(g)^*\colon \ldots\big]\ x(g[a(g)/2a])$ won in $\underline{g[a(g)/2a](1s)}$

$[\![\text{CP}]\!] \approx \lambda g_g\,.\,\forall w$ s.t. $w(g) = \underline{@(g(1a))}, \big[\iota a(g)^*\colon \ldots\big]$ Alice won in $w(g)$

$[\![\text{S}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*\colon \ldots\big]$ Alice won in $\underline{@(g^-)}$

A crucial move in §3 was to treat complementizers such as 'that' as base-generated in the world-argument position of the clause's main predicate, and as raising for type reasons as quantifiers over worlds. The approach to the syntax/semantics interface helped capture (among other things) the apparent obligatory local reading of the predicate's world argument. Yet we needn't assume that all occurrences of complementizers necessarily undergo raising from their base-generated position. The relevant modal domain for interpreting the main predicate in examples with VP-modifiers isn't a domain directly determined by the embedding assignment-

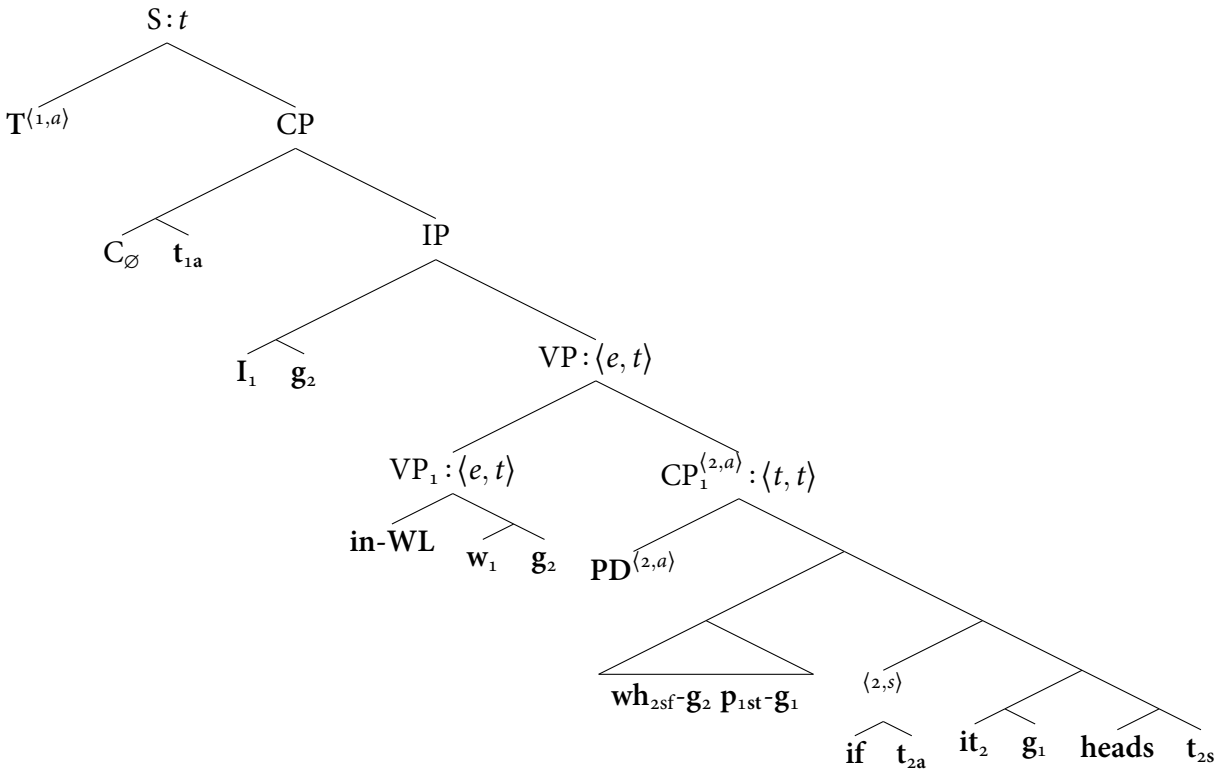
[36] See below for related discussion regarding the proform binding requirement in correlatives.

quantifier — e.g., $\mathbf{T}^{\langle 1,\mathbf{a}\rangle}$, determining $@(g_c)$ — but rather a domain as modified by the adjunct.

Accordingly, I suggest that the main predicate's world argument in such examples may be supplied by a world-pronoun, rather than a world-trace left from movement of the complementizer. Coindexing between the world pronoun and the assignment-binder on an adjoined 'if'-clause captures the role of the 'if'-clause in modifying the VP and shifting the modal domain, as derived below. Modal elements, including the topmost assignment-binder, can still be treated as raising from an assignment-argument position; however, unlike the examples considered thus far, the complementizer won't be what provides the source of intensionality. The embedding C° can be treated as denoting the identity function and base-generated in its position at LF. (We will see additional applications and motivations for the vacuous complementizer shortly.)

I offer the following LF for (101d), assuming the context from Santorio 2012 in (100) where the pronoun 'I' receives a local reading. (Note that the vacuous complementizer, written $\mathbf{C}_{\varnothing}$, is distinct from the unpronounced declarative complementizer $\mathbf{C}_{\mathbf{dec}}$, which is still given its substantive lexical entry.)

(115) *Sentence-final 'if'-clause. Shifted indexical.* (VP-adjunction)
'I am in Widmore Library if it landed heads.'




$[\![\text{IP}]\!] = ([\![\text{CP}_1]\!] \circ [\![\text{VP}_1]\!])(\lambda g_g.g(2a)(1e))$
$\approx [\lambda x_e.[\lambda T_t.[\lambda g_g.\big[\iota a(g)^*\!:\! g(1a)(2e)$ landed heads in $@(a(g))$
$\wedge @(a(g)) = a(g)(2\text{sf})(g(1a)(1st))\big]\ T(\underline{g[a(g)/2a]})]]$
$(\lambda g_g.x(g)$ is in WL in $\underline{g(2a)(1s)})]\ (\lambda g_g.g(2a)(1e))$
$\approx \lambda g_g\,.\,\big[\iota a(g)^*\!:\! g(1a)(2e)$ landed heads in $@(a(g)) \wedge @(a(g)) = a(g)(2\text{sf})(g(1a)(1st))\big]$
$\underline{a(g)(1e)}$ is in WL in $\underline{a(g)(1s)}$
$[\![\text{C}_\varnothing]\!] = \lambda a_a.\lambda T_t.\lambda g_g\,.\,T$
$[\![\text{S}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*\!:\! g(2e)$ landed heads in $@(a(g)) \wedge @(a(g)) = a(g)(2\text{sf})(g^-(1st))\big]$
$a(g)(1e)$ is in WL in $a(g)(1s)$

The conditional is true iff the maximal relevant possibility $h^* \in G$ where the contextually relevant object $g_c(2e)$ landed heads, $@(h) = h(2\text{sf})(g_c(1st))$, is s.t. the shifted

counterpart individual $h(1e)$ is in WL in the world of that possibility $h(1s)$.[37]

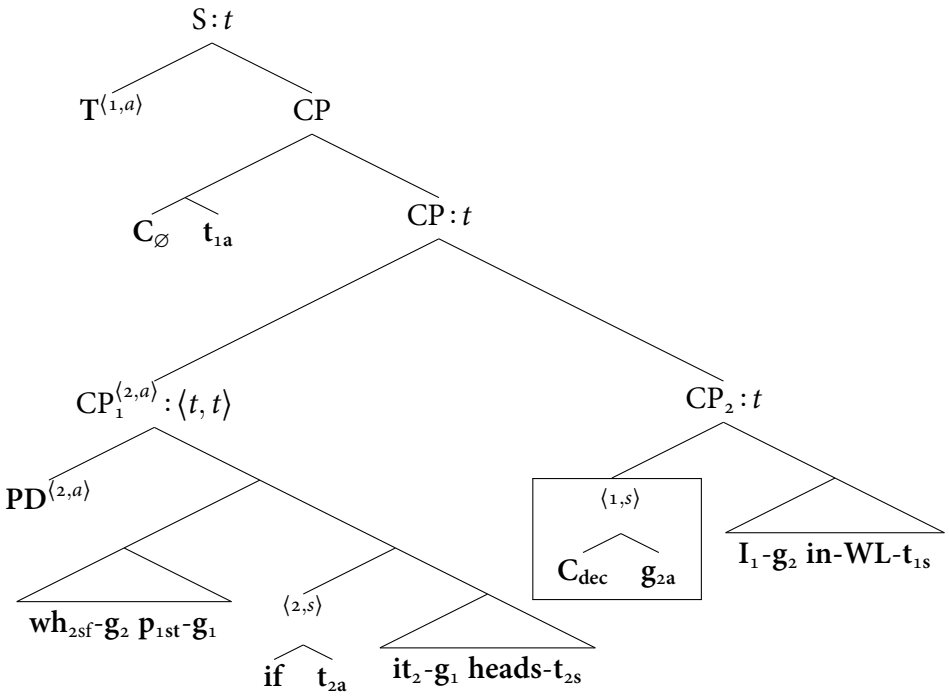
The pronoun 'it' in the 'if'-clause is interpreted with respect to the discourse assignment, while the predicate 'landed-heads' receives an obligatory local reading derived via movement of the complementizer 'if'. As with the adnominal conditional in (111), the 'if'-clause combines with the adjoined $\text{VP}_1$ via function composition, yielding the complex VP of type $\langle e, t\rangle$. The world argument of the predicate 'be-in-WL' in $\text{VP}_1$ is supplied by the world pronoun $[\mathbf{w}_1\ \mathbf{g}_2]$. Given the sort of interpretive principle in (113), LFs where the world pronoun isn't coindexed with the adjoined 'if'-clause's assignment binder will be generally excluded. The 'if'-clause thus shifts the interpretation of the adjacent world-pronoun, capturing the local reading. Crucially, although the 'if'-clause doesn't combine at the level of the main clause, the subject pronoun 'I' can still receive a local reading under the supposition. The shifted reading of the subject is compositionally derived from the general analysis of 'if'-clauses and function composition.

### 7.5 Sentence-initial 'if'-clauses

Conditionals with sentence-initial 'if'-clauses may be treated as adjoined to IP or CP (cf. Iatridou 1991, von Fintel 1994, Izvorski 1996, Bhatt & Pancheva 2006). Consider the following alternative LFs, again on the relevant local reading of 'I' from Santorio 2012. (The 'if'-clause CP in (117) is as in (116).)

[37] As in our examples with modals, one might invoke additional principles specifying that in the intended interpretation the shifted individual $a(g)(1e)$ is an epistemic counterpart of the speaker $g_c(1e)$ (n. 12, §§3–4).

(116) *Sentence-initial 'if'-clause* (CP-adjunction)
'If it landed heads, I am in Widmore Library.'




$[\![\mathrm{CP}_2]\!] = \lambda g_g\,.\,\forall w$ s.t. $w(g) = @(g(2a)), g(2a)(1e)$ is in WL in $w(g)$

$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*\!: g^-(2e)$ landed heads in $@(a(g)) \wedge @(a(g)) = a(g)(2\mathrm{sf})(g^-(1st))\big]$
$\forall w$ s.t. $w(g) = \underline{@(a(g))}, a(g)(1e)$ is in WL in $w(g)$

(117) *Sentence-initial 'if'-clause* (IP-adjunction)

a. $[_{\mathrm{S}}\ \mathrm{T}^{\langle 1,a\rangle}\ [_{\mathrm{CP}}\ [\mathbf{C}_{\varnothing}\ \mathrm{t}_{1a}]\ [_{\mathrm{IP}}\ [_{\mathrm{CP}_1}\ \ldots]^{\langle 2,a\rangle}\ [_{\mathrm{IP}}\ \mathrm{I}_2\text{-}\mathrm{g}_2$ in-WL-$\underline{\mathrm{w}_1\text{-}\mathrm{g}_2}]]]]$

b. $[\![\mathrm{S}]\!] = [\![(115)]\!] \approx \lambda g_g\,.\,[\iota a(g)^*\!: \ldots]\ a(g)(1e)$ is in WL in $\underline{a(g)(1s)}$

Roughly, in both (116)–(117), the conditional is true iff the maximal relevant possibility $h^* \in G$ where $g_c(2e)$ landed heads, $@(h^*) = h^*(2\mathrm{sf})(g_c(1st))$, is such that the first-positioned individual $h^*(1e)$ is in WL in the world of that possibility.

The semantic value in (117) where the 'if'-clause adjoins to IP is identical to the semantic value in (115): The world argument is again supplied by the world pronoun $[\mathbf{w}_1\ \mathbf{g}_2]$ which receives its interpretation from the adjoined 'if'-clause; and the derived modal domain is $a(g)(1s)$, which, given our metasemantic assumptions, represents the world of the possibility represented by $a(g)$, i.e. $@(a(g))$. By contrast,

in (116) the modal domain for interpreting the main clause is explicitly identified with $@(a(g))$. This represents an important point about the LFs.

In (116) the main predicate's world argument is, as usual, supplied by a world-trace left from movement of the main clause complementizer. Yet unlike the examples considered thus far, the complementizer's assignment argument is supplied by an assignment-variable coindexed with the 'if'-clause. The topmost assignment-binder raises from the assignment argument position of $\mathbf{C}_{\varnothing}$, as in (115)/(117). However, in (116), where the 'if'-clause adjoins to a full CP, there is an independently motivated mechanism for generating the vacuous complementizer embedding the conditional: *CP-recursion* (Iatridou & Kroch 1993; see e.g. Vikner 1995, Browning 1996, Nyvad et al. 2017 for general discussion). Conditionals with sentence-initial 'if'-clauses — and correlative constructions generally (de Vries 2002) — follow the complementizer in attitude ascriptions.

(118) Alice thinks [$_{\text{CP}_1}$ that [$_{\text{CP}_2}$ [if it snows] [$_{\text{CP}_3}$ (then) school will close]]]

Treating the complementizer embedding the conditional as semantically vacuous satisfies the requirement for CP-recursion in Iatridou & Kroch 1993 that any content of the higher complementizer be recoverable from the content of the lower complementizer. $\mathbf{C}_{\varnothing}$ may be pronounced, as in (118), where what raises from the assignment argument position in C$^{\text{o}}$ is the embedding attitude verb, or implicit, as in (116), where what raises is the topmost assignment-binder **T**.

Hypothetical conditionals (in the sense of Iatridou 1991) can be understood as a type of **correlative** construction, where the free relative clause obligatorily binds a correlate/proform in the main clause (Iatridou 1991, von Fintel 1994, Bittner 2001, Schlenker 2004, Bhatt & Pancheva 2006, Arsenijević 2009).

(119) *Correlatives / Proform binding*

[$_{\text{IP/CP}}$[$_{\text{CP}}$ free relative clause]$_i$ [$_{\text{IP/CP}}$ … correlate$_i$ …]]

Syntactic work on correlatives indicates that fronted correlative proforms must be structurally adjacent to the sentence-initial relative clause (Bhatt & Pancheva 2006, den Dikken 2009, Lipták 2012).[38] This requirement helps capture the apparent **obligatory local reading** of the main clause's modal domain in a hypothetical 'if…' conditional, even if the 'if'-clause is a base-generated adjunct. For instance, the

[38]One way of formalizing the relevant notion of adjacency might be that $\beta$ is *structurally adjacent* to $\alpha$ iff (i) $\alpha$ c-commands $\beta$, and (ii) there is a non-branching path from $\beta$ which terminates at the sister of $\alpha$. (One could then say that $\alpha$ and $\beta$ are structurally adjacent iff $\alpha$ is structurally adjacent to $\beta$ or $\beta$ is structurally adjacent to $\alpha$.)

correlative 'if'-clause in (116) binds the assignment-variable in the main clause complementizer, shifting the modal domain to that of the topical antecedent possibility.

It is standard in analyses of 'if'-clauses as free relatives to treat conditional 'then' as the correlate proform in correlative constructions.

(120) [If it snowed,]$_i$ *then*$_i$ it was cold.

Not all sentence-initial 'if…' conditionals are compatible with 'then', e.g.:

(121) a. If John is dead or alive, (#then) Bill will find him.
b. Even if John is drunk, (#then) Bill will vote for him.

(Iatridou 1994: exs. 6,10)

(122) a. What does John think that if his mother comes (*then) the guests will eat?
b. How/where did Mary say that if her mother visits (*then) the car will be fixed?

(Iatridou & Kroch 1993: exs. 58–59)

Such data lead Bhatt & Pancheva 2006 to deny that hypothetical 'if…' conditionals without 'then' are correlatives. This strikes me a prima facie cost. Like other correlatives, hypothetical 'if…' conditionals without 'then' consist of a sentence-initial free relative clause which shifts the interpretation of an element in the main clause. Unlike relevance conditionals, which intuitively predicate the consequent of the actual world (cf. n. 35), hypothetical conditionals shift the modal domain with or without an overt 'then'. The analysis in this section captures the connection between hypothetical 'if…' conditionals and correlatives: the free relative 'if'-clause is coindexed with the assignment-variable determining the modal domain relevant for interpreting the main clause. Hypothetical conditionals contrast with correlatives of individuals in this respect, where the proform fills a lexical argument position and in general must be expressed.

Treating hypothetical conditionals generally as correlatives is compatible with acknowledging a contrast between conditionals with and without 'then'. Overtly expressing the conditional proform requires raising it from its base position and *topicalizing* it (cf. Izvorski 1996, Arsenijević 2009, Lipták 2012), as reflected in (123) where 'then' occupies its own projection in SpecCP (Iatridou 1991, Iatridou & Kroch 1993, Collins 1998).

(123) $[_S \ldots [_{CP} [_{CP}$ if-clause$]^{\langle i,a\rangle} [_{CP} [_{XP}$ then-X$_i]^k [_{\overline{C}} \ldots t_k \ldots ]]]]$

Explicitly topicalizing the proform can have distinctive interpretive and syntactic

effects. It is often claimed that 'If $p$, then $q$' conditionals carry an implication roughly that some/all $\neg p$-possibilities are $\neg q$-possibilities (cf. Iatridou 1991, 1994, von Fintel 1994).

(124) If the weather is good, Alice will win
$\rightsquigarrow$ In some possibility where the weather isn't good, Alice won't win

Izvorski 1996 shows that this exhaustiveness implication associated with conditional 'then' is shared among correlative proforms generally. In correlatives of individuals the proform is also interpreted at LF in a topicalized position in the left periphery of the main clause. It isn't implausible that focusing the moved proforms in this way is what leads to the apparent exhaustiveness implications — hence the exclusion of 'then' in (121) where the antecedent is already exhaustive. Topicalizing the proform can also have syntactic implications, as in (122). $\overline{\text{A}}$-raising the proform to SpecCP excludes further argument or adjunct extractions out of the main clause (Iatridou 1991, Iatridou & Kroch 1993, Collins 1998, Bhatt & Pancheva 2006; cf. Dayal 1996, Izvorski 1996).

So, the assignment-variable-based syntax/semantics for hypothetical conditionals in this section unifies 'if…(then)' with correlatives in the sense that there is a left-adjoined free relative clause which binds a correlate in the main clause. In conditionals with overt 'then' the proform is topicalized and raises to SpecCP of the main clause. We can capture the idea that 'if'-clauses are topics (e.g. Haiman 1978) without analyzing all conditional constructions as involving movement via topicalization. (I return to analyses of 'then' and correlative proforms in §7.7.)

## 7.6 Modalized conditionals: Restricting and shifting

So far we have focused on "bare" conditionals — conditionals without an overt operator in the main clause. Although there may be evidence for a covert operator in some bare conditionals (epistemic, generic, frequency; Lewis 1975, Kratzer 1991), the account in this section captures the function of 'if'-clauses in shifting a modal domain without needing to posit an additional operator. Let's turn now to modalized conditionals and consider the role of 'if'-clauses in modifying the interpretation of a modal. (I focus on hypothetical conditionals with sentence-initial 'if'-clauses.)

### *7.6.1 Direct restriction*

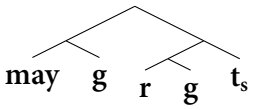
The traditional Kratzerian line is that the 'if'-clause in a modalized conditional such as (125) restricts the domain of the modal.

(125) If it rains, he might cry.
≈ for some epistemic possibility in which it rains, he cries

A prominent approach to quantifier domain restriction is to analyze quantifier phrases as interpreted with respect to a contextually supplied resource domain (n. 27). Adapting von Fintel 1994, one option is thus to treat modal verbs as taking a **resource domain argument** in addition to the modal background representing the reading of the modal, i.e. epistemic, deontic, etc. A revised lexical entry for 'may' is in (126). (The structure of the modal's restrictor argument is modified as well to give the modal a "world-invariant" entry analogous to determiner quantifiers (cf. von Fintel & Heim 2011). As previously I use '$r$' in indices for type $\langle s, at\rangle$.)

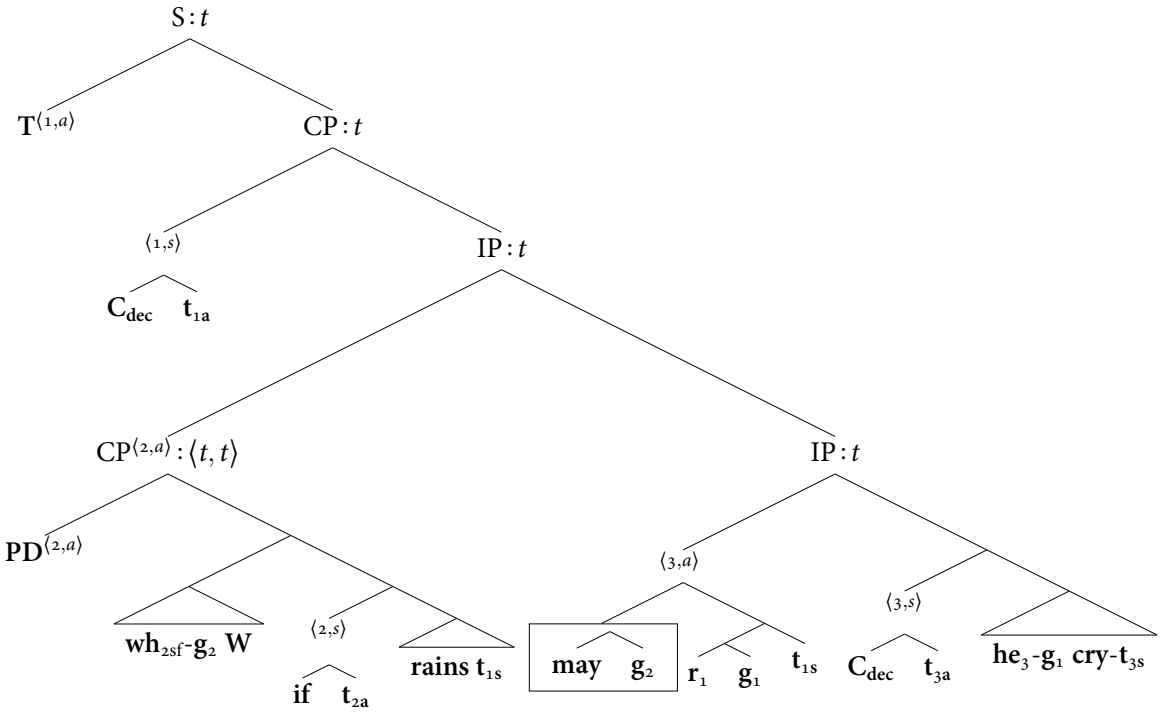
(126) $[\![\textbf{may}]\!] = \lambda a_a.\lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,\exists a'_a$ s.t. $a'(g) \leq a(g) \wedge A(a')(g) \colon A'(a')(g)$

(127)




In modalized conditional correlatives, the correlative binding requirement can be satisfied by coindexing the resource domain with the 'if'-clause, as reflected in (128). (Ignore any contextual restriction in the specifier argument of 'if', and assume **W** represents the domain of worlds.)

(128) *Modalized conditional* (IP-adjunction)
'If it rains, he may cry.'




$[\![\text{IP}]\!] \approx \lambda g_g\,.\,\exists a'$ s.t. $a'(g) \leq g(2a) \wedge g(1a)(1r)(g(1s))(a'(g))$:
$g(1a)(3e)$ cries in $@(a'(g))$

$[\![\text{S}]\!] \approx \lambda g_g\,.\,\left[\iota a(g)^*\text{: it rained in } @(a(g)) \wedge @(a(g)) = a(g)(2\text{sf})(W)\right]$
$\exists a'$ s.t. $\underline{a'(g) \leq a(g)} \wedge g^-(1r)(@(g^-))(a'(g))$: $g^-(3e)$ cries in $@(a'(g))$

This treats the modalized 'may' conditional as saying that the maximal relevant possibility $h^*$ in which the antecedent is verified is such that some accessible possibility that is a part of $h^*$ verifies the consequent. Roughly put, (128) is true iff the maximal relevant possibility where it rains $h^*$ is such that the contextually relevant individual $g_c(3e)$ cries in some possibility $h'$ that is a part of $h^*$ and is included in the set of accessible possibilities, as determined by the contextually relevant modal background $g_c(1r)$ at the actual world ($g_c$).

The modal 'may' in the consequent is interpreted with respect to the same contextually relevant domain of possibilities as would figure in the interpretation of an unembedded 'may' sentence: the relevant reading is supplied by the discourse assignment, and the modal background is indexed to the actual world. The role

of the 'if'-clause is simply to restrict this domain to possibilities where it rained. As von Fintel notes, the relation between the 'if'-clause and the modal's restrictor argument in such structures is apparently stronger than an optional binding relation; von Fintel suggests analyzing it as an $\overline{\text{A}}$-chain (1994: 88–89; cf. Dayal 1996). For instance, in nested conditionals such as (129) the modal must receive the restriction of the closest 'if'-clause (cf. Bhatt & Pancheva 2006).

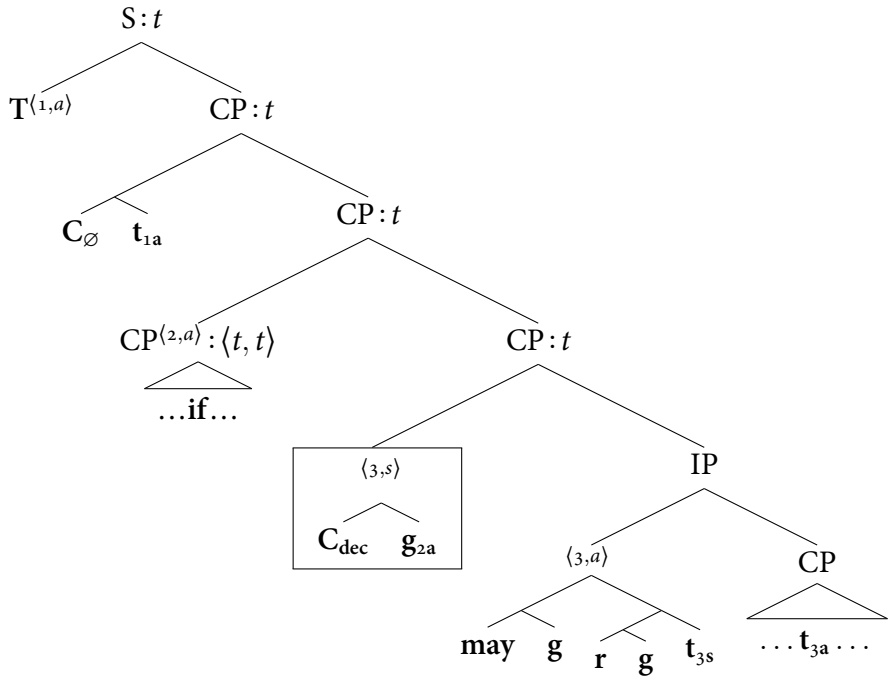
(129) If you get back in time for the show, then [if Timmy isn't tired]$_i$ we'll *have to*$_i$ take him.

The close connection between the topical possibility described by the 'if'-clause and the modal's resource domain can be captured by the locality requirement on correlative correlates discussed above. This general requirement suggests a new way of understanding the correlate in modalized hypothetical 'if…' conditionals: The structurally adjacent element bound by the 'if'-clause in (128) is [**may** $\mathbf{g}_2$] (n. 38). The binder-index on the 'if'-clause is coindexed with the assignment-variable supplying the resource domain argument of the modal.

### *7.6.2 Indirect restriction/modification: "Double modal" and "information-sensitive" readings*

The above analysis captures both the correlative binding requirement and the restricting function of the 'if'-clause via the modal's resource domain. In (128) the modal's resource domain variable supplies the correlate, the correlative 'if'-clause combines with IP, and (as in §§3–4) the embedding complementizer raises from the modal's world-argument position. One might wonder what predictions would follow if the complementizer raised locally under the 'if'-clause, as in (130).

(130) *Modalized conditional* (CP-adjunction)




Just as with the bare conditional in (116), the complementizer adjacent to the 'if'-clause supplies the correlate, and the modal domain for the (here modalized) main clause is determined by the 'if'-clause. I suggest that such LFs can represent so-called **"double modal"** and **"information-sensitive"** readings of modalized conditionals.

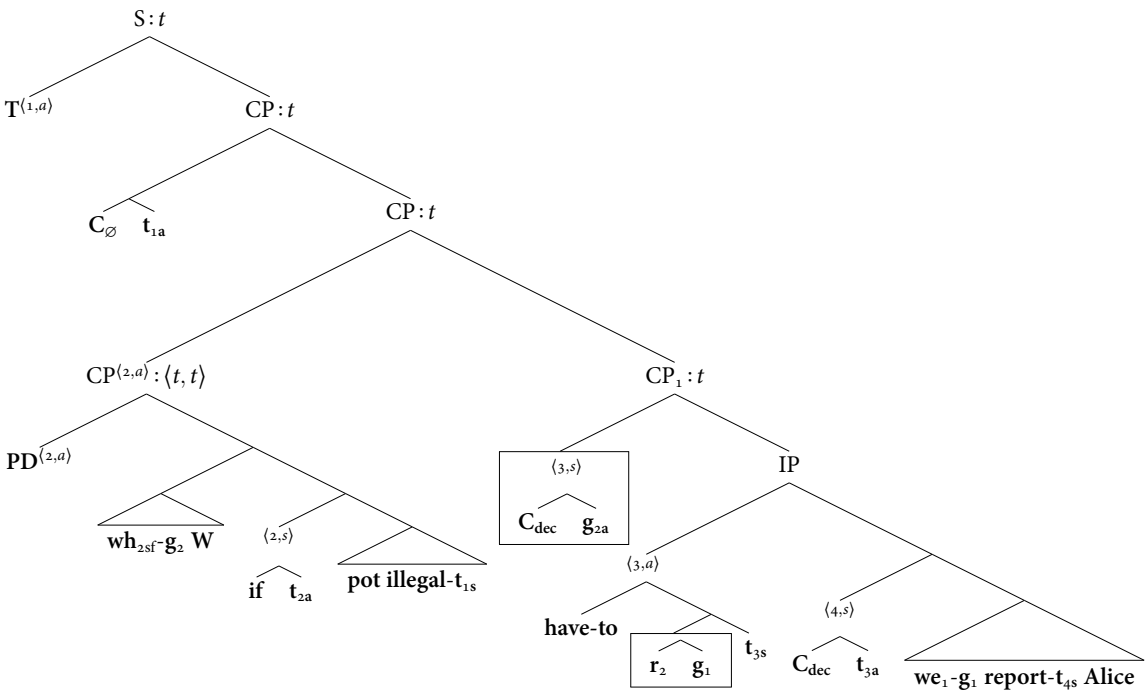
First, examples such as (131) have led some theorists to posit that at least some modalized conditionals have a covert modal in addition to overt modal in the consequent (Frank 1996, Geurts 2004, von Fintel & Iatridou 2005, Swanson 2010).

(131) If marijuana is illegal here, we have to report Alice. (cf. Geurts 2004: ex. 1)
≈ for every epistemically accessible world $w'$ where marijuana is illegal, every world $w''$ conforming to the law in $w'$ is s.t. we report Alice in $w''$

In a Kratzerian restrictor approach, the 'if'-clause restricts the domain of the covert (epistemic) necessity modal, and the overt deontic modal is evaluated at each world in the covert modal's restricted domain. The account in this section captures putative "double modal" readings without positing a covert modal, as reflected in the simplified LF and derivation in (132). (Assume that in the intended interpretation $\mathbf{r}_2$

represents a modal background for the relevant laws. For simplicity in what follows I will often ignore the modal's potential resource domain argument.)

(132) *"Double modal" reading*




$[\![\mathrm{CP}_1]\!] \approx \lambda g_g\,.\,\forall a'$ s.t. $\underline{g(1a)(2r)(@(g(2a)))}(a'(g))$:$g(1a)(1e)$ reports Alice in $@(a'(g))$

$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*$: marijuana is illegal in $@(a(g)) \wedge @(a(g)) = a(g)(2\mathrm{sf})(W)\big]$
$\forall a'$ s.t. $\underline{g^-(2r)(@(a(g)))}(a'(g))$:$g^-(1e)$ reports Alice in $@(a'(g))$

This says, roughly, that the maximal possibility where marijuana is illegal $h^*$ is such that for every possibility $h'$ compatible with the law in $@(h^*)$ — i.e. every $h' \in g_c(2r)(@(h^*))$ — we report Alice in $@(h')$.

As in (116), the correlative 'if'-clause is coindexed with the assignment-variable $\mathbf{g}_2$ in the adjacent complementizer, which determines the modal domain for evaluating the main clause. The felt "double modal" interpretation follows from the following combination of features: (i) the modal's modal-background pronoun $[\mathbf{r}_2\ \mathbf{g}_1]$ receives its interpretation from the discourse assignment $g_c$, as in (116); however, (ii) the world applied to the modal background is the world of the antecedent-verifying possibility $@(h^*)$. The discourse context supplies the relevant *function* $\langle s, at\rangle$ from

worlds to sets of possibilities, $g_c(2r)$, which represents the law and determines the intended deontic reading of the modal. What the law provides may vary across worlds. In contrast to (116), the specific content of the law relevant for evaluating the modalized main clause is the law in the possibility $h^*$ in which marijuana is illegal. The 'if'-clause introduces a topical possibility, and the modal's deontic modal background is indexed to the world of that possibility.

The informal intuition in the literature on information-sensitivity is that the deontic modal's modal background seems to be updated, in some sense to be explained, in light of the information in the antecedent, as reflected informally in (133) (e.g. Kolodny & MacFarlane 2010, Dowell 2012, Charlow 2013b, Cariani et al. 2013, Silk 2014b, 2016).[39]

(133) [Context: Ten miners are trapped in shaft A or shaft B, but we don't know which, and floodwaters are threatening. All ten miners will be saved if we block the shaft they're in, but all ten will drown if we block the wrong shaft. One miner will drown if we block neither shaft.]

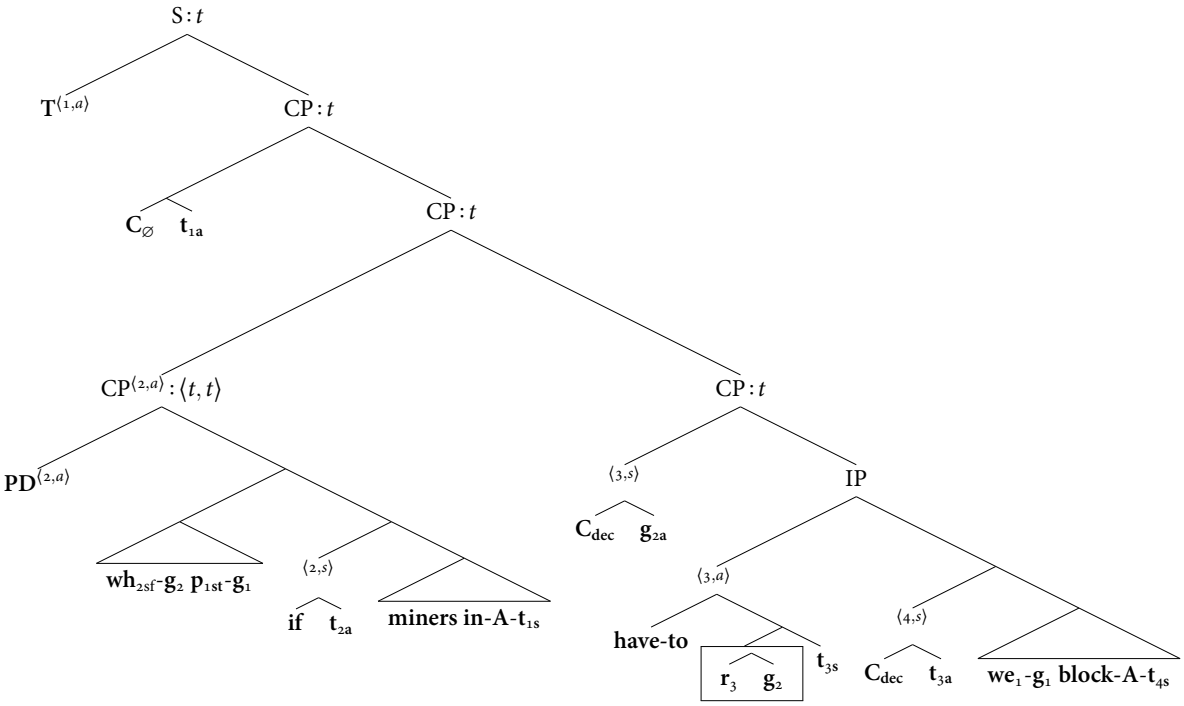
If the miners are in shaft A, we have to block shaft A.

≈ If the miners are in shaft A, then, given that information, the deontically preferred worlds are worlds where we block shaft A. (Though, given our actual information, the deontically preferred worlds are worlds where we block neither shaft.)

The "shifty" interpretation in examples such as (131)–(132) was derived by applying the *shifted worlds* of the possibility introduced by the antecedent to the deontic modal background supplied by the *global context*. I suggest that LFs in which the modal-background variable receives its interpretation from an assignment-variable bound by the 'if'-clause can represent **information-sensitive readings**. The putative non-restricting function of the conditional clause is diagnosed as a local readings of the modal's modal-background pronoun, as reflected in (134).

[39] On related phenomena with modalized conditionals generally, see Gillies 2010, Yalcin 2012, Charlow 2013a. Given our purposes I ignore any differences between weak/strong necessity modals in information-sensitivity, though see Silk 2013, Charlow 2013b.

(134) *"Information-sensitive" reading*




$$[\![\text{S}]\!] \approx \lambda g_g\,.\,\Big[\iota a(g)^*\text{: the miners are in A in } @(a(g)) \wedge @(a(g)) = a(g)(2\text{sf})(g^-(1st))\Big]$$
$$\forall a' \text{ s.t. } \underline{a(g)(3r)(@(a(g)))}(a'(g))\text{: } g^-(1e) \text{ blocks A in } @(a'(g))$$

This says, roughly, that the maximal relevant possibility where the miners are in shaft A, $h^*$, is such that, for every possibility $h'$ compatible with the deontic ideal determined by $h^*$ — i.e. every $h' \in h^*(3r)(@(h^*))$ — we block shaft A in $@(h')$.

As in (132) the modal domain for evaluating the modalized main clause is set by the assignment-variable $\mathbf{g}_2$ in the complementizer coindexed with the correlative 'if'-clause. However, the deontic modal-background pronoun — here $[\mathbf{r}_3\ \mathbf{g}_2]$ — receives a local reading as well. The deontic modal background for evaluating the modal's prejacent is determined by the topical antecedent possibility that the miners are in shaft A. Crucially, this possibility may be a *plural* object. The plural possibility $a(g_c)^*$ represents a state throughout which the miners are in shaft A. Which deontic ideal, set of accessible worlds, etc. is determined by a possibility may be due to a feature of the possibility qua plurality. The discourse context may be such that $g_c(3r)$ implies that we block neither shaft; yet its image under $a$, such that the miners are

in shaft A in the world of every part of the plurality $a(g_c)^*$, may determine a deontic ideal $a(g_c)^*(3r)$ implying that we block shaft A.

Some theorists have appealed to information-sensitive readings to motivate revising traditional semantics for modals and conditionals. For instance, modals' domains of quantification may be treated as determined relative to an additional parameter such as an information state (e.g. Kolodny & MacFarlane 2010, Silk 2014b). Plural domains may provide the structure to capture intuitions behind certain revisionary approaches to information-sensitivity while still relativizing modal backgrounds simply to worlds, as in the traditional semantics. An analysis of conditionals as plural definite descriptions may thus be of general interest, independent of the assignment-variable implementation developed here.

Let's recap. This section has examined how an assignment-variable-based approach to local/global readings and §§3–6-accounts of modals and relative clauses may be extended to conditionals. The syntax/semantics in §7.2 yields a uniform analysis of 'if'-clauses in various positions and conditional structures — in sentence-final positions adjoined to VP, in sentence-initial positions adjoined to IP/CP, and in adnominal conditionals when adjoined to NP; in conditionals with/without a proform such as 'then'; and in conditionals with/without a main clause modal. 'If'-clauses are analyzed syntactically as free relatives and interpreted as plural definite descriptions of possibilities, represented by assignments. The account compositionally derives various types of local readings and ways 'if'-clauses may shift/modify the interpretation of modals and other expressions, while still allowing for global readings in the 'if'-clause and the rest of the sentence. In correlative constructions the sentence-initial 'if'-clause obligatorily binds a correlate in the main clause. The correlate may be overtly expressed and topicalized such as in hypothetical 'if…then' conditionals.

## 7.7 Correlatives and proforms: Individual and conditional

The account in §§7.5–7.6 exploited connections between hypothetical 'if…(then)' conditionals and correlative constructions. Before moving on I would like to briefly consider how the proposed assignment-variable-based syntax/semantics for 'if'-clauses might be extended to a general treatment of correlatives and correlative proforms.

Cross-linguistic work demonstrates robust links among conditionals, interrogatives, and correlatives of individuals (see Dayal 1996, Bhatt & Pancheva 2006, Lipták 2009b and references therein). For instance, there are systematic structural parallels between conditional and interrogative clauses, and many languages (e.g. Bulgarian) use the same type of complementizer in expressing conditionals

and questions. Although English doesn't have correlatives of individuals, many languages where correlativization is more productive use the same type of marker in both conditionals and individual correlatives for introducing the relative clause, and for the main clause proforms. In some languages the same construction can be ambiguous between a conditional and individual correlative interpretation, as in (135) (cf. Cable 2009 on Lhasa Tibetan).

(135) Ako je (ko) već (ko) ustao, (taj) (onda) neka (taj) i izade.
if aux who already who raised that then let that and go.out
a. '[If anyone already stood up]$_i$ (then)$_i$ let him also go out.'
b. 'Whoever$_i$ stood up, let him$_i$ also go out.'
(Arsenijević 2009: ex. 10; Serbo-Croatian)

Suppose as a working hypothesis that we give a uniform analysis of correlative clauses in conditionals and individual correlatives. (We will return to interrogative clauses in §8.) I suggest that what distinguishes conditional and non-conditional interpretations of correlative clauses (cf. (135)) is the nature of the complementizer's external world argument and its relation to the main clause's modal domain. In conditional correlatives, the 'if'-clause introduces a topical modal possibility, and the correlative binding requirement is satisfied by binding a correlate determining the main clause's modal domain. In individual correlatives the topical possibility is still the possibility described by the correlative clause. However, rather than introducing a modal possibility, the correlative clause introduces an *actual* possibility about certain *topical individuals*. The modal domain for both clauses is the world of the discourse: the external argument of the correlative clause complementizer is identified with the actual world, and the main clause's modal domain is determined by the embedding modal/assignment-binder. The correlative binding requirement is satisfied by binding an individual correlate in the main clause. Extending the treatments of linguistic anaphora from §6, conditional and individual proforms alike may be represented as copies of their antecedent relative/*wh* word.

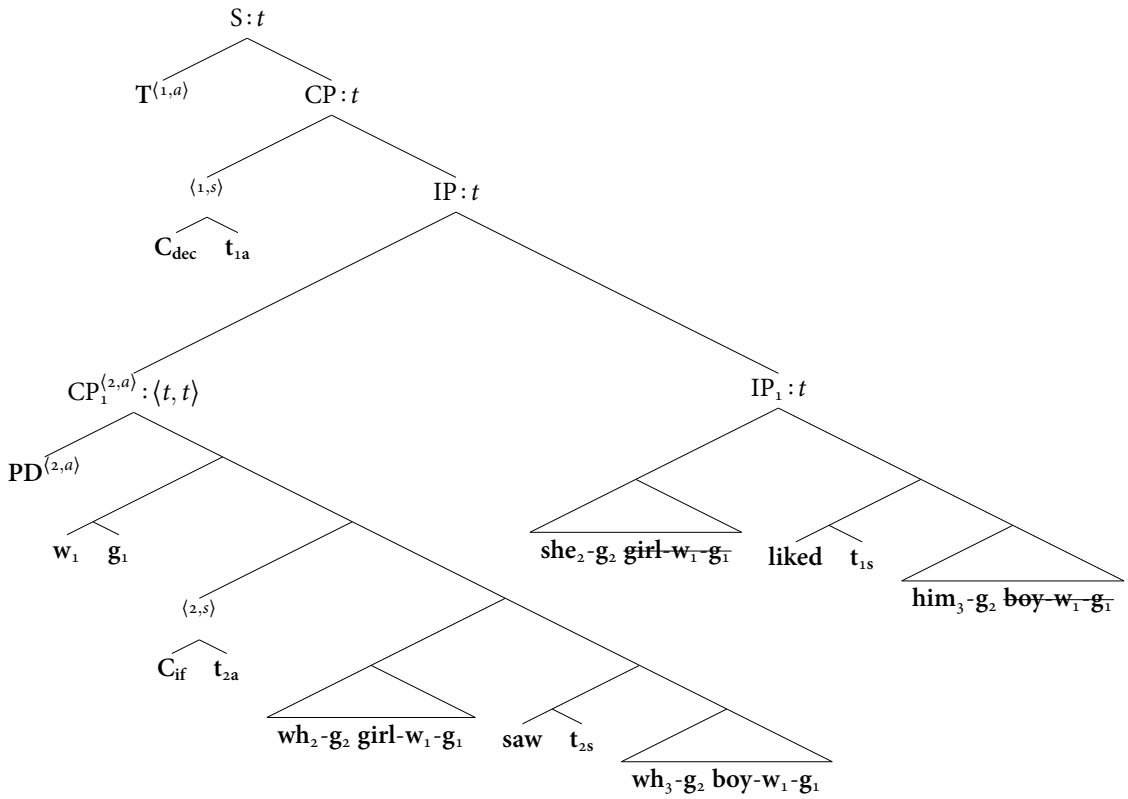
### *7.7.1 Individual correlatives and proforms*

An example with a multiple correlative of individuals is in (136). (I use '$\mathbf{C}_{\mathbf{if}}$' for the complementizer, where $[\![\mathbf{C}_{\mathbf{if}}]\!] = [\![\mathbf{if}]\!]$. The external argument could be represented with $[\mathbf{wh}_{\mathrm{sf}}\text{-}\mathbf{g}\ \mathbf{p}_{\mathrm{st}}\text{-}\mathbf{g}]$, as in conditionals, where the semantic value for [**p g**] is ultimately identified with $\{g_c(1s)\} = \{@(g_c)\}$. However, for clarity I represent the ex-

ternal argument in individual correlative interpretations with a world-pronoun.)[40]

(136) *Correlative of individuals*

jis laRkiiNE jis laRkeKO dekhaa usNE usKO pasand kiyaa.
REL girl REL boy saw DEM DEM liked
'Which girl saw which boy, she liked him.' (Srivastav 1991: ex. 32)




$[\![\mathrm{IP}_1]\!] \approx \lambda g_g \,.\, g(2a)(2\mathrm{cf})(girl_{g(1a)(1s)})$ liked $g(2a)(3\mathrm{cf})(boy_{g(1a)(1s)})$ in $g(1s)$

$[\![\mathrm{CP}_1^{\langle 2,a\rangle}]\!] \approx \lambda T_t.\lambda g_g \,.\, \big[\iota a(g)^*\!: a(g)(2\mathrm{cf})(girl_{g(1a)(1s)})$ saw $a(g)(3\mathrm{cf})(boy_{g(1a)(1s)})$
in $@(a(g)) \wedge \underline{@(a(g)) = g(1a)(1s)}\big]\ T(g[a(g)/2a])$

$[\![\mathrm{S}]\!] \approx \lambda g_g \,.\, \big[\iota a(g)^*\!: a(g)(2\mathrm{cf})(girl_{g^-(1s)})$ saw $a(g)(3\mathrm{cf})(boy_{g^-(1s)})$ in $@(a(g))$
$\wedge \underline{@(a(g)) = g^-(1s)}\big]\ \underline{a(g)(2\mathrm{cf})(girl_{g^-(1s)})}$ liked $\underline{a(g)(3\mathrm{cf})(boy_{g^-(1s)})}$ in $@(g^-)$

[40] I treat the main clause as an IP, but it could also be a CP. As in §§6, 7.2 with the relative complementizer and 'if', I assume that the relative word must have the same assignment-variable as $\mathbf{C_{if}}$ (more on this in §8). As previously I use abbreviations such as '$baby_u$' for the characteristic function of the set of individuals $o \in E$ such that $o$ is a baby in $u$.

Informally, this treats the correlative as saying that the assignment providing a true answer to the question "which girl$_i$ saw which boy$_j$?" verifies the matrix clause statement "that girl$_i$ liked that boy$_j$". The correlative clause describes the unique possibility in which the selected girl $o$ (=$a(g)(2\text{cf})(girl_{g(1s)})$) saw the selected boy $o'$ (=$a(g)(3\text{cf})(boy_{g(1s)})$), where the world $u$ of that possibility is s.t. $u = g_c(1s)$. The sentence is true iff the selected girl $o$ liked the selected boy $o'$ in $@(g_c)$.

First, the individual correlative clause in (136) is given the same structural representation as an 'if'-clause. In (136) the world of the possibility introduced in the correlative clause is specified as being identical to, $g_c(1s)$ — given our metasemantic assumptions, the world identical to the world of the discourse $@(g_c)$. The topical possibility is the unique *actual* possibility in which a certain girl saw a certain boy. The main clause says that that same girl liked that same boy. The correlative binding requirement is captured by (i) the syntactic representation of the proform as a copy of its antecedent relative word and here elided NP [$\mathbf{wh_i}$-$\mathbf{g}_2$ NP], and (ii) the assignment-quantification introduced by the operator **PD** in the correlative clause.

In a slogan: Individual correlatives are **material relevance conditionals with donkey pronouns** (nn. 34, 35) — (i) "material" insofar as the modal domain for the correlative clause is restricted to the actual world $g_c(1s)$: the correlative clause describes a possibility in the actual world; (ii) "relevance" insofar as the modal domain for the main clause is identified directly with $@(g_c)$ via the syntax/semantics interface: the main clause comments on the actual world; and (iii) "donkey" insofar as the main clause proforms are anaphorically identified with their non-c-commanding antecedents [**wh**-$\mathbf{g}_2$ **P**], via the correlative clause assignment-binder from $\mathbf{PD}^{\langle 2,a\rangle}$.[41]

[41]Interestingly, though Cable 2009 avoids giving "a 'simple' conditional analysis" (219n.7; 204–205) of Tibetan correlatives, he notes that the correlatives are glossed literally as conditional donkey sentences, as in (i).

(i) [Khyodra-s gyag gare nyos yod na] nga-s de bsad pa yin.
you-ERG yak what buy AUX if I-ERG that kill PERF AUX
'I killed whatever yak you bought.'
*Lit.*: 'If you bought what/a yak, I killed that/it.' (Cable 2009: 195; Tibetan)

Indeed correlative proforms are typically formed from a demonstrative. It may be interesting to compare the proposed representation of correlative proforms with Sportiche's (2006) informal analysis of copies reconstructed from preposed/A-bar positions as demonstratives, as in (ii).

(ii) a. 'Je lui ai donné la photo que le vieux peintre m'a demandée.'
b. 'I gave him the picture the old painter asked for yesterday.'
c. [The picture the old painter asked for]$_i$ I gave him *this picture*$_i$
(Sportiche 2006: ex. 132; typo corrected, subscript-indexing added)

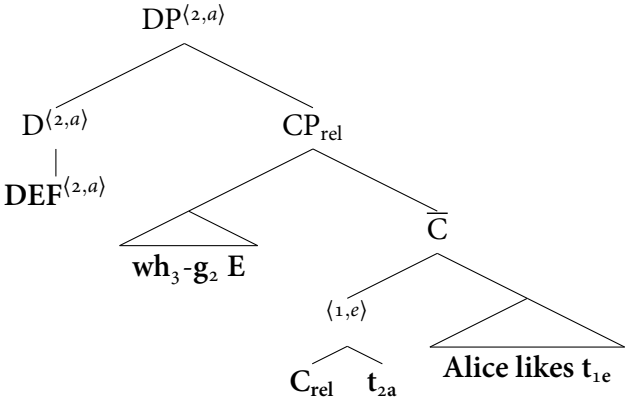
Individual correlates contrast with individual pronouns in being compatible with overtly expressing the complement NP. In some cases of individual correlatives, the overt NP in the correlate may

It is common in semantics for correlatives to give roughly uniform interpretations of correlative clauses and ordinary (non-correlative) free relatives, say as plural definite descriptions (e.g. Srivastav 1991, Dayal 1996, Grosu & Landman 1998). Yet it is interesting that individual correlative clauses pattern with interrogative and conditional clauses with respect to various syntactic/semantic properties, in contrast to non-correlative free relatives. For instance, they also pattern with interrogative clauses in the availability of multiple *wh*-words, reconstruction effects, and exhaustivity (Dayal 1996, Cable 2009, Citko 2009).

(137) a. Which boy read which book? (cf. (136))
b. Everyone got what she/*who wants.

The account in this section assimilates individual correlative clauses and conditional clauses: they include the same definite operator of assignments, which raises from an equivalent complementizer. Ordinary non-correlative free relatives can be assimilated instead to restrictive relatives as reflected in (45), reproduced in (138) (ignoring worlds and any contextual restriction associated with 'what').

(138) '(Bert likes) what Alice likes'




$[\![\mathbf{DEF}]\!] = \lambda P^{+}_{\langle a,et\rangle}.\lambda Q^{+}_{\langle a,et\rangle}.\lambda g_g\,.\,\left[\iota x(g) {}^{*}\exists a\colon P^{+}(a)(x)(g)\right] Q^{+}(a)(x)(g)$

$[\![\mathrm{DP}^{\langle 2,a\rangle}]\!] \approx \lambda Q_{et}.\lambda g_g\,.\,\left[\iota x(g) {}^{*}\exists a\colon x(g) = a(g)(3\mathrm{cf})(E) \wedge \text{Alice likes } x(g)\right]$
$Q(x)(g[a(g)/2a])$

differ from the antecedent NP, typically denoting a contextual subset (e.g. Dayal 1996, Beshears 2017) — hence the qualification that proforms are analyzed copies of the antecedent relative/*wh* word. Correlatives also have a "matching requirement" that there be the same number of correlates as relative/*wh* phrases; see Bhatt 2003, Leung 2009 and references therein.

As in the analysis of headed relatives from §6, a determiner quantifier of individuals raises from the relative complementizer $\mathbf{C_{rel}}$. The implicit quantifier in the free relative can be given the same sort of assignment-quantificational semantics as the matrix determiners in §6: The plural definite operator **DEF** picks out a unique maximal *individual*. In contrast, the plural definite operator **PD** in a correlative/conditional picks out a unique maximal possibility.

### *7.7.2 Conditional correlatives and 'then'*

Despite extensive syntactic and typological research on correlatives, there has been surprisingly little work on the compositional semantics of conditional proforms such as 'then'. Pioneering developments came with Iatridou 1991, 1994, who showed that conditional 'then' isn't semantically inert, and with Izvorski 1996, who observed that the exhaustivity implications associated with 'then' are shared among correlative proforms generally, as discussed in §7.5. Yet specific derivations of these apparent interpretive effects aren't provided. A prominent approach, following especially Schlenker 2004, is to analyze 'then' as a world pronoun (see also Bhatt & Pancheva 2006, Arsenijević 2009). Such a move is certainly compatible with the present framework; 'then' could be analyzed as a topicalized expression of the main predicate's world argument, as reflected schematically in (139).

(139) $[_{S} \ldots [_{CP} [_{CP}$ IF-CLAUSE $]^{\langle k,a\rangle} [_{CP} [_{XP} \underline{\text{then}_{1s}\ g_k}]^{\langle 1,s\rangle} [_{\overline{C}} \ldots t_{1s} \ldots ]]]]$

Yet I think there are reasons to be dissatisfied with approaches along these lines, reasons both theory-internal and independent of an assignment variable framework.

Analyzing 'then' as a simple pronoun leaves various linguistic phenomena with conditional proforms unexplained. First, cross-linguistic work on correlatives shows that correlative proforms undergo movement to the left periphery of the main clause (esp. Izvorski 1996, also Bhatt 2003, Arsenijević 2009, Lipták 2012). Interestingly, whether this movement occurs overtly or covertly in a given language often patterns with *wh*-movement. For instance, in English, an overt *wh*-movement language, 'then' also raises overtly, as in (140).

(140) a. If it rains *then* I think that we should stay at home.
b. *If it rains I think that *then* we should stay at home.
(Izvorski 1996: ex. 29)

(141) Who$_i$ did you persuade $t_i$ to come?

With individual proforms, one might say that the movement patterns with *wh* movement given their association with the relative phrases in the correlative clause. One

might wonder what would provide the basis for the movement patterns with a conditional proform like 'then', if the correlative construction simply involves world pronoun anaphoric to a pluralization operator. Even if the proform isn't itself a *wh*-phrase and the raising may be triggered for reasons of topicalization, analyzing (e.g.) 'then' as a simple variable leaves it obscure why the overt/covert status of the movement would correlate with that of *wh*-words.

Second, if 'then' is a simple world pronoun, one might wonder why the pronoun would in many cases be lexicalized by an expression specified as being anaphoric to an 'if'-clause. For instance, although English has various proforms which can serve as propositional anaphors, such as 'that' and 'it', only 'then' can be anaphoric to an 'if'-clause (or other supposition). Likewise, in German, although proforms such as *es* can be anaphoric to a proposition, only *dann* 'then' can correlate with a conditional *wenn* 'if' clause:

(142) Q: Unter welcher Bedingung bedauert Max, [dass Lea singt]$_i$?
under which condition regrets Max, that Lea sings
'Under which condition does Max regret that Lea sings?'
A: Max bedauert es$_i$ DANN$_k$, [wenn Lea nicht geÜBT hat]$_k$.
Max regrets it then if Lea not practiced has
'Max regrets it then if Lea has not practiced.'
(Schwabe 2016: ex. 42; German)

It isn't the case that correlative proforms in general lexically specify a particular type of antecedent. Cross-linguistically, the proform is typically a demonstrative.

Third, in individual correlatives the correlate may consist of a bare demonstrative, as in (143a), or a demonstrative with an explicit nominal, as in (143b).

(143) a. jo laRkii khaRii hai vo lambii hai
REL girl standing is DEM tall is
lit. Which girl is standing, that is tall
b. [jo khaRii hai] vo laRkii lambii hai
REL standing is DEM girl tall is
lit. Who is standing, that girl is tall
'The girl who is standing is tall.' (from Srivastav 1991: ex. 13a; Hindi)

One might wonder whether additional structure is similarly involved in conditional proforms, especially given the point, noted above, that many languages use the same type of marker for the proforms in conditionals and individual correlatives.

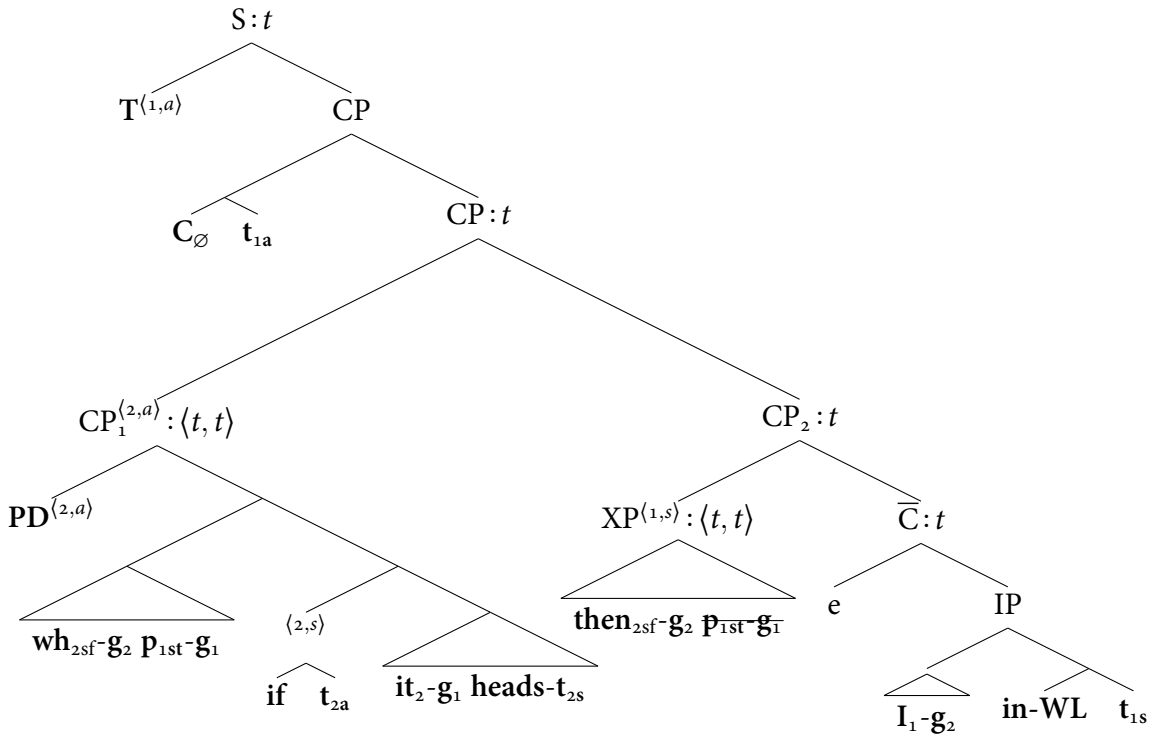
Our revised syntax/semantics for 'if'-clauses in §7.2 affords a straightforward

way of capturing the above data and of unifying our analyses of correlative proforms: Proforms are *topicalized copies* of their antecedent relative/*wh* word, bound by the correlative clause. The proform in an individual correlative is a copy of the choice-function pronoun of individuals and (elided) NP ((137); n. 41). In conditional correlatives the antecedent is the (possibly implicit) 'whether'-like element in the specifier argument of 'if'. 'Then' is a copy of the choice-function pronoun of worlds $[\mathbf{wh}_{sf}\ \mathbf{g}]$ and (elided) proposition-type argument.

'Then' may still be analyzed as a topicalization of the main predicate's world argument. However, it is represented as anaphoric to the implicit 'whether'-like element in SpecCP of the correlative conditional clause, as reflected in (144).[42]

[42]I leave 'then' in its fronted position, though I leave open whether it might instead be interpreted in its trace position at LF (cf. Bhatt 2003, Sportiche 2006). The LF in (123) leaves the main clause complementizer position empty. This choice of representation isn't forced on us. For instance, one could represent the structure of the 'if…then' conditional as in (116) — including the unpronounced declarative complementizer — and analyze 'then' as topicalizing the complementizer's assignment-variable; the derived semantic value would be equivalent. Yet one motivation for the approach in (123) may come from comparisons with V2 (verb-second) languages such as German, where 'then' (e.g. *dann*) is followed directly by the verb in the complementizer position (see Iatridou 1991, Iatridou & Kroch 1993 for discussion in the context of CP-recursion). 'Then' could still be analyzed as in (123), though with the verb in C. I return to these issues in §8.5 when considering conditional questions.

(144) *'If…then'*
'If it landed heads, then I am in Widmore Library'




$[\![\mathrm{XP}^{\langle i,s\rangle}]\!] = \lambda T_t\,.\,[\lambda p_{st}.[\lambda g_g.p(\lambda g_g.g(2a)(2\mathrm{sf})(g(1a)(1st)))]](\lambda w_s.\lambda g_g.T(g[w(g)/is]))$
$= \lambda T_t.\lambda g_g\,.\,T(g[g(2a)(2\mathrm{sf})(g(1a)(1st))])/is])$
$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,[\iota a(g)^*\colon \underline{@(a(g)) = a(g)(2\mathrm{sf})(g^{-}(1st))} \wedge \ldots]$
$a(g)(1e)$ is in WL in $\underline{a(g)(2\mathrm{sf})(g^{-}(1st))}$

The type $s$ world argument is lifted to type $\langle st, t\rangle$ in the usual way, and after attachment of the binder-index becomes type $\langle t, t\rangle$. The 'then'-phrase combines via function application with the consequent, shifting the relevant modal domain to that determined by the 'if'-clause. Parallel to the individual correlative in (136), the correlative binding requirement is captured by (i) the representation of the proform as a copy of the implicit 'whether'-element in the correlative clause, here $[\mathbf{wh}_{2\mathrm{sf}}\text{-}\mathbf{g}_2\ \mathbf{p}_{1\mathrm{st}}\text{-}\mathbf{g}_1]$, and (ii) the assignment-quantification introduced by the operator **PD**. Roughly put: 'then' is to 'whether' ((144)) as DEM/'that' is to REL/'which' ((137)/(143)).

To recap: The accounts of relative clauses and conditionals in §§6–7 have developed a unified assignment-variable-based syntax/semantics for relativization. This

subsection suggested one way of extending the comparisons to correlative clauses and proforms in individual and conditional correlatives. Alternative interpretations are derived from differences in the (individual, modal) relative phrases in the correlative clause and their relation to corresponding (individual, modal) elements in the main clause. For instance, individual correlative interpretations arise when (among other things) the correlative clause is such that the external argument for the complementizer is identified with the actual world, the relative (individual) choice-function pronoun $[\mathbf{wh}_{\mathrm{cf}}\ \mathbf{g_i}]$ is bound by $\mathbf{PD}^{\langle i,a\rangle}$, and the world pronoun in the relative-phrase NP $[\mathbf{P\ w} - \mathbf{g_j}]$ is bound long-distance and anchored to the world of the discourse. Correlative proforms are analyzed uniformly as **topicalized copies of their relative/*wh* antecedent**. I am not aware of other analyses of 'then' that capture the syntactic/semantic connection between conditional proforms and proforms in individual correlatives.

Our discussion has been speculative. It is worth examining more thoroughly how the accounts of relativization and conditionality in these sections might help capture other similarities/differences among free relatives, correlatives, conditionals, and interrogatives — e.g., regarding the connections between exhaustivity/uniqueness interpretations and topicalization/*wh*-movement. §8 examines how the assignment-variable-based treatments of conditionals and correlatives can be extended to interrogatives.

## 8 Interrogatives

This section begins investigating how the assignment-variable framework may be applied to non-declarative sentences, focusing on interrogatives. Key features of the proposed account are as follows:

- it affords a unified syntax/semantics of **interrogative, conditional, and correlative clauses** (§8.2)
- it unifies the treatment of *wh*-words with the §6-treatments of relative pronouns and (certain) indefinites as **choice-function pronouns** (§8.3)
- it provides a precise diagnosis of **"interrogative flip"** in terms of local readings under the question operator (§8.4)
- it integrates with the §7-accounts of 'if'-clauses and correlatives, providing compositional derivations for various types of **conditional questions** (§8.5

The resulting assignment-variable account affords a unified approach to conditionality, relativization, and questions.

### 8.1 Local and global readings in questions

A principal aim of the assignment-variable framework has been to capture various types of local/global readings of variables and context-sensitive expressions. Consider (145)–(149) with interrogatives. (Following common practice I typically use 'interrogative' for the clause/sentence and 'question' for the semantic object.)

(145) Did you$_i$ feed it$_j$? (*global reading*)

a. ≈ Given that $g_c(i) = o_1$ and $g_c(j) = o_2$, did $o_1$ feed $o_2$?

(146) Is it raining$_i$? (*local reading*)

a. ≈ Is there a relevant raining event in the actual world, whatever it is?

(147) [Context: *S* isn't sure who the killer is, and wants to see if *A* has a better idea:]
Might$_i$ the gardener have done it? (*local reading*)

a. ≈ What is the relevant evidence like (=value for $g(i)$)? Is our information, whatever it is, compatible with the gardener's being the killer?

(148) [Context: We all accept classical utilitarianism. *S* isn't sure about Charity X's reliability in getting aid to the people who need it most:]
Should$_i$ we give to Charity X? (*global reading*)

a. ≈ Does our giving to Charity X follow from what our norms $g_c(i)$ enjoin? Would our giving to Charity X maximize overall happiness?

(149) Is Rita rich$_i$?

a. [Context: *S* knows approximately how much money Rita earns (say, $X/yr), and *S* thinks that *A* does too. Hoping to ascertain *A*'s views on whether such a salary counts as rich, *S* utters (149).]
≈ What is the standard for richness like (=value for the degree standard $g(i)$)? Is it, whatever it is, greater than around $X/yr? (*local reading*)

b. [Context: We're millionaires and we agree that one must be a millionaire to count as rich. Hoping to ascertain Rita's income, *S* utters (149).]
≈ Is Rita's income enough to make her a millionaire? (*global reading*)

Informally put, an expression receiving a "local reading" in an interrogative sentence is one whose value or interpretation is being questioned. *S*'s question in (149a) targets the relevant standard associated with 'rich' — how rich one must be to count as rich. If *A* gives a *yes*-answer *S* can infer that *A* assumes that the standard for richness $g(i)$ is no greater than $X/yr. *S*'s question in (148), by contrast, isn't asking *A* what substantive normative view to accept; it's presupposed that classical utili-

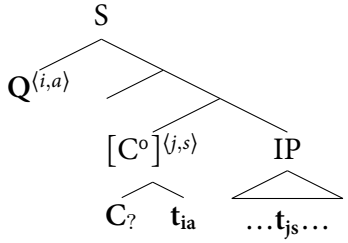
tarianism is correct. *S* is inquiring about the implications of these norms given the empirical facts. Likewise, whereas the individual-pronouns in (145) receive their interpretation from the discourse context, the value for the world-variable in (146) is targeted by the question. Possible answers to (146) aren't propositions (roughly) like $\{w : \text{it is/isn't raining in } u\}$ which take as given a particular world, say $g(i) = u$.

Data such as (145)–(149) will constrain how we formalize interrogative elements' lexical entries and implement world- and assignment-binding in the syntax/semantics. (i) Like with declarative sentences, the interpretation of certain variables in an interrogative must be provided by the discourse assignment, to capture global readings of expressions whose values aren't being questioned. Yet (ii) the question operator should allow certain variables to be targeted by the question, so that the values for expressions receiving local readings vary across possible answers. In particular, (iii) unlike with the declarative complementizer and **T**, the world argument of the main predicate shouldn't be linked to the discourse but should receive a local reading.

### 8.2 Syntax, semantics, metasemantics

It is standard to distinguish at least two elements in the interpretation of interrogative sentences: (i) an interrogative complementizer (call it $\mathbf{C}_?$), which may e.g. trigger interrogative movement in languages such as English, and (ii) a question operator (call it **Q**), which provides the source of the question semantics (e.g. Dayal 1996, Cable 2010, Kotek 2014). Heim 2012 suggests a syntax in which the question operator is base-generated as an argument of the interrogative complementizer and raises as a quantifier over propositions. Heim's account provides precisely the sort of precedent for an interrogative analogue to our §3-treatment of declaratives. Our syntax/semantics for declaratives treated assignment-quantifiers as raising for type reasons from an internal assignment argument position of the declarative complementizer (e.g. 'that'). Drawing on Heim's suggestion, we can try treating **Q** as raising for type reasons from an assignment argument position of $\mathbf{C}_?$. Whereas Heim includes an independent node for the binder-index to trigger a non-compositional Predicate Abstraction rule, we can treat **Q** as combining via function application with the generalized binder-index, as reflected in (150).

(150)



The semantic interactions among the question nucleus, interrogative complementizer, and question operator are fully compositional.

In §7 we noted systematic cross-linguistic links among conditional, correlative, and interrogative clauses. §§7.5, 7.7 applied an analysis of 'if'-clauses as free relatives of assignments (possibilities) to correlative 'if…(then)' conditionals; §7.7 considered how the syntax/semantics might be extended to correlative clauses generally. In light of the cross-linguistic data an attractive idea is that (at some relevant level of analysis) interrogative clauses share a common linguistic representation with conditional/correlative clauses. So, let's suppose as a working hypothesis that $\mathbf{C}_?$ has a roughly parallel argument structure and semantics as 'if'/$\mathbf{C}_{\mathbf{if}}$.

I offer (151)–(152) as lexical entries for the interrogative complementizer $\mathbf{C}_?$ and question operator $\mathbf{Q}$ — where '$g \approx g'$' says, intuitively, that $g$ and $g'$ are equivalent in the values assigned across indices, yet potentially different in what world constitutes the world of the possibility represented by the assignment.

(151) $[\![\mathbf{C}_?]\!] = \lambda a_a.\lambda p_{st}.\lambda w_s.\lambda g_g : @(a(g)) = w(g)\,.\,\forall w' \text{ s.t. } w'(g) = @(a(g)), p(w')(g)$

(152) $[\![\mathbf{Q}]\!] = \lambda A_{at}.\lambda T_t.\lambda g_g\,.\,\text{for } a_a = \lambda g_g.g^{-}, \exists g''_g : T = [\lambda g' : g' \approx g''\,.\,A(a)(g') = A(a)(g'')]$

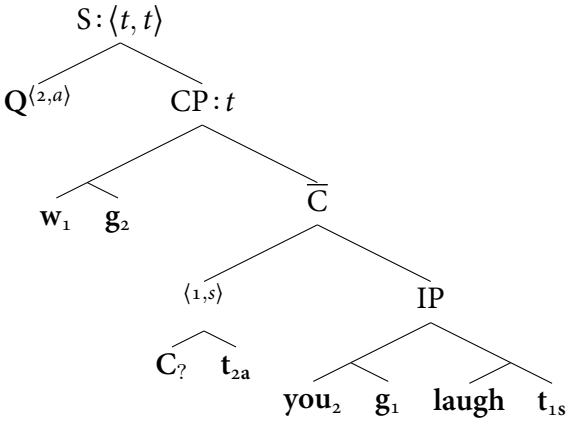
a. $g \approx g' := \forall i\tau\left[\neg\left(\tau = s \wedge g(i\tau) = g'(i\tau) = @(g) = @(g')\right) \rightarrow g(i\tau) = g'(i\tau)\right]$

(153) $[\![\mathbf{Q}^{\langle j,a\rangle}]\!] = [\![\mathbf{Q}]\!]([\![^{\langle j,a\rangle}]\!]) = \lambda T'_t.\lambda T_t.\lambda g_g\,.\,\text{for } a_a = \lambda g_g.g^{-}, \exists g''_g:$
$T = [\lambda g' \approx g''\,.\,T'(g'[a(g')/ja]) = T'(g''[a(g'')/ja])]$

To fix ideas I assume an approach to interrogatives which treats question meanings as a set of possible answers (Hamblin 1973, Karttunen 1977, Heim 1994). The interrogative complementizer $\mathbf{C}_?$ in effect forms an equivalence class with respect to the embedded proposition (cf. Groenendijk & Stockhof 1984). $\mathbf{Q}$ constructs a set of possible answers, where answers are represented by sets of assignments; the semantic value of an interrogative sentence is type $\langle t, t\rangle$. Following our generalized theoretical interpretation of assignments as representing possibilities (§2), the possibilities constituting a question's answers may fix facts including facts determining values for context-sensitive expressions. Local readings are captured by shifting assignment-variables coindexed with $\mathbf{Q}^{\langle j,a\rangle}$ to the assignment in the given answer. The values for items targeted by the question may vary across the possible answers; yet the constraint $g' \approx g''$ requires the assignments in each answer to agree on the particular value assigned.

To clarify, let's start with a simple *yes*/*no* question:[43]

(154) *Simple yes/no question*
'Did you laugh?'




$[\![\text{CP}]\!] \approx \lambda g_g : @(g(2a)) = g(2a)(1s)\,.\,g(1a)(2e)$ laughed in $@(g(2a))$
$\quad \approx \lambda g_g\,.\,g(1a)(2e)$ laughed in $@(g(2a))$

$[\![\text{S}]\!] \approx \lambda T_t.\lambda g_g\,.\,\exists g'' : T = \big[\lambda g' \approx g''\,.\,g'(1a)(2e)$ laughed in $@(g'^{-}) = g'^{-}(1s)$
$\quad$ iff $g''(1a)(2e)$ laughed in $@(g''^{-}) = g''^{-}(1s)\big]$

This treats the semantic value of the interrogative sentence in (154) as a set of propositions $T$, where each such proposition is a set of assignments $g'$ that return the same truth value for the proposition that a certain individual — the individual assigned to $2e$ by the assignment $g'$ happens to assign to $1a$ — laughed.

First, note the world pronoun $[\mathbf{w}_1\ \mathbf{g}_2]$ supplying the external argument of the complementizer. With complementizers such as $\mathbf{C_{rel}}$ and 'if'/$\mathbf{C_{if}}$ in subordinating clauses there was a natural story about what would supply the external (individual, world) argument: In restrictive relatives the quantifier's restrictor argument targets a specified subset of individuals supplied by the relative phrase. In individual correlatives the correlative clause targets topical individuals in the (actual) world. In conditionals the 'if'-clause targets a topical subdomain of the background modal possibility relevant for the supposition supplied by the 'whether'-like element. For interrogatives a natural thought is that the argument determines the possibility targeted by the question. In simple unembedded questions such as (154) the external

[43] Officially, as with **T**, I leave open whether **Q** raises to SpecCP or heads its own projection (e.g. ForceP) (n. 10). In the general definition of the binder-index (§3.5): with $\mathbf{C}_?$, $\tau = s$, $\sigma = \langle s, t\rangle$; with **Q**, $\tau = a$; $\sigma = \langle t, t\rangle$.

argument of $\mathbf{C}_?$ supplies a world argument bound by **Q**;[44] the question is about what is the case in the actual world. In (154) the argument is semantically trivial, given our general metasemantic assumption that, for any $h \in G$, $h(1s)$ represents the world of $h$ (§§2,6.1). We will see more substantive roles for the argument in more complex examples.

The semantic value in (154) captures the local reading of the main predicate's world argument: the question nucleus places a constraint on the worlds of the assignments $g'$ in each possible answer $T$. Which world represents the world of the assignments may vary. The assignments in each answer are otherwise equivalent in what values are assigned across indices, via the constraint $g' \approx g''$; this constraint will help capture local readings of context-sensitive expressions (below).

The derived semantic value in (154) obviously fails to represent the intended global reading of 'you'. The semantic value represents the question as targeting what assignment to associate with the index $1a$, rather than as targeting a property of the particular individual $g_c(2e) \in E$ determined by the discourse assignment $g_c$. The assignments in each $T$ may not even agree on the identity of the individual $o \in E$ that did/did not do the laughing.

One response would be to capture global readings by complicating the semantics of **Q**. An alternative is to maintain the simpler lexical entry and semantic value for interrogative clauses, and capture global readings in the **metasemantics** of answers. Our metasemantics for declaratives from §2 treated a declarative sentence $S$ as true in a context $c$ iff the derived semantic value $[\![S]\!]$ was true with respect to the assignment $g_c$ representing the context. Correspondingly, I treat a proposition $T \in [\![S?]\!]$ in the semantic value of an interrogative sentence $S?$ as an **answer** to $S?$ in $c$ iff every assignment $g' \in T$ assigns $g_c^-$ to all assignment-indices.

(155) **Metasemantics**

a. A declarative sentence $S$ is **true** in $c$ iff $[\![S]\!](g_c) = 1$

b. $T_t$ is an **answer** to an interrogative sentence $S?$ in $c$ iff (i) $T \in [\![S?]\!]$, and (ii) for all $g' \in T$ and assignment-indices $ia$, $g'(ia) = g_c^-$.

Applied to our example (154) above, for any $T \in [\![\mathrm{S}]\!]$, $T$ is an answer to S in $c$ iff $\forall ia, g' \in T\colon g'(ia) = g_c^-$. Since $g'(1a) = g_c^-$, answers will be sets of assignments $g'$ s.t. $g_c^-(2e)$ (=$g'(1a)(2e)$) did/did not laugh in $@(g'^-)$. The assignments in each answer

[44] Parallel to the case of correlative clauses discussed in §7.7, the world argument might instead be represented with a complex $[\mathbf{wh}_{\mathbf{sf}}\ \mathbf{g}_2\ \mathbf{p}_{\mathbf{st}}\text{-}\mathbf{g}]$, where the semantic value for $[\mathbf{p}\ \mathbf{g}]$ is ultimately identified with (e.g.) $\{g(2a)(1s)\} = \{g'^-(1s)\}$. However, to clarify the intended interpretation I represent the world argument with a simple world-pronoun.

constitute an equivalence class with respect to the possible-worlds proposition that $g_c^-(2e)$ individual laughed, as desired. (Hereafter I continue often to omit the superscripts in expressions such as '$g'^-$', '$g_c^-$', though they should be understood when relevant.)

In effect, what **T** does in the semantics of declarative sentences, (155b) does in the metasemantics of interrogative sentences. Yet we shouldn't overstate the contrast: In both cases a bridge principle is required to link a sentence's compositional semantic value to an interpretation and function in discourse.[45] The semantics of **T** links a certain assignment-index, say $1a$, to the assignments $g$ in the sentence's semantic value $[\![S]\!]$; and the metasemantics of declaratives treats the sentence as true in $c$ iff the assignment representing the context, $g_c$, is in that set of assignments $[\![S]\!]$. Analogously, the metasemantics of interrogatives treats a set of assignments $T$ as constituting an answer in $c$ only if every assignment in $T$ assigns the assignment representing the context, $g_c$, to that same index — the index that would be targeted by **T** in a use of a declarative. In this sense, for declarative sentences and interrogative sentences alike, global readings are ultimately captured in the metasemantics.

Capturing global readings in interrogative sentences in the metasemantics has the advantage of maintaining a uniform theoretical interpretation of assignment-variables/quantification. If a concrete discourse determines that the assignment index $1a$ represents the context, it does so regardless of whether a sentence being used is declarative or interrogative. Just as assignment-variables coindexed with 'wonder' in (157) represent readings of expressions whose values are objects of Alice's wondering, assignment-variables coindexed with **Q** in (156) represent readings whose values are being questioned.

(156) a. Is Rita rich$_i$?
b. ≈ Q$^{\langle i,a\rangle}$… Rita rich-g$_i$

(157) a. Alice wondered whether Rita is rich.
b. ≈ …Alice wondered$^{\langle i,a\rangle}$… Rita rich-g$_i$

Coindexing between assignment variables and assignment binders represents readings of expressions whose interpretation is targeted by the assignment quantifier.

### 8.3 *wh* questions

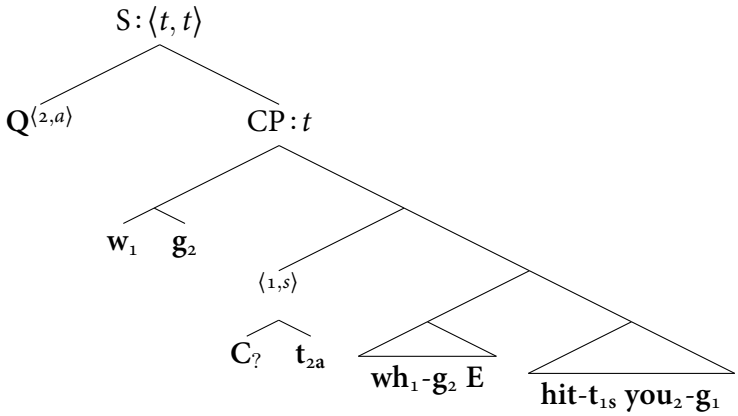
There is a divide in approaches to interrogative *wh*-words about whether they are related to relative pronouns, typically construed as $\lambda$-binders (Groenendijk & Stock-

[45] Cf. e.g. Stalnaker 1978, 2014, Lewis 1980, Dummett 1973, Stanley 1997, MacFarlane 2014, Yalcin 2014.

HOF 1982), or related to indefinites such as 'a' (KARTTUNEN 1977). §§6, 7.2, 7.7 developed analyses of relative pronouns and certain indefinites as choice-function pronouns. Interestingly, in some languages the relative clauses in correlative constructions are introduced with interrogative *wh*-words (e.g. Polish). A natural move is to extend the account of relative pronouns to interrogative *wh*-words, and treat *wh*-words similarly as **choice-function pronouns**. Just as relative choice-function pronouns are targeted by a determiner quantifier so that the domain is determined from the set of NP-individuals, interrogative *wh* choice-function pronouns are targeted by the question operator so that the values for *wh*-phrases vary across possible answers.

An example with a simple *wh* question is in (158). (For purposes of illustration I show how the variation in values for the *wh*-phrase can be derived while keeping the *wh*-word in situ below C; more on this below. As previously ignore any contextual restriction associated with 'what', and assume **E** represents the domain of individuals. Hereafter when describing the answers to a question I often omit the presuppositional constraint when trivial.)

(158) *wh question*
'What hit you?'




$[\![\mathbf{wh}_1\ \mathbf{g}_2]\!] = \lambda P_{et}.\lambda g_g\,.\,g(2a)(1\mathrm{cf})((^{\downarrow}P)(g))$

$[\![\mathrm{CP}]\!] \approx \lambda g_g : @(g(2a)) = g(2a)(1s)\,.\,g(2a)(1\mathrm{cf})(E)$ hit $g(1a)(2e)$ in $@(g(2a))$

A proposition $T_t \in [\![\mathrm{S}]\!]$ is an *answer* to S in *c* iff

$\exists g'_g : T = \big[\lambda g'_g \approx g''\,.\,\underline{g'^{-}(1\mathrm{cf})(E)}$ hit $\underline{g_c^{-}(2e)}$ in $@(g'^{-})$
iff $g''^{-}(1\mathrm{cf})(E)$ hit $g_c^{-}(2e)$ in $@(g''^{-})\big]$

The possible answers to the *wh* question are propositions *T*, where each such propo-

sition is a set of assignments $g'$ that return the same truth value for the proposition that a selected individual $g'(1\text{cf})(E) \in E$ hit $g_c(2e)$.

First, as in (154), the global reading of 'you' is captured via the metasemantic condition on answerhood: A set of assignments $T$ in the sentence's semantic value constitutes an answer only if $g'(1a) = g_c$. Given the constraint that $g' \approx g''$, the assignments in each answer constitute an equivalence class with respect to a proposition about the contextually relevant individual $g'(1a)(2e) = g''(1a)(2e) = g_c(2e) \in E$.

Second, the "shifting" of *wh*-words in the interpretation of interrogatives is assimilated to the general phenomenon of local readings of context-sensitive expressions. The local reading of 'what' is captured in the coindexing between the question operator and the choice-function pronoun $[\mathbf{wh}_1\ \mathbf{g}_2]$ representing the *wh*-phrase. Just as with relative pronouns and the relative complementizer, I assume that *wh*-words, having the feature [WH], must have the same assignment-variable as the interrogative complementizer, e.g. due to agreement. Relative and *wh* words thus receive obligatory local readings under the local assignment-binder — e.g., a matrix determiner in a restrictive relative (§6), **PD** in a conditional or individual correlative (§7), or the question operator in an interrogative. Given the constraint that $g' \approx g''$, the assignments $g'$ in each answer $T$ assign the same value to the choice-function index and hence select the same individual. Yet the particular value assigned and individual selected may vary across answers: If $E = \{o_1, o_2\}$, the possible answers are the propositions that $o_1$ hit $g_c(2e)$, and that $o_2$ hit $g_c(2e)$. The *wh*-phrase is targeted by the question, and the possible answers are about different individuals.

Third, although the assignments $g'$ in each answer assign the same choice function to the index 1cf and agree about whether the selected individual hit $g_c(2e)$, they may differ regarding other worldly facts. The possible answers $T$ aren't singleton sets.

Questions with multiple *wh*-phrases raise notorious syntactic/semantic challenges — e.g., regarding movement and reconstruction, single-/pair-list readings and answers, and exhaustiveness and uniqueness, such as the apparent implication of (159) that each baby liked a unique toy (e.g. DAYAL 2016a,b and references therein).

(159) Which baby liked which toy?

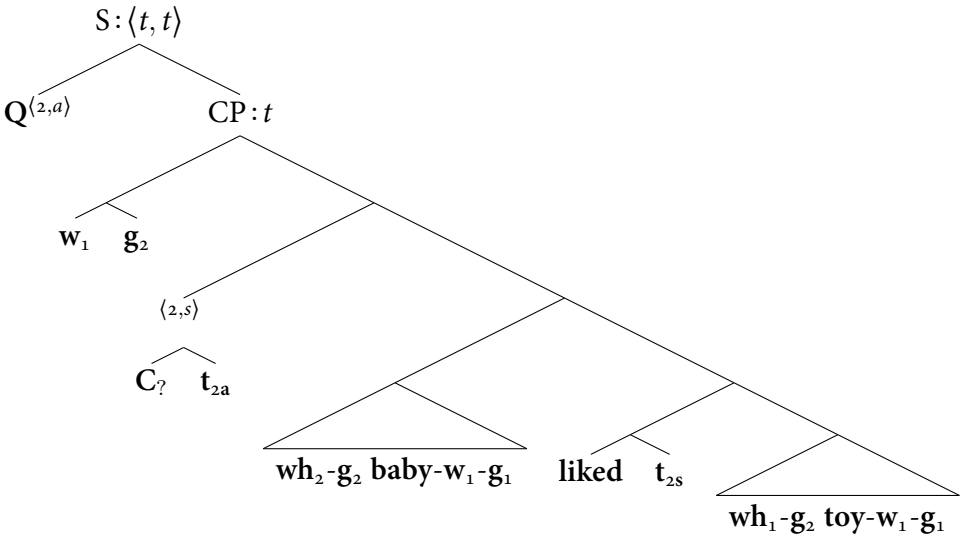
a. ≈ Timmy liked the doll, Clio liked the blocks, …
(baby-toy relation ≠ one-many)

For present purposes I simply note two features of the assignment-variable account in this section: It is common in diverse approaches to the semantics of questions to require all *wh*-phrases to be interpreted in a specifier position of the interrogative complementizer (e.g. KARTTUNEN 1977, PESETSKY 2000, CABLE 2010, GEORGE

2011).[46] A critical issue in such accounts is what in general requires the movement and how the order at LF of *wh*-phrases in multiple *wh*-interrogatives is derived, given the cross-linguistic variation in pronunciation rules for *wh*-words (e.g., requiring all *wh*-words to be fronted (Bulgarian), requiring all *wh*-words to be in situ (Japanese), or allowing variation in movement (English)). By contrast, the account in this section is compatible with alternative approaches to the syntax/phonology of *wh*-movement and reconstruction in different languages. The account captures the local reading of *wh*-words and the contribution of *wh*-words to the semantics of the question without requiring or forbidding *wh*-movement to SpecCP at LF. Further, the semantics extends to multiple *wh* questions without requiring innovations such as (e.g.) a type-flexible question operator or tuple types, which track the number of *wh*-words and their relative positions (as in e.g. Higginbotham & May 1981, Groenendijk & Stockhof 1984, George 2011).

A preliminary derivation for a multiple *wh* question such as (159) is as follows: (I continue to use abbreviations such as '$baby_u$' for the characteristic function of the set of individuals $o \in E$ such that $o$ is a baby in $u$ (§§2, 6.1.2).)

(160) *Multiple wh question*




A proposition $T_t \in [\![\mathrm{S}]\!]$ is an *answer* to S in $c$ iff

$$\exists g''_g : T = \left[\lambda g'_g \approx g'' \,.\, g'^{-}(\mathrm{2cf})\left(baby_{g_c^-(1s)}\right) \text{ liked } g'^{-}(\mathrm{1cf})\left(toy_{g_c^-(1s)}\right) \text{ in } @(g'^{-})\right.$$

[46] Contrast Chomsky 1995, Kratzer & Shimoyama 2002. The movement may be triggered for semantic reasons (Kotek 2014), or syntactic reasons, e.g. that any XP headed by an item with [+wh]-features move to SpecCP.

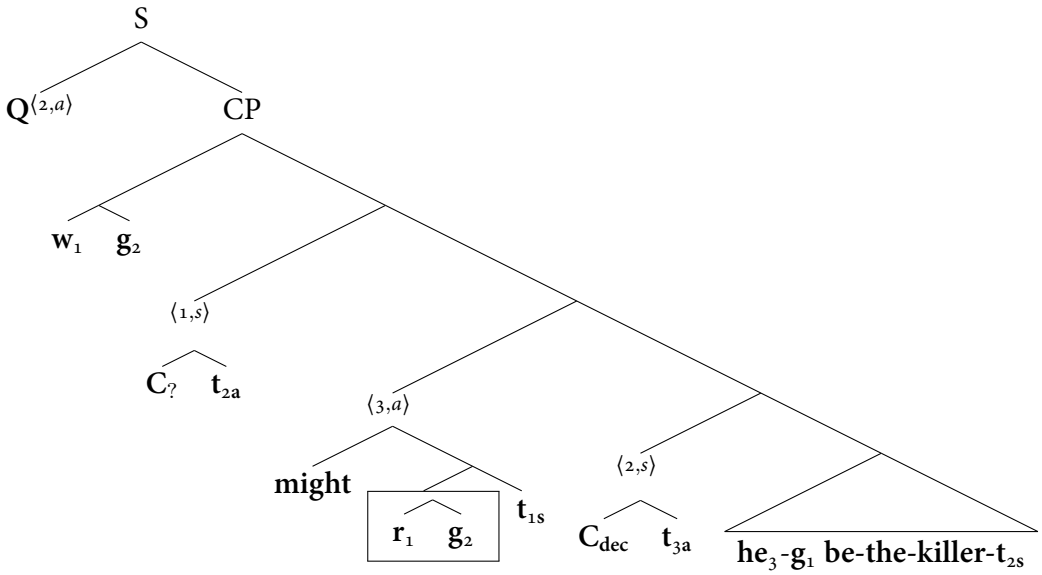
$$\text{iff } g''^{-}(2\text{cf})(baby_{g_c^{-}(1s)}) \text{ liked } g''^{-}(1\text{cf})(toy_{g_c^{-}(1s)}) \text{ in } @(g''^{-})$$

This says, roughly, that given sets of actual babies and toys — say, $b_1, b_2, b_3 \in baby_{g_c(1s)}$ and $t_1, t_2, t_3 \in toy_{g_c(1s)}$ — the set of possible answers is the set of propositions that $b_i$ liked $t_j$. Given the metasemantic condition on answerhood, the world-pronouns in the noun phrases 'baby' and 'toy' receive global readings anchored to $g_c(1s)$, which is taken to represent the world $@(g_c)$ of the discourse (§6.1.2). However, as in (158), the world-argument of the main predicate 'liked' and the *wh*-words receive (obligatory) local readings, targeted by the question. For each possible answer $T$, the set of assignments $g' \in T$ constitute an equivalence class with respect to what actual baby $b_i = g'(2\text{cf})(baby_{g_c(1s)}) \in E$ and what actual toy $t_j = g'(1\text{cf})(toy_{g_c(1s)}) \in E$ are selected, and whether the selected baby $b_i$ liked the selected toy $t_j$ in the world $@(g')$ of the possibility represented by $g'$. The account derives how each answer in the multiple *wh* question is about a particular *pair* of individuals.

## 8.4 "Interrogative flip"

The assignment-variable account in §8.2 affords a precise diagnosis of so-called "interrogative flip" (Speas & Tenny 2003): cases of "interrogative flip" can be assimilated to (possibly conventionalized) local readings (§§3.1, 4.3). Consider (161), on the salient reading which questions the relevant evidence and the doings of the contextually relevant individual. (I bracket any resource domain argument associated with the modal (§7.6), and I treat 'be the killer' as an unanalyzed predicate. As previously I use '$r$' in indices for type $\langle s, at \rangle$.)

(161) Might he be the killer?




$[\![\text{S}]\!] \approx \lambda T_t.\lambda g_g\,.\,\exists g'_g\text{: } T = \big[\lambda g'_g \approx g''\,.\,\exists a_a \text{ s.t. } g'^{-}(1r)(@(g'^{-}))(a(g'))\text{:}$
$g'(1a)(3e)$ is the killer in $@(a(g'))$
iff $\exists a_a$ s.t. $g''^{-}(1r)(@(g''^{-}))(a(g''))\text{: } g''(1a)(3e)$ is the killer in $@(a(g''))\big]$

A proposition $T_t \in [\![\text{S}]\!]$ is an *answer* to S in $c$ iff
$\exists g'_g\text{: } T = \big[\lambda g'_g \approx g''\,.\,\exists a_a \text{ s.t. } \underline{g'^{-}(1r)(@(g'^{-}))}(a(g'))\text{:}\underline{g_c^{-}(3e)}$ is the killer in $@(a(g'))$
iff $\exists a_a$ s.t. $g''^{-}(1r)(@(g''^{-}))(a(g''))\text{: } g_c^{-}(3e)$ is the killer in $@(a(g''))\big]$

Each possible answer $T$ is a set of assignments $g'$ that determine the same modal background $R$ ($=g'(1r)$, via $g' \approx g''$), and return the same truth value for the proposition that the contextually relevant individual $g_c(3e)$ ($=g'(1a)(3e)$) is the killer in the world of some epistemic possibility $R(@(g'))$, as determined by $g'$. Roughly, answers to the epistemic modal question are propositions of the form that there is/is not an epistemic possibility ($=g'(1r)(@(g'))$) where $g_c(3e)$ is the killer.

Local readings under assignment-quantifiers are represented uniformly in terms of coindexing between assignment-variables and binder indices (§8.2). The compositional semantics of the interrogative elements $\mathbf{C}_?$ and **Q** derive the obligatory local reading of the modal's world argument $\mathbf{t}_{1s}$. The question nucleus places a constraint on the worlds of the assignments $g'$ in each possible answer, i.e. that $g_c(3e)$ is the killer in some world accessible from $@(g')$. Likewise the obligatory local reading of the embedded predicate's world argument $\mathbf{t}_{2s}$ is captured via the coindexing between

the embedding (declarative) complementizer and the modal's binder index. The local reading of the epistemic modal is captured by allowing the value for the modal-background pronoun $[\mathbf{r}_1\ \mathbf{g}_2]$ to vary across the propositions comprising the possible answers. The assignments in each answer assign the same value to $1r$; however, the particular epistemic modal background assigned may differ across answers. The relevant evidence is targeted by the question.

In §4.3 we discussed how there may be reasons for positing conventionalized locality/globality principles for certain context-sensitive expressions — e.g., a globality principle for gendered pronouns, or a locality principle for epistemic modals. We noted that a locality principle requiring (e.g.) epistemic modal-background pronouns to be coindexed with the closest c-commanding assignment-binder may help capture the apparently obligatory linking of epistemic modals to the subject in attitude ascriptions. Such a principle would apply to epistemic modals in questions as well: An epistemic modal question such as (161) would typically be interpreted as being about what the evidence is — represented by what value $R \in D_{\langle s,at\rangle}$ to assign to the modal-background index $1r$ — rather than about what the logical implications are of a contextually agreed-upon body of evidence $g_c(1r)$ at the evaluation world (contrast (148)). For present purposes I leave open whether conventionalizing such an interpretation is appropriate in the general case (cf. Silk 2016, 2017).

### 8.5 Conditional questions

Informally, whereas the possible answers in a non-conditional question partition the relevant space of possibilities, the possible answers to a **conditional question** such as (162) partition the subdomain of possibilities that verify the antecedent.

(162) If it snows, will school be canceled?

Capturing this idea has proven a persistent challenge for traditional approaches to questions and quantificational analyses of conditionals (see Isaacs & Rawlins 2008, Groenendijk & Roelofsen 2009, 2010, Starr 2010; cf. Charlow 2010, 2011 on challenges with conditional imperatives). An additional challenge is to capture the various types of local and global readings in both the 'if'-clause and interrogative main clause. Consider the following conditional-question analogues of the shifted-indexical example from Santorio 2012 in §7:

(163) [See (100). After the experiment, one of the amnesiacs wakes up. Feeling fuzzy about the experimental protocol, he asks himself:]
If it landed heads, might I be in Widener?

(164) [The awoken amnesiac also can't remember if funds were going to be left in one of the libraries, or what the standards for richness are wherever he is.]
($Q^k$) [If $it_i$ landed heads]$^j$ am $I_j$ in Widener and $rich_k$? (cf. Santorio 2012)

In (164), for instance, we need to capture (among other things) (i) the global reading of 'it' in the 'if'-clause; (ii) the local reading of 'I' in the consequent, interpreted with respect to the assignment representing the conditional supposition; and (iii) the local reading of the world argument and standard of richness associated with 'rich' in the consequent, targeted by the question operator and varying across possible answers. The conditional question in (164) is in part a question about how rich one must be to count as rich, on the supposition that the coin landed heads.

In light of cross-linguistic links among conditionals, correlatives, and interrogatives, §8.2 suggested as a working hypothesis that we treat the interrogative complementizer $\mathbf{C}_?$ as having an analogous argument structure and semantics as 'if'/$\mathbf{C}_{\mathbf{if}}$. As a way of developing the approach I suggested interpreting the external argument of $\mathbf{C}_?$ as determining a relevant possibility targeted by the question. In unembedded questions the argument has been a world argument coindexed with $\mathbf{Q}$ (n. 44); the questions are about what is the case in the actual world. We will see that this argument, though semantically trivial in the examples thus far, can play a non-trivial role in the interpretation of complex sentences such as conditional questions.

### *8.5.1 Relevance conditional questions*

Before turning to hypothetical conditional questions such as those in (163)–(164), let's start with a "non-shifty" **relevance conditional question** such as (166).

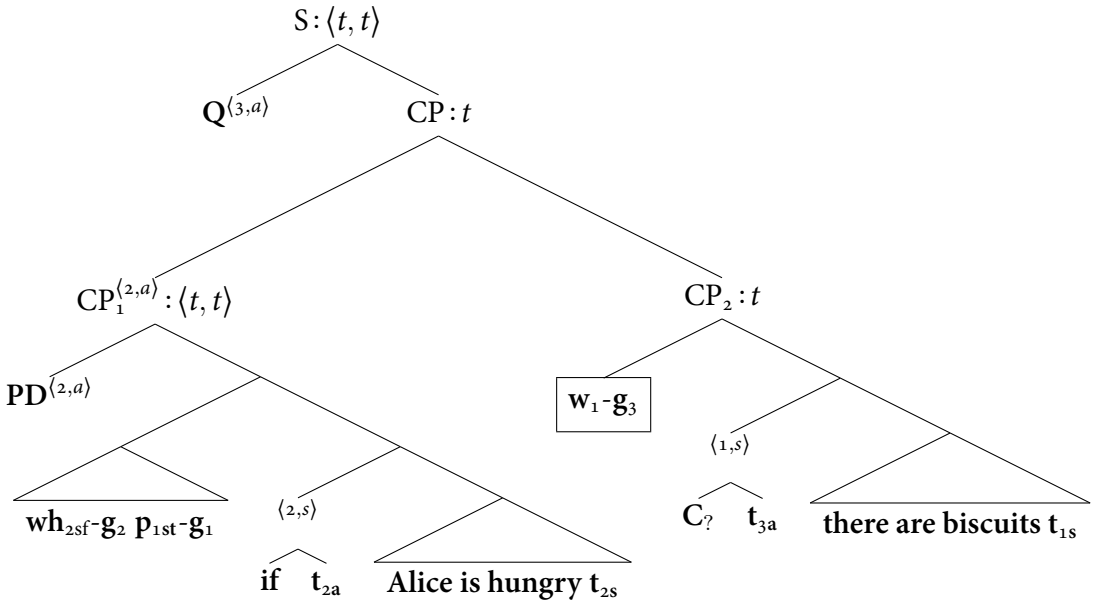
(165) If Alice is hungry, there are biscuits in the kitchen.

(166) If Alice is hungry, are there biscuits in the kitchen?

In an ordinary relevance conditional such as (165), the 'if'-clause introduces a modal topic and the main clause declarative is used to assert something about the actual world: that there are biscuits. Likewise in the relevance conditional question in (166), the 'if'-clause introduces a modal topic and the main clause interrogative is used to question something what is actually the case: whether there are biscuits.

Relevance conditional questions raise no new complications. The sentence-initial 'if'-clause can be analyzed as in §7.5, and the interrogative main clause can be analyzed as in our examples with unembedded interrogatives, as in (167) (cf. n. 35).

(167) *Relevance conditional question*




$[\![\text{CP}]\!] \approx \lambda g_g \,.\, \big[\iota a(g)^*$: Alice is hungry in $@(a(g)) \wedge @(a(g)) = a(g)(2\text{sf})(g(1a)(1st))\big]$
there are biscuits in $@(g(3a)) = g(3a)(1s)$

A proposition $T_t \in [\![\text{S}]\!]$ is an *answer* to S in $c$ iff $\exists g''_g$: $T = \big[\lambda g'_g \approx g'' \,.$
$[\iota a(g')^*$: Alice is hungry in $@(a(g')) \wedge @(a(g')) = a(g')(2\text{sf})(g_c^-(1st))]$
there are biscuits in $\underline{@(g'^-) = g'^-(1s)}$ iff
$[\iota a(g'')^*$: Alice is hungry in $@(a(g'')) \wedge @(a(g'')) = a(g'')(2\text{sf})(g_c^-(1st))]$
there are biscuits in $@(g''^-) = g''^-(1s)\big]$

Roughly put, each possible answer $T$ is a set of assignments $g'$ that return the same truth value for the proposition that the contextually relevant possibility where Alice is hungry is such that there are biscuits in $@(g')$.

First, the 'if'-clause introduces the maximal relevant possibility $h^*$ where Alice is hungry. The global reading of the pronoun $[\mathbf{p}_{1\text{st}}\ \mathbf{g}_1]$ which supplies the contextually relevant background domain is captured in the metasemantic answerhood condition: for each answer $T$, every $g' \in T$ is s.t. $g'(1a)(1st) = g_c(1st)$.

Second, just as external argument of 'if' determines the possibility to be targeted by the supposition, the external argument of $\mathbf{C}_?$ determines the possibility to be targeted by the question. In relevance conditional questions this possibility is the actual world: Intuitively, (166) isn't about whether there are biscuits in some subdomain of

possibilities where Alice is hungry; it's about whether there are actually any biscuits. So, the external argument of $\mathbf{C}_?$ is again supplied by a world-pronoun coindexed with the question operator. The assignments $g'$ in each possible answer $T$ constitute an equivalence class with respect to whether there are biscuits in the world $@(g')$ of the possibility represented by $g'$.

A remark on interpreting the metalanguage quantification over assignments is in order. The argument of $a$ in the denotation of the 'if'-clause varies across the assignments $g', g''$ in the set of possible answers; however, as discussed in §§2.2, 7.2, the items in terms of which the uniqueness condition is stated are images of the assignments under $a$, i.e. items $h \in G$ in the model. The metalanguage expression "$\iota a(g)^*$: . . . " abbreviates the quantificational condition that for some function $a \in D_a$, its value constitutes *the unique maximal plurality* $h^* \in G$ such that… (§7.2). Varying the argument of $a$ has no effect on which $h^* \in G$ constitutes the unique such maximal plurality in the model.

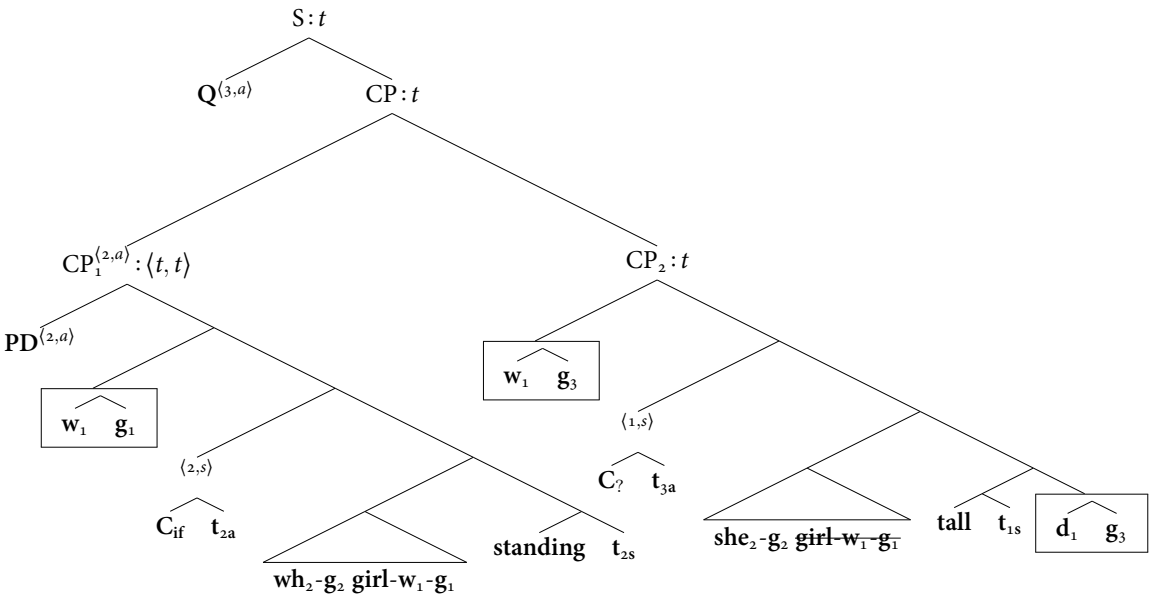
### *8.5.2 Correlative questions*

Correlatives with main clause interrogatives are rarely if ever considered in semantics for interrogatives or correlatives. It is instructive to compare the treatment of relevance conditional questions in (167) with the predicted analysis of an **individual correlative question** such as (168). (Assume a local reading targeted by the question for 'tall', and assume a toy context-sensitive semantics for positive form relative gradable adjectives, where **d** is a variable for degrees $d \in D_d$ and 'o is $s$-tall' abbreviates that o's height is at least as great as the degree-standard $s$ for counting as tall. As in §7.7, to highlight the intended reading I represent the external arguments of the complementizers with a simple world-pronoun.)

(168) *Individual correlative question*

| | | | | | |
|---|---|---|---|---|---|
| jo | laRkii | khaRii | hai | vo | lambii hai? |
| REL | girl | standing | is | DEM | tall is |

'Which girl is standing, is she tall?' (cf. Srivastav 1991: ex. 3a)




$[\![\textbf{tall}]\!] = \lambda w_s.\lambda d_d.\lambda x_e.\lambda g_g\,.\, x(g)$ is $d(g)$-tall in $w(g)$

$[\![\mathrm{CP}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*\colon a(g)(2\mathrm{cf})(girl_{g(1a)(1s)})$ is standing in $@(a(g))$
$\wedge\, @(a(g)) = g(1a)(1s)\big]$
$a(g)(2\mathrm{cf})(girl_{g(1a)(1s)})$ is $g(3a)(1d)$-tall in $@(g(3a)) = g(3a)(1s)$

A proposition $T_t \in [\![\mathrm{S}]\!]$ is an *answer* to S in $c$ iff $\exists g''_g\colon T = \big[\lambda g'_g \approx g''\,.$
$\big[\iota a(g')^*\colon a(g')(2\mathrm{cf})(girl_{g_c^-(1s)})$ is standing in $\underline{@(a(g')) = g_c^-(1s)}\big]$
$a(g')(2\mathrm{cf})(girl_{g_c^-(1s)})$ is $\underline{g'^-(1d)\text{-tall}}$ in $\underline{@(g'^-) = g'^-(1s)}$ iff
$\big[\iota a(g'')^*\colon a(g'')(2\mathrm{cf})(girl_{g_c^-(1s)})$ is standing in $@(a(g'')) = g_c^-(1s)\big]$
$a(g'')(2\mathrm{cf})(girl_{g_c^-(1s)})$ is $g''^-(1d)$-tall in $@(g''^-) = g''^-(1s)\big]$

Like with the relative conditional question in (167), the modal domain for the main clause interrogative is targeted directly by the question operator. But whereas the 'if'-clause in (167) introduces a topical modal possibility, the correlative clause introduces an actual possibility about a topical individual. As in (136), the world of the possibility introduced in the correlative clause is identified with the world of the discourse, $g_c(1s)$. Though the correlative clause in (168) doesn't shift a modal domain, it shifts the interpretation of the correlative proform. The correlative clause introduces a topical girl (=$a(g)(2\mathrm{cf})(girl_{g_c(1s)})$) who is actually standing, and the interrogative main clause comments on that same girl, asking whether she is tall.

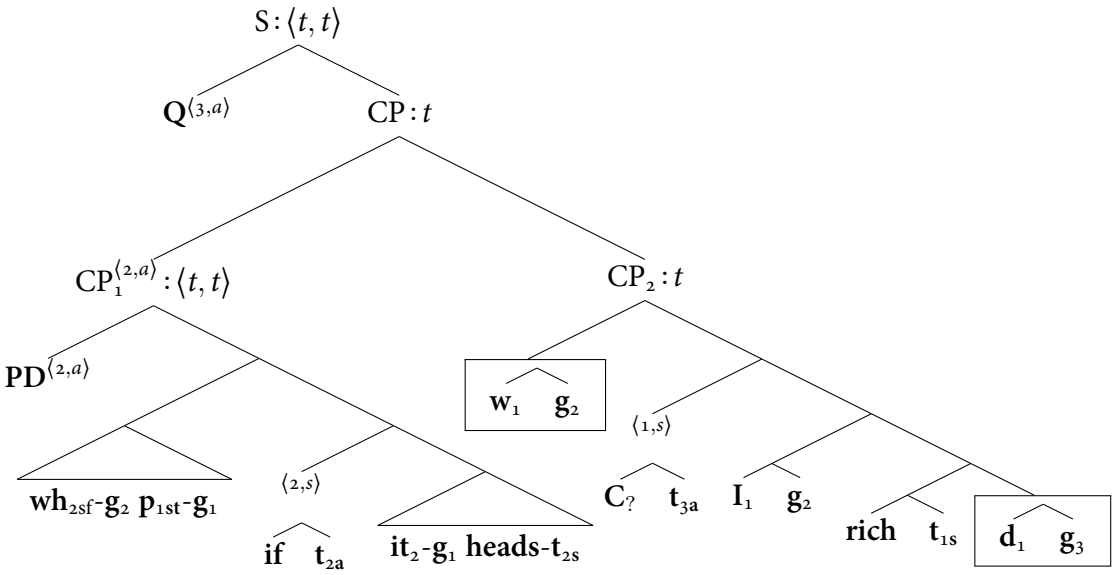
Each possible answer $T$ is, roughly, a set of assignments $g'$ which determine the same standard $s$ for counting as tall ($=g'(1d)$), and return the same truth value for the proposition that the selected girl ($=a(g)(2\text{cf})(girl_{g_c(1s)})$) who is standing in the actual world $@(g_c)$ is $s$-tall in $@(g')$.

So, our analyses of correlatives, proforms, and interrogatives compositionally derive the relevant inventory of readings: (i) the **global reading of 'girl'** in the correlative clause, (ii) the **local reading of the proform** in the main clause bound by the correlative clause, and (iii) the **local reading of 'tall'** in the main clause, targeted by the question. The global reading of 'girl' and correlative clause domain is captured via the metasemantic condition on answerwood. The local reading of the correlate follows from the representation of the proform as a copy of its antecedent relative expression, here $[\mathbf{she}_2\text{-}\mathbf{g}_2\ \sout{\mathbf{girl}\text{-}\mathbf{w}_1\ \mathbf{g}_1}]$, and the correlative clause assignment-binder from $\mathbf{PD}^{\langle 2,a\rangle}$. The proform in the interrogative clause correctly receives a local reading under the correlative clause without being targeted by the question. On the flip side, the world-argument and standard-pronoun $[\mathbf{d}_1\ \mathbf{g}_3]$ associated with 'tall' receive local readings under the question operator without being shifted by the correlative clause. (168) is in part a question about how tall one must be to count as tall. The assignments $g'$ in each answer determine the same standard of tallness $g'(1d)$ (via $g' \approx g''$), though which standard is determined varies across possible answers. So, the correlative interrogative is correctly derived as a question about whether a certain girl who is actually standing is tall.

### *8.5.3 Hypothetical conditional questions*

Finally, let's turn to hypothetical conditional questions such as (162)–(164). The §8.2-syntax/semantics of interrogatives integrates straightforwardly with the account of correlative conditionals in §§7.5, §7.7. The predicted LF and interpretation for (164) are as follows, on the shifted reading of 'I' under the conditional supposition, and local reading targeted by the question of the relevant standard for richness associated with 'rich'. (As with 'tall' in (168), assume a simplified context-sensitive semantics for 'rich', where 'o is $s$-rich' abbreviates that o's degree of wealth is at least as great as the degree-standard $s$ for counting as rich.)

(169) *Hypothetical conditional question*
'If it landed heads, am I rich?'




$[\![\mathrm{CP}_2]\!] \approx \lambda g_g : \underline{@(g(3a)) = g(2a)(1s)}\,.\, g(2a)(1e)$ is $g(3a)(1d)$-rich in $@(g(3a))$

$[\![\mathrm{CP}]\!] \approx \lambda g_g\,.\,\big[\iota a(g)^*\!: g(1a)(2e)$ landed heads in $@(a(g)) \wedge @(a(g)) = a(g)(2\mathrm{sf})(g(1a)(1st))\big]$
$a(g)(1e)$ is $g(3a)(1d)$-rich in $@(g(3a))$, provided $@(g(3a)) = a(g)(1s)$

A proposition $T_t \in [\![\mathrm{S}]\!]$ is an *answer* to S in $c$ iff $\exists g''_g\!: T = \big[\lambda g'_g \approx g''$ .
$\big[\iota a(g')^*\!: g_c^-(2e)$ landed heads in $@(a(g')) \wedge @(a(g')) = a(g')(2\mathrm{sf})(g_c^-(1st))\big]$
$a(g')(1e)$ is $\underline{g'^-(1d)}$-rich in $@(g'^-)$, provided $\underline{@(g'^-) = a(g')(1s)}$ iff
$\big[\iota a(g'')^*\!: g_c^-(2e)$ landed heads in $@(a(g'')) \wedge @(a(g'')) = a(g'')(2\mathrm{sf})(g_c^-(1st))\big]$
$a(g'')(1e)$ is $g''^-(1d)$-rich in $@(g''^-)$, provided $\underline{@(g''^-) = a(g'')(1s)}\big]$

Roughly, each possible answer $T$ is a set of assignments $g'$ which (i) determine the same standard $s$ for counting as rich ($=g'(1d)$), and (ii) return the same truth value for the proposition that the relevant possibility $h^*$ where the coin $g_c(2e)$ landed heads, $@(h^*) = h^*(2\mathrm{sf})(g_c(1st))$, is s.t. the shifted individual $h^*(1e)$ is $s$-rich, provided (iii) that the world of $g'$ is identical to the world of $h^*$.

The account derives the range of local/global readings for conditional questions discussed above and in §8.1 — notably, global readings (e.g. 'it'), local readings under the conditional supposition (e.g. 'I'), and local readings in the interrogative consequent targeted by the question (e.g. 'rich'). The standard associated with 'rich'

correctly receives a local reading under the question operator. (169) is in part a question about what standard of richness to accept; the question is about the nature of a topical *possibility*, not simply about the world narrowly construed. The assignments in each answer agree in what standard of richness $g'(1d)$ they determine (via $g' \approx g''$), though which standard is determined varies across the possible answers. By contrast, the interpretations of the pronouns 'it' and 'I' are constant across answers. Just as in each possible answer the topical modal possibility $h^*$ is about the same contextually relevant object $g_c(2e)$, likewise each possible answer is a proposition about the individual $h(1e)$ representing the counterpart of 'I' in that possibility. 'I' in the interrogative consequent receives a local reading under the conditional supposition without necessarily receiving a local reading targeted by the question. The global readings of 'it' and specifier argument of 'if' are again captured via the metasemantic condition on answerhood, anchoring their interpretation to the discourse context. I am not aware of other accounts of conditionals, questions, or conditional questions which similarly derive the observed range of local and global readings.

The semantics captures the intuition that the possible answers in a hypothetical conditional question are specifically about the possibility described by the antecedent. There are two critical moving parts: the presupposition associated with the interrogative complementizer, and the correlative binding requirement.

First, §§6–7 pursued a uniform approach to relativization in our semantics for relative complementizers — $\mathbf{C}_{\mathbf{rel}}$ in relativization of individuals (§6.1), and 'if'/$\mathbf{C}_{\mathbf{if}}$ in relativization of possibilities (§§7.2, 7.7). Drawing on cross-linguistic links between conditional and interrogative clauses, §8.2 followed suit in proposing a parallel treatment for the interrogative complementizer $\mathbf{C}_?$. The relevant contrast in the entry for $\mathbf{C}_?$ in (151) is that the condition on the external (world, individual) argument is a *presupposition*. Intuitively, a *no*-answer to a conditional question such as (162) shouldn't end up including possibilities where school is canceled (and perhaps even where it snows) but fail to verify the interrogative due to being outside the contextually relevant set of *snow*-possibilities. The possibilities in each answer should count as relevantly equivalent due to being equivalent with respect to whether school is canceled. Implementing the condition as a presupposition captures this. The assignments in each possible answer $T$ in (169) are restricted to assignments representing the topical modal possibility described by the 'if'-clause — assignments $g'$ s.t. $@(g'^{-}) = h^*(1s) = @(h^*)$.

By contrast, there isn't an analogous *no*-answer relevant in the semantics of relative clauses or 'if'-clauses. For purposes of deriving the embedding operator's restrictor argument, what matters is simply the items that *do* satisfy both of the conditions in question — e.g., in 'every toy which broke', the broken things which

are identical to some toy or other, or in 'if it snows', the *snow*-possibilities which are part of the relevant domain. That said, it would be interesting to compare presuppositional variants of the lexical entries for $\mathbf{C}_{\mathbf{rel}}$/'if' in (53)/(108) analogous to the entry for $\mathbf{C}_?$ in (151), as e.g. in (170) where $[\![\mathbf{if}]\!] = [\![\mathbf{C}_{\mathbf{if}}]\!] = [\![\mathbf{C}_?]\!]$.

(170) $[\![\mathbf{if}]\!] = [\![\mathbf{C}_{\mathbf{if}}]\!] = [\![\mathbf{C}_?]\!] = \lambda a_a.\lambda p_{st}.\lambda w'_s.\lambda g_g : @(a(g)) = w'(g)\,.\,\forall w \text{ s.t. } w(g) = @(a(g)), p(w)(g)$

Developing the account in this way could be understood as providing a general presuppositional approach to quantifier domain restriction.

Second, as part of the unified approach to relative, conditional, and interrogative clauses, I suggested understanding the external world argument in a conditional/interrogative clause as determining the relevant possibility to be targeted by the supposition/question. The questions in our previous examples were about what is the case in the actual world. Accordingly, the external argument was a world pronoun receiving a local reading under **Q**, and the presuppositional constraint was the trivial constraint that $@(g'^{-}) = g'^{-}(1s)$ (given our general metasemantic assumption). In contrast, in hypothetical conditional questions the possibility targeted by the interrogative clause is the possibility introduced in the antecedent. The external argument of $\mathbf{C}_?$ receives a local reading under the antecedent supposition rather than the question operator, represented via the world-pronoun $[\mathbf{w}_1\ \mathbf{g}_2]$ coindexed with the 'if'-clause (cf. n. 44). The derived presuppositional constraint is the non-trivial constraint $@(g') = @(h^*)$ that the assignments $g'$ in each possible answer represent the world of the topical possibility $h^*$. The possible answers $T$ are correctly diagnosed as being propositions specifically about the relevant possibility where the coin landed heads.

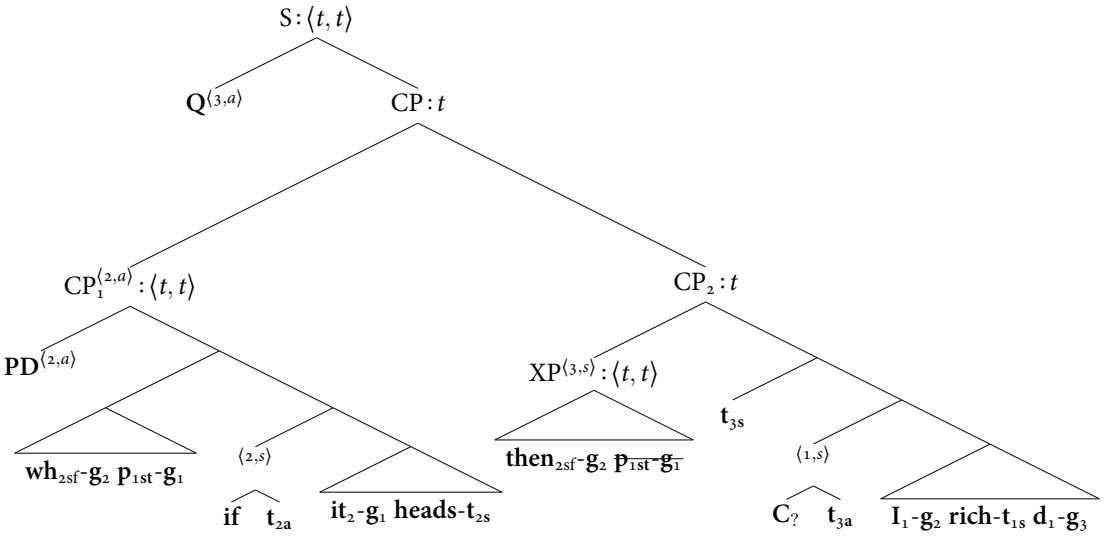
There is an important contrast between the treatments of the correlates/proforms in hypothetical conditionals with main clause interrogative vs. declarative CPs. In §§7.5–7.7, the predicted correlate of the 'if'-clause was directly linked to the main predicate's world argument. The assignment-binder **T** — or an embedding modal, as in (118) reproduced in (171) — was treated as raising from a semantically vacuous complementizer generated by CP-recursion above the conditional.

(171) Alice thinks $[_{\text{CP}_1}$ that $[_{\text{CP}_2}$ [if it snows] $[_{\text{CP}_3}$ (then) school will close]]]

In contrast, in correlative conditional questions the correlate cannot be directly linked to the main predicate's world argument; the (non-vacuous) embedded interrogative complementizer must be generated (e.g.) to trigger *wh* movement, satisfy the selection requirements of the question-embedding operator, and derive the

intended question meaning. The predicted correlate is instead the adjacent world argument in SpecCP — an adjacent world-pronoun, as in (169), or a topicalized proform such as 'then', as in (172) (n. 44).

(172) *'If…then' conditional question*
'If it landed heads, then am I rich?'




A proposition $T_t \in [\![\mathrm{S}]\!]$ is an *answer* to S in $c$ iff $\exists g''_g$: $T = \big[\lambda g'_g \approx g''$ .
$[\iota a(g')^*: g_c^-(2e)$ landed heads in $@(a(g')) \wedge \underline{@(a(g')) = a(g')(2\mathrm{sf})(g_c^-(1st))}]$
$a(g')(1e)$ is $\underline{g'^-(1d)}$-rich in $@(g'^-)$, provided $\underline{@(g'^-) = a(g')(2\mathrm{sf})(g_c^-(1st))}$ iff
$[\iota a(g'')^*: g_c^-(2e)$ landed heads in $@(a(g'')) \wedge @(a(g'')) = a(g'')(2\mathrm{sf})(g_c^-(1st))]$
$a(g'')(1e)$ is $g''^-(1d)$-rich in $@(g''^-)$, provided $@(g'') = a(g'')(2\mathrm{sf})(g_c^-(1st))\big]$

Just like in our examples with unembedded interrogatives, the question operator (or a question-embedding modal) raises from the assignment argument position of the embedded interrogative complementizer. No mechanism of CP-recursion is predicted.

This is a critical feature of the account, since CP-recursion has been argued to be degraded or impossible under interrogative complementizers (e.g. Iatridou & Kroch 1993). Unlike (118), the examples in (173)–(174) are unacceptable with 'then'.

(173) a. Every boy wonders if his mother comes what he will eat.
b. *Every boy wonders if his mother comes then what he will eat.
(Iatridou & Kroch 1993: exs. 54a–55a)

(174) a. Every boy wonders whether if his toy breaks he will get a new one.
b. *Every boy wonders whether if his toy breaks then he will get a new one.

The $\overline{\text{A}}$-movement from topicalizing the proform, as in (172), degrades the further *wh* movement in examples such as (173)–(174) (cf. §7.5). The contrast between embedded 'then' conditionals with main clause declaratives vs. interrogatives falls out of our general account of conditional proforms and syntax/semantics for interrogative (conditional, relative) clauses.[47]

## 8.6 Recap: Standardizing quantification / Unifying relativization, conditionals, questions

The compositional semantics of interrogatives in this section parallels our previous treatments of type-driven movement with other quantifiers and complementizers:

- Interrogative, conditional, and (non-vacuous) declarative complementizers raise from V as quantifiers over worlds, capturing the obligatory local reading of the main predicate's world argument. Analogously, the relative complementizer raises from the gap position in an individual relative clause, capturing the obligatory link between the gap and nominal head.
- Modal quantifiers — including the topmost assignment-binders **T** and **Q**, modal and attitude verbs, and **PD** — raise from inside their complement clause as quantifiers over assignments, determining the relevant modal domain. Analogously, determiner quantifiers in relative constructions raise from inside their complement relative clause, determining the relevant domain of individuals.
- Relative/*wh* pronouns are analyzed as choice-function pronouns — type $\langle et, e\rangle$ in relativization of individuals (e.g. 'which'), type $\langle st, s\rangle$ in relativization of possibilities (e.g. 'whether'). Conditional and individual proforms are represented as copies of their antecedent relative/*wh* expression.
- Relative, conditional, correlative, and interrogative complementizers — $\mathbf{C_{rel}}$ in relativization of individuals, 'if'/$\mathbf{C_{if}}$ in relativization of possibilities, $\mathbf{C_?}$ in interrogatives — relate a pair of individuals/worlds with respect to the property of individuals/worlds expressed by the complement.

[47] It is interesting that conditional 'then' questions such as (172) (where 'then' is fronted) are ungrammatical in V2 languages; unlike in (144), there is no empty complementizer position for the verb to move to. This of course isn't a general account of the licensing of embedded 'then' conditionals. CP-recursion is degraded in various environments, not simply in questions (e.g. Iatridou 1991, Iatridou & Kroch 1993, Bhatt & Pancheva 2006).

- In individual relatives the relative clause targets a topical subset of individuals supplied by the relative phrase. The set of individuals may then be commented on by a determiner quantifier's scope argument.
- In conditional interpretations with 'if', the 'if'-clause targets a topical subdomain of a relevant modal possibility. This topical possibility may then be commented on by an adjoined phrase (NP/VP/IP/CP).
- In individual-correlative interpretations with $\mathbf{C_{if}}$ the correlative clause targets a possibility describing topical individuals in the actual world. This topical possibility is commented on by the adjoined main clause.
- In interrogatives the interrogative clause targets the possibility to be targeted by the question.

The proposed assignment-variable-based account affords a unified approach to conditionality, relativization, and questions, and an elegant generalized treatment of quantification in various types of sentences and clausal structures.[48]

## 9 Conclusion

This paper (?) has initiated a project of developing a linguistic theory which posits variables for assignment functions in the syntax, and treats semantic values systematically in terms of sets of assignments in the model. Principal features of the account are that it standardizes quantification across domains, and it systematizes various seemingly diverse linguistic shifting phenomena. Such phenomena include data with quantifiers and scope, intensionality, and local/global readings in various embedded environments, such as with modals, attitude verbs, questions, and conditionals. The semantics affords a unified analysis of the context-sensitivity of pronouns, epistemic modals, etc., in the spirit of contextualist theories. Yet it improves in compositionally deriving certain distinctive shifting/binding phenomena (e.g. with epistemic modals), and in providing a framework for theorizing about expressions' different tendencies for local/global readings. Resources for capturing these phenomena have grown increasingly complex in current theories.

The syntax and lexical/compositional semantics delineate the sources of intensionality and assignment-shifting in the clausal architecture. Binding with individuals/worlds/assignments is derived uniformly from a generalized binder-index, which attaches directly to expressions. The account avoids introducing added parameters of interpretation, quantification-specific composition rules, or interpretive principles (such as for reconstructed phrases, pronouns vs. traces, donkey pronouns). The semantics is fully compositional.

[48] If only.

Along the way I appealed to independently motivated resources from the syntax and semantics literatures in motivating analyses of particular constructions. Certain features of the account are of general interest, independent of the particular assignment-variable-based implementation. These include the formalization of assignment modification; the definition of the generalized binder-index; the approach to the syntax/semantics interface with determiner quantifiers, modal quantifiers, and various types of complementizers; a distinction between trace- and pronoun-binding, with potential applications to (weak) crossover; the treatments of locality/globality constraints (e.g., with pronouns, epistemic modals); a unified analysis of *wh*-words, relative words, and (at least some) indefinites; a speculative general treatment of apparent binding out of DPs and weak crossover effects with donkey pronouns, inverse linking, and genitive binding; a uniform compositional semantics for 'if'-clauses when adjoined to NP, VP, IP, and CP; a unified syntax/semantics for 'if'-clauses and individual correlative clauses, and unified analysis of conditional and individual proforms; a unified approach to relative, conditional, and interrogative complementizers; and a fully compositional semantics for quantifier raising, *wh* interrogatives, and relativization.

The initial focus of the paper was on applying the assignment-variable-based framework to local/global readings with quantifiers, attitude verbs, and modal verbs; however, we have seen that the potential applications of the account extend more broadly. Diverse types of shifting phenomena were examined across a range of linguistic environments, such as relativization structures, conditionals, and interrogatives. Although I emphasized certain formal similarities among context-sensitive expressions, there are of course differences among them. Issues regarding further (grammatical, lexical, metasemantic, conversational) constraints on readings, to help rein in the flexibility of the system, call for more thorough investigation. The speculative discussions of assignment-quantification with determiner quantifiers and comparisons among conditionals, individual correlatives, and interrogatives raise difficult questions about traces vs. pronouns, linguistic and discourse anaphora, and *wh* movement and topicalization, among many others. Applications to other types of conventional meanings, such as conventional implicature, presupposition, and expressives; categories such as tense, aspect, and mood; and expressions and constructions such as imperatives, counterfactuals, modal adjectives/adverbs, and ellipsis, may provide interesting avenues to explore. I hope the preliminary developments here may illustrate the fruitfulness of an assignment-variable-based approach to investigating these and additional linguistic phenomena.

# Appendix Formal overview: Syntax, Semantics, Metasemantics

## A Sample lexical entries

(16) $[\![\textbf{loves}]\!] = \lambda w_s.\lambda x_e.\lambda y_e.\lambda g_g\,.\, y(g)$ loves $x(g)$ in $w(g)$

(16) $[\![\textbf{everything}]\!] = \lambda P_{\langle e,t\rangle}.\lambda g_g.\forall x_e\colon P(x)(g)$ (*preliminary*)

(14) $[\![\mathbf{v}_{\mathrm{i}\sigma}]\!] = \lambda a_a.\lambda\gamma^n_{\sigma_n}\ldots\lambda\gamma^1_{\sigma_1}.\lambda g_g\,.\, a(g)(\mathrm{i}\sigma)((^{\downarrow}\gamma^n)(g))\ldots((^{\downarrow}\gamma^1)(g))$

a. For $\alpha \in \{e,s,t\}$, $[\![\mathbf{v}_{\mathrm{i}\alpha}]\!] = \lambda a_a.\lambda g_g\,.\, a(g)(\mathrm{i}\alpha)$ b. $[\![\mathbf{g}_{\mathbf{i}}]\!] = \lambda g_g\,.\, g(\mathrm{i}a)$

(15) $[\![\mathbf{t}_{\mathrm{i}\sigma}]\!] = \lambda\gamma^n_{\sigma_n}\ldots\lambda\gamma^1_{\sigma_1}.\lambda g_g\,.\, g(\mathrm{i}\sigma)((^{\downarrow}\gamma^n)(g))\ldots((^{\downarrow}\gamma^1)(g))$

a. For $\beta \in \{e,s,t,a\}$, $[\![\mathbf{t}_{\mathrm{i}\beta}]\!] = \lambda g_g\,.\, g(\mathrm{i}\beta)$

(25) *Generalized binder-index*

$$[\![^{\langle i,\tau\rangle}]\!] = \lambda\alpha_{\langle\langle\tau,\langle_1\sigma_1\cdots\sigma_n,\,t\rangle_1\cdots\rangle_n\rangle,\sigma\rangle}\,.\,\lambda\beta_{\langle_1\sigma_1\cdots\sigma_n,\,t\rangle_1\cdots\rangle_n}\,.\;\alpha\Big(\lambda\chi.\lambda\gamma^1\cdots\lambda\gamma^n.\lambda g\,.\,\beta(\gamma^1)\cdots(\gamma^n)(g[(^{\downarrow}\chi)(g)/\mathrm{i}\tau])\Big)$$

(20) $[\![\textbf{that}]\!] = [\![\mathbf{C}_{\textbf{dec}}]\!] = \lambda a_a.\lambda p_{\langle s,t\rangle}.\lambda g_g\,.\,\forall w$ s.t. $w(g) = @(a(g)), p(w)(g)$

(108) $[\![\textbf{if}]\!] = [\![\mathbf{C}_{\textbf{if}}]\!] = \lambda a_a.\lambda p_{st}.\lambda w'_s.\lambda g_g\,.\,@(a(g)) = w'(g) \wedge \forall w$ s.t. $w(g) = @(a(g)), p(w)(g)$

(151) $[\![\mathbf{C}_?]\!] = \lambda a_a.\lambda p_{st}.\lambda w'_s.\lambda g_g\colon @(a(g)) = w'(g)\,.\,\forall w$ s.t. $w(g) = @(a(g)), p(w)(g)$

(53) $[\![\mathbf{C}_{\textbf{rel}}]\!] = \lambda a_a.\lambda P_{et}.\lambda y_e.\lambda x_e.\lambda g_g\,.\, x(g) = y(g) \wedge P(x)(g)$

(24) $[\![\textbf{think}]\!] = \lambda w_s.\lambda A_{\langle a,t\rangle}.\lambda x_e.\lambda g_g\,.\,\forall a_a$ s.t. $a(g)$ is compatible with $x(g)$'s state of mind in $w(g)\colon A(a)(g)$

(23) $[\![\textbf{may}]\!] = \lambda w_s.\lambda r_{\langle s,at\rangle}.\lambda A_{\langle a,t\rangle}.\lambda g_g\,.\,\exists a_a$ s.t. $r(w)(a)(g)\colon A(a)(g)$

(126) $[\![\textbf{may}]\!] = \lambda a_a.\lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,\exists a'_a$ s.t. $a'(g) \leq a(g) \wedge A(a')(g)\colon A'(a')(g)$ (*alternative argument structure in (127)*)

(22) $[\![\mathbf{T}]\!] = \lambda A_{\langle a,t\rangle}.\lambda g_g\,.$ for $a_a = \lambda g_g.g^{\frown}, A(a)(g)$

(152) $[\![\mathbf{Q}]\!] = \lambda A_{at}.\lambda T_t.\lambda g_g\,.$ for $a_a = \lambda g_g.g^{\frown}, \exists g''_g\colon T = [\lambda g'\colon g' \approx g''\,.\,A(a)(g') = A(a)(g'')]$

(106) $[\![\textbf{PD}]\!] = \lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,[\iota a(g)^*\colon A(a)(g)]\;A'(a)(g)$

(138) $[\![\textbf{DEF}]\!] = \lambda P^+_{\langle a,et\rangle}.\lambda Q^+_{\langle a,et\rangle}.\lambda g_g\,.\,\big[\iota x(g)^*\exists a\colon P^+(a)(x)(g)\big]\;Q^+(a)(x)(g)$

(55) $[\![\textbf{every}]\!] = \lambda P^+_{\langle a,et\rangle}.\lambda Q^+_{\langle a,et\rangle}.\lambda g_g\,.\,\big[\forall x_e\exists a_a\colon P^+(a)(x)(g)\big]\;Q^+(a)(x)(g)$ (*universal donkey reading*)

(62) $[\![\textbf{every}]\!] = \lambda P^+_{\langle a,et\rangle}.\lambda Q^+_{\langle a,et\rangle}.\lambda g_g\,.\,\big[\forall x_e\exists a_a\colon P^+(a)(x)(g)\big]$

$\exists a'_a\colon P^{+}(a')(x)(g) \wedge Q^{+}(a')(x)(g)$ (*existential donkey reading*)

*relative/wh choice-function pronouns*

a. $[\![\mathbf{wh}_{\mathrm{i,cf}}]\!] = \lambda a_a.\lambda P_{\tau t}.\lambda g_g\,.\, a(g)(i\mathrm{cf})((\downarrow P)(g))$
b. A *choice function* $F_{\mathrm{cf}}$ is a function $F\colon [X \to T] \to X$ s.t. $\forall P\colon X \to T \neq \varnothing\colon P(F(P))$.

## B Metasemantics / Metalanguage

(11) **Models $\mathcal{M}$:**
- $E$: set of entities
- $T$: set of truth-values, $\{0, 1\}$
- $W$: set of worlds
- $G$: set of assignments$_M$

(12) **Domains / Semantic types:**
- $D_e = E^{D_g}$
- $D_t = \{0, 1\}^{D_g}$
- $D_s = W^{D_g}$
- $D_a = G^{D_g}$
- $D_g$ =domain of assignments$_D$
- $D_{\alpha\beta} = D_{\beta}^{D_\alpha}$

(37) *Assignment modification*

a. $[z/\mathrm{i}\tau] \coloneqq \lambda g_g\,.\,\iota m_g\colon m(\mathrm{i}\tau) = z \wedge m(\mathrm{j}\sigma) = g(\mathrm{j}\sigma)$, for all $\mathrm{j}\sigma \neq \mathrm{i}\tau$
b. $g_g[\cdots]_1 \ldots [\cdots]_n \coloneqq [\cdots]_1 \circ \ldots \circ [\cdots]_n(g)$

Constraints on readings / Interpretation of assignments: §§1, 2.1, 3.1, 3.3, 3.4, 4.1, 4.3.3, 5, 6.3.2, 7.7

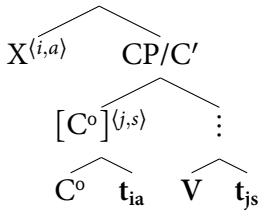
Metasemantics: §§2.2, 3.3, 4.1, 6.1.2, 7.2, 8.2, 8.5

(155) a. A declarative sentence $S$ is **true** in $c$ iff $[\![S]\!](g_c) = 1$
b. $T_t$ is an **answer** to an interrogative sentence $S?$ in $c$ iff (i) $T \in [\![S?]\!]$, and (ii) for all $g' \in T$ and assignment-indices $\mathrm{i}a$, $g'(\mathrm{i}a) = g_c^{-}$

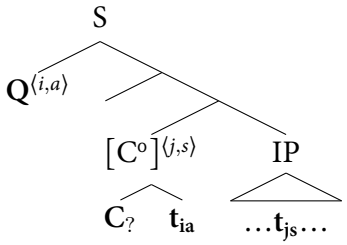
## C Syntax

Sample trees and examples: e.g., §§3.2, 4, 6.1, 6.2, 6.3.2, 7.2, 7.5–7.7, 8.2, 8.5

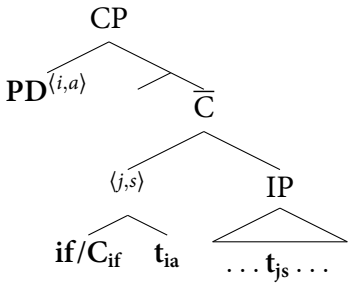
(19)



(150)

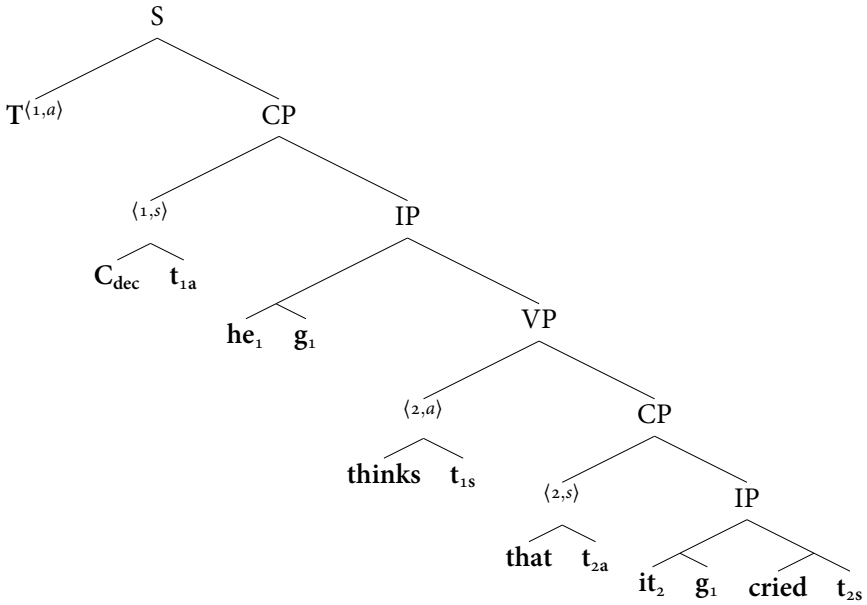



(104)

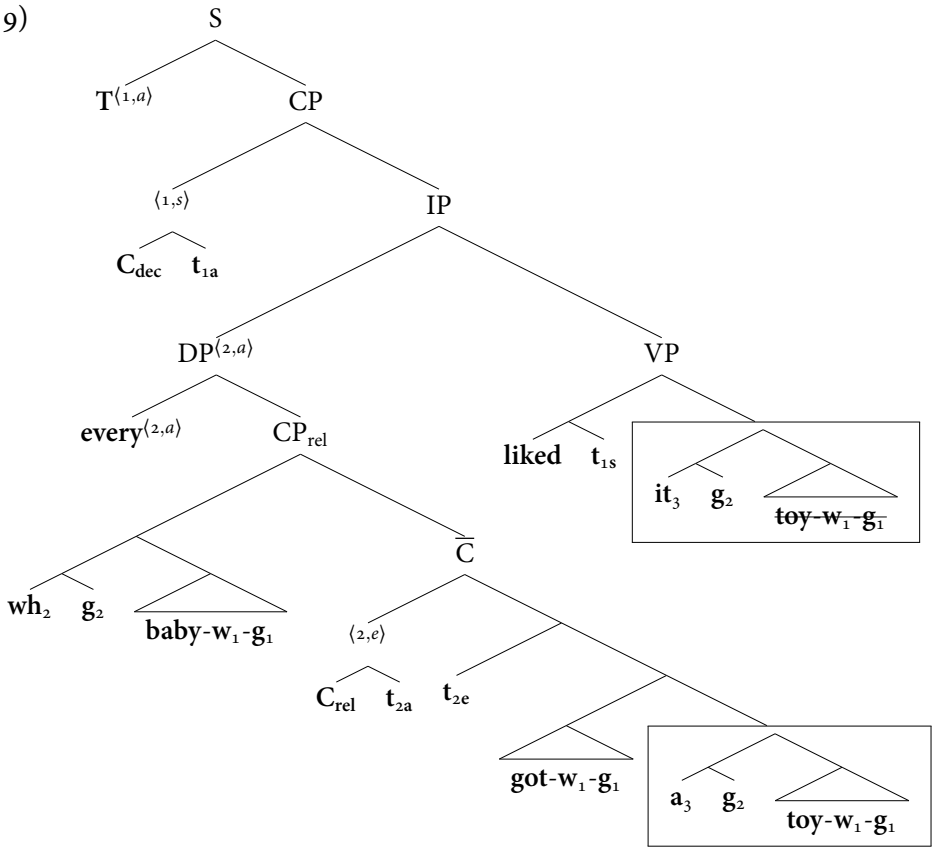



(43) $[_{DP}\ D^{o}\ [_{CP_{rel}}\ wh_{rel}\ NP\ [_{\overline{C}}\ C_{rel}\ IP\ ]]]]$

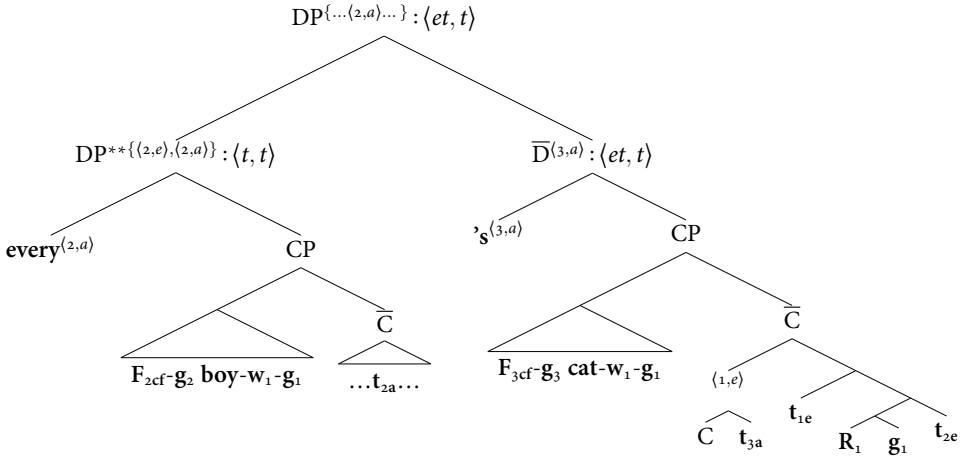
(29)



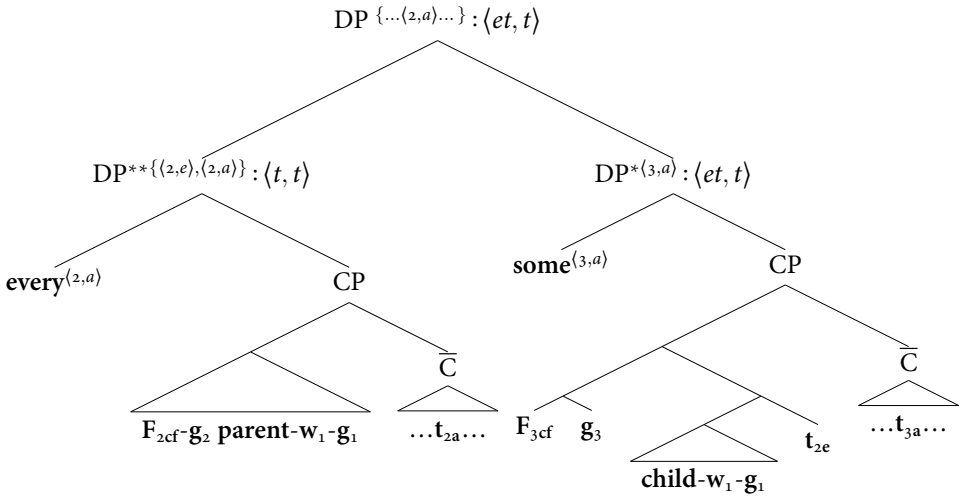
(59)


S
T⟨1,a⟩
CP
⟨1,s⟩
IP
Cdec t1a
DP⟨2,a⟩
VP
every⟨2,a⟩
CPrel
liked t1s
it3 g2
toy-w1-g1
C̄
wh2 g2
baby-w1-g1
⟨2,e⟩
Crel t2a
t2e
got-w1-g1
a3 g2
toy-w1-g1

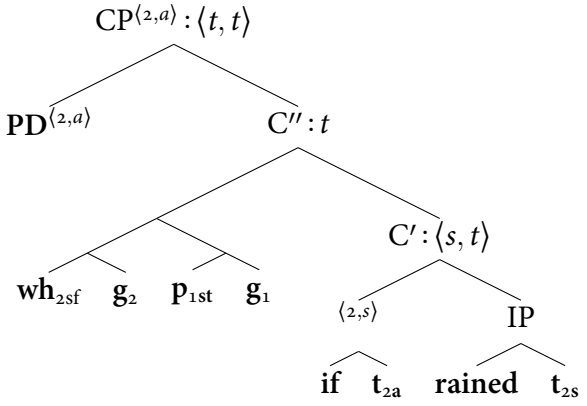
(89) ‘every boy’s cat’



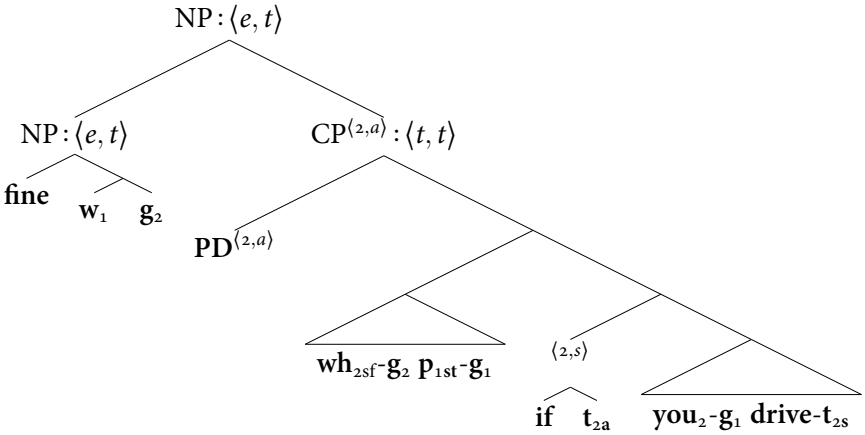

(93) ‘some child of every parent’



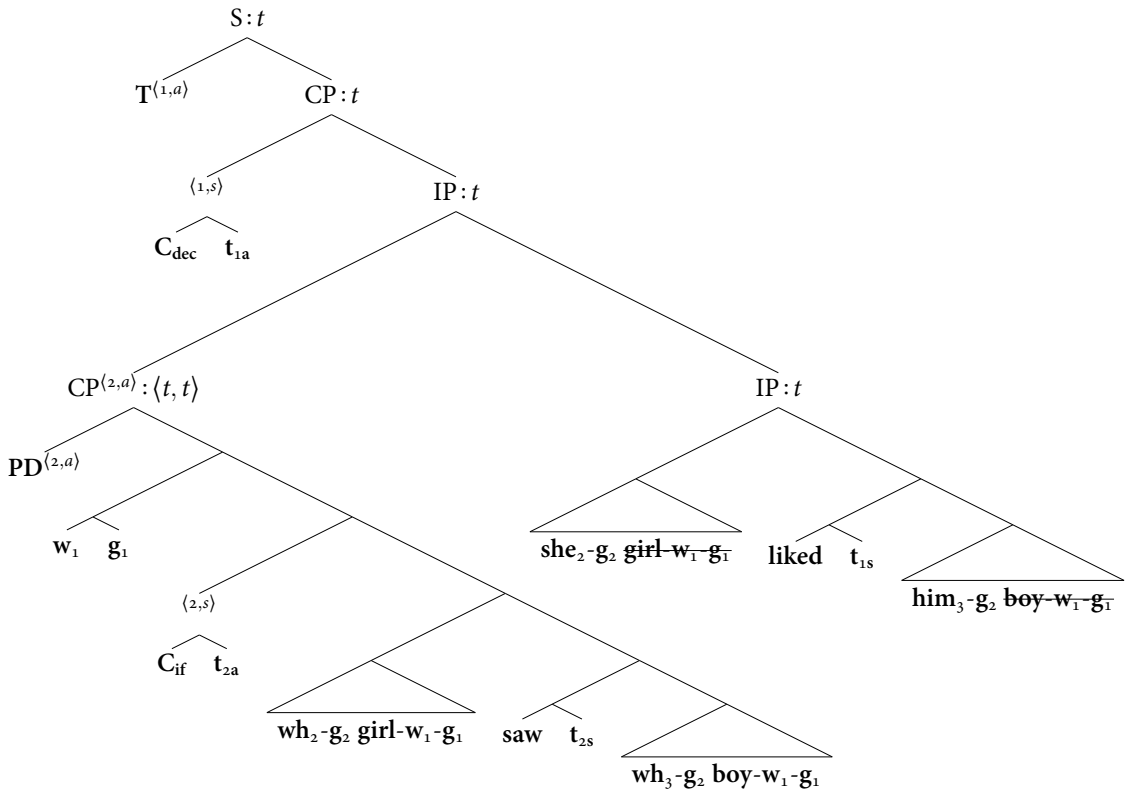

(109)



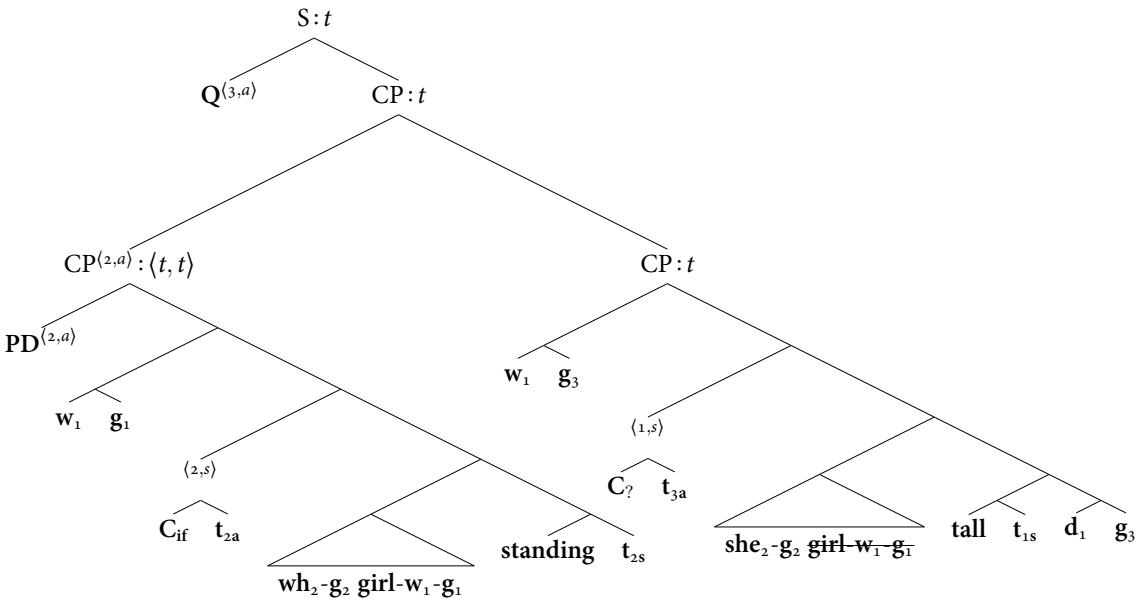
(111) 'fine if you drive'



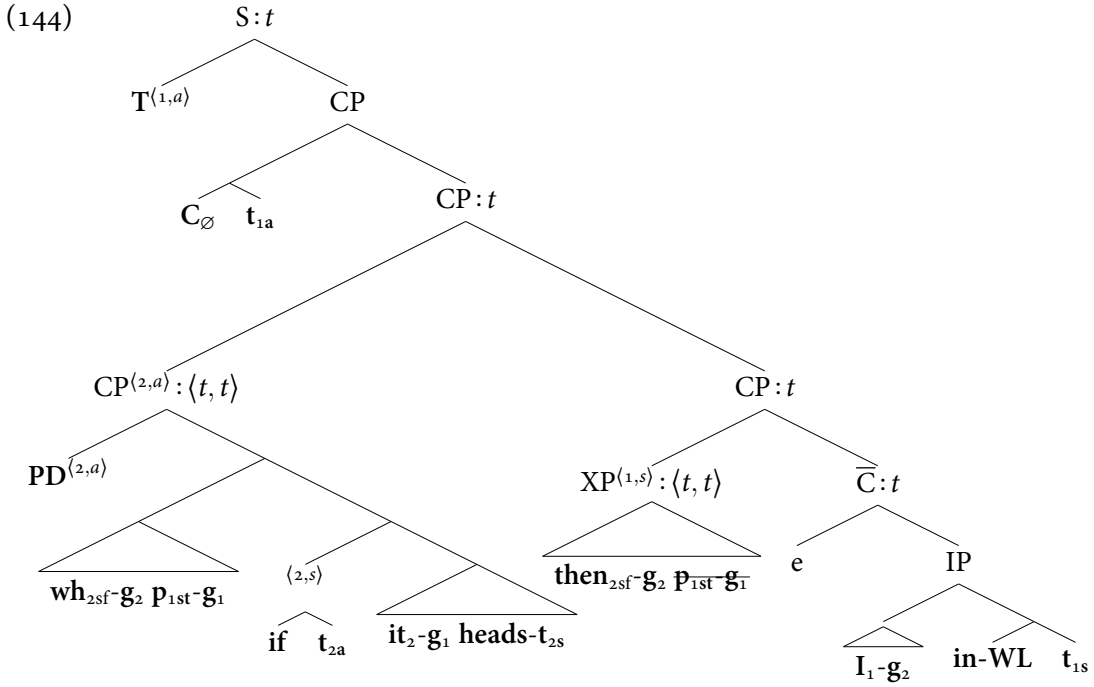

(136) Hindi correlative: 'Which girl saw which boy, she liked him.' (Srivastav 1991)



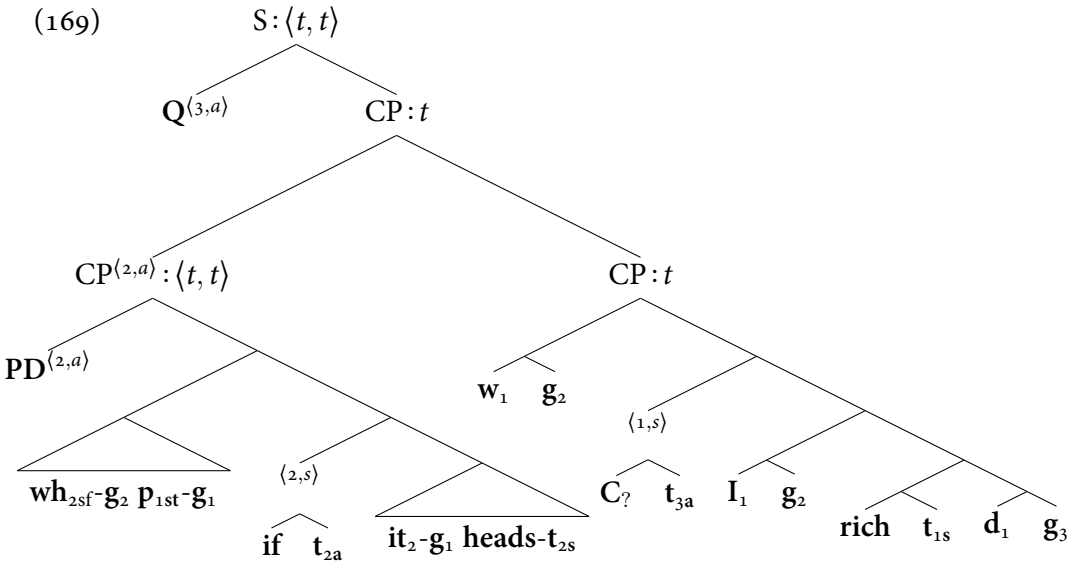
(168) Correlative question: 'Which girl is standing, is she tall?' (cf. Srivastav 1991)



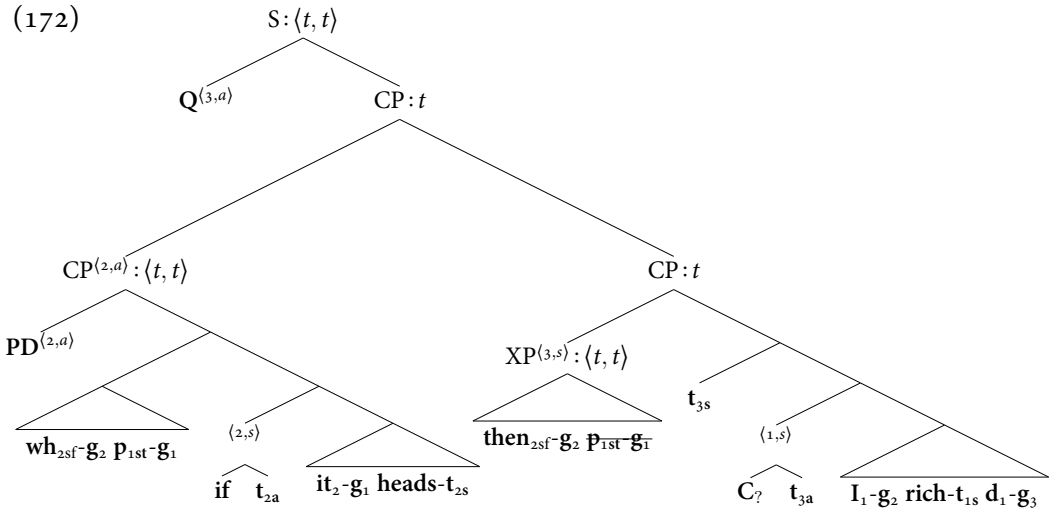

(144)



(169)




(172)




## References


Abusch, Dorit. 1994. The scope of indefinites. *Natural Language Semantics 2*, 83–135.

Anand, Pranav & Andrew Nevins. 2004. Shifty operators in changing contexts: Indexicals in Zazaki and Slave. In *Proceedings of SALT 14*. Evanston, IL.

Arsenijević, Boban. 2009. Correlatives as types of conditional. In Lipták (2009a),

pp. 131–156.

Bach, Emmon, Eloise Jelinek, Angelika Kratzer, & Barbara H. Partee (Eds.). 1995. *Quantification in natural languages*. Dordrecht: Kluwer.

Beshears, Anne. 2017. *The demonstrative nature of the Hindi/Marwari correlative*. Ph.D. thesis, Queen Mary University of London.

Bhatt, Rajesh. 2002. The raising analysis of relative clauses: Evidence from adjectival modification. *Natural Language Semantics 10*, 43–90.

Bhatt, Rajesh. 2003. Locality in correlatives. *Natural Language and Linguistic Theory 21*, 485–541.

Bhatt, Rajesh & Roumyana Pancheva. 2006. Conditionals. In Martin Everaert & Henk van Riemsdijk (Eds.), *The Blackwell companion to syntax*, vol. 1, pp. 638–687. Oxford: Blackwell.

Bianchi, Valentina. 1999. *Consequences of antisymmetry: Headed relative clauses*. Berlin: Mouton de Gruyter.

Bittner, Maria. 2001. Topical reference for individuals and possibilities. In Rachel Hastings, Brendan Jackson, & Zsofia Zvolenszky (Eds.), *Proceedings from SALT XI*, pp. 36–55. Ithaca, N.Y.: CLC Publications.

Brasoveanu, Adrian. 2007. *Structured nominal and modal reference*. Ph.d. thesis, Rutgers University.

Browning, M.A. 1996. CP recursion and *that-t* effects. *Linguistic Inquiry 27*, 237–255.

Büring, Daniel. 2004. Crossover situations. *Natural Language Semantics 12*, 23–62.

Büring, Daniel. 2005. *Binding Theory*. Cambridge: Cambridge University Press.

Cable, Seth. 2009. The syntax of the Tibetan correlative. In Lipták (2009a), pp. 195–222.

Cable, Seth. 2010. *The grammar of Q: Q-particles, wh-movement, and pied-piping*. Oxford: Oxford University Press.

Caponigro, Ivano. 2002. Free relatives as DPs with a silent D and a CP complement. In Vida Samiian (Ed.), *Proceedings of the Western Conference on Linguistics 2000 (WECOL 2000)*. Fresno: California State University.

Caponigro, Ivano. 2003. *Free not to ask: On the semantics of free relatives and* wh*-words cross-linguistically*. Ph.D. thesis, UCLA.

Caponigro, Ivano. 2012. Acquiring the meaning of free relative clauses and plural definite descriptions. *Journal of Semantics 29*, 261–293.

Cariani, Fabrizio, Stefan Kaufmann, & Magdalena Kaufmann. 2013. Deliberative modality under epistemic uncertainty. *Linguistics and Philosophy 36*, 225–259.

Charlow, Nate. 2010. Restricting and embedding imperatives. In Maria Aloni, Harald Bastiaanse, Tikitu de Jager, & Katrin Schulz (Eds.), *Logic, language and meaning: Selected papers from the 17th Amsterdam Colloquium*, pp. 223–233. Berlin: Springer.

Charlow, Nate. 2011. *Practical language: Its meaning and use*. Ph.D. thesis, University of Michigan.

Charlow, Nate. 2013a. Conditional preferences and practical conditionals. *Linguistics and Philosophy 36*, 463–511.

Charlow, Nate. 2013b. What we know and what to do. *Synthese 190*, 2291–2323.

Charlow, Simon & Yael Sharvit. 2014. Bound 'de re' pronouns and the LFs of attitude reports. *Semantics and Pragmatics 7*, 1–43.

Chierchia, Gennaro. 1994. Intensionality and context change: Towards a dynamic theory of propositions and properties. *Journal of Logic, Language and Information 3*, 141–168.

Chierchia, Gennaro. 1995. Individual-level predicates as inherent generics. In Gregory N. Carlson & Francis Jeffrey Pelletier (Eds.), *The generic book*, pp. 176–223. Chicago: Chicago University Press.

Chomsky, Noam. 1977. On wh-movement. In Peter Culicover, Tom Wasow, & Adrian Akmajian (Eds.), *Formal syntax*, pp. 71–132. New York: Academic Press.

Chomsky, Noam. 1995. *The minimalist program*. Cambridge: MIT Press.

Citko, Barbara. 2001. Deletion under identity account of relative clauses. In Minjoo Kim & Uri Strauss (Eds.), *Proceedings of NELS 31*. Amherst: GLSA Publications.

Citko, Barbara. 2009. What don't wh-questions, free relatives, and correlatives have in common? In Lipták (2009a), pp. 49–79.

Collins, Chris. 1998. A note on extraction from conditionals. In Niken Adisasmito-Smith & Toby Doeleman (Eds.), *Cornell workings papers in linguistics*, vol. 16, pp. 66–75. Ithaca, N.Y.: Cornell University Press.

Cresswell, M.J. 1990. *Entities and indices*. Dordrecht: Kluwer.

Cumming, Samuel. 2008. Variabilism. *Philosophical Review 117*, 525–554.

Dayal, Veneeta. 1996. *Locality in WH quantification*. Dordrecht: Kluwer Academic Publishers.

Dayal, Veneeta. 2016a. Multiple-*wh*-questions. In Martin Everaert & Henk van Riemsdijk (Eds.), *The Blackwell companion to syntax*. Oxford: Blackwell, 2nd edn.

Dayal, Veneeta. 2016b. *Questions*. Oxford: Oxford University Press.

den Dikken, Marcel. 2009. Comparative correlatives and successive cyclicity. In Lipták (2009a), pp. 263–306.

Dowell, J.L. 2012. Contextualist solutions to three puzzles about practical conditionals. In Russ Shafer-Landau (Ed.), *Oxford studies in metaethics*, vol. 7, pp. 271–303. Oxford: Oxford University Press.

Dummett, Michael. 1973. *Frege: Philosophy of language*. London: Duckworth, 2nd edn.

Elbourne, Paul D. 2005. *Situations and individuals*. Cambridge: MIT Press.

Fabb, Nigel. 1990. The difference between English restrictive and nonrestrictive relative clauses. *Journal of Linguistics 26*, 57–78.

Fiengo, Robert & Robert May. 1994. *Indices and identity*. Cambridge, Mass.: MIT Press.

von Fintel, Kai. 1994. *Restrictions on quantifier domains*. Ph.D. thesis, University of Massachusetts, Amherst.

von Fintel, Kai & Irene Heim. 2011. Intensional semantics. MS, MIT.

von Fintel, Kai & Sabine Iatridou. 2005. What to do if you want to go to Harlem: Anankastic conditionals and related matters. MS, MIT.

von Fintel, Kai & Sabine Iatridou. 2009. Lecture notes for LSA 220: Morphology, syntax, and semantics of modals. MIT.

Fodor, Janet Dean. 1970. *The linguistic description of opaque contexts*. Ph.D. thesis, MIT.

Fodor, Janet Dean & Ivan A. Sag. 1982. Referential and quantificational indefinites. *Linguistics and Philosophy 5*, 355–398.

Fox, Danny. 2000. *Economy and semantic interpretation*. Cambridge, Mass.: MIT Press.

Fox, Danny. 2002. Antecedent-contained deletion and the copy theory of movement. *Linguistic Inquiry 33*, 63–96.

Frank, Anette. 1996. *Context dependence in modal constructions*. Ph.D. thesis, University of Stuttgart.

Gajewski, Jon. 2008. On the semantics of Hindi-Urdu multiple correlatives. *Linguistic Inquiry 39*, 327–334.

George, Benjamin. 2011. *Question embedding and the semantics of answers*. Ph.D. thesis, UCLA.

Geurts, Bart. 2004. On an ambiguity in quantified conditionals. MS, University of Nijmegen.

Gillies, Anthony S. 2010. Iffiness. *Semantics and Pragmatics 3*, 1–42.

Groenendijk, Jeroen & Floris Roelofsen. 2009. Inquisitive semantics and pragmatics. MS, ILLC.

Groenendijk, Jeroen & Floris Roelofsen. 2010. Radical inquisitive semantics. MS, ILLC.

Groenendijk, Jeroen & Martin Stockhof. 1982. Semantic analysis of *wh*-complements. *Linguistics and Philosophy 5*, 175–233.

Groenendijk, Jeroen & Martin Stockhof. 1984. *Studies on the semantics of questions and the pragmatics of answers*. Ph.D. thesis, University of Amsterdam.

Groenendijk, Jeroen & Martin Stockhof. 1991. Dynamic predicate logic. *Linguistics and Philosophy 14*, 39–100.

Groenendijk, Jeroen & Martin Stokhof. 1990. Dynamic Montague Grammar. In L. Kalman & L. Polos (Eds.), *Proceedings of the Second Symposium on Logic and Language*, pp. 3–48. Budapest: Adakemiai Kiado.

Groos, Aneeke & Henk van Riemsdijk. 1981. Matching e ects in free relatives: a parameter of matching effects in free relatives: A parameter of core grammar. In Adriana Belletti, Luciana Brandi, & Luigi Rizzi (Eds.), *Theory of markedness in generative grammar*, pp. 171–216. Pisa: Scuola Normale Superiore di Pisa.

Grosu, Alexander. 1996. On the proper analysis of 'missing P' free relative constructions. *Linguistic Inquiry 27*, 41–58.

Grosu, Alexander & Fred Landman. 1998. Strange relatives of the third kind. *Natural Language Semantics 6*, 125–170.

Hacquard, Valentine. 2006. *Aspects of modality*. Ph.D. thesis, MIT.

Hacquard, Valentine. 2010. On the event relativity of modal auxiliaries. *Natural Language Semantics 18*, 79–114.

Haegeman, Liliane. 2010. The movement derivation of conditional clauses. *Linguistic Inquiry 41*, 595–621.

Haiman, John. 1978. Conditionals are topics. *Language 54*, 565–589.

Hamblin, C.L. 1973. Questions in Montague English. *Foundations of language 10*, 41–53.

Hankamer, Jorge & Line Mikkelsen. 2012. CP complements to D. MS, UC Santa Cruz & UC Berkeley.

Heim, Irene. 1982. *The semantics of definite and indefinite noun phrases*. Ph.D. thesis, University of Massachusetts Amherst.

Heim, Irene. 1990. E-type pronouns and donkey anaphora. *Linguistics and Philosophy 13*, 137–177.

Heim, Irene. 1994. Interrogative semantics and Karttunen's semantics for *know*. In Rhonna Buchalla & Anita Mitwoch (Eds.), *IATL 1*, pp. 128–144. Hebrew University of Jerusalem.

Heim, Irene. 2001. Features of pronouns in semantics and morphology. MS.

Heim, Irene. 2008. Features on bound pronouns. In Daniel Harbour, David Adger, & Susana Béjar (Eds.), *Phi theory: Phi-features across modules and interfaces*, pp. 35–56. Oxford: Oxford University Press.

Heim, Irene. 2012. Lecture notes for 24.973: Advanced semantics. MIT.

Heim, Irene & Angelika Kratzer. 1998. *Semantics in Generative Grammar*. Oxford: Wiley-Blackwell.

Hendriks, Herman L.W. 1993. *Studied flexibility: Categories and types in syntax and semantics*. Amsterdam: ILLC.

Higginbotham, James & Robert May. 1981. Questions, quantifiers and crossing. *The Linguistic Review 1*, 41–80.

Hornstein, Norbert. 1995. *Logical form: From GB to Minimalism*. Oxford: Blackwell.

Iatridou, Sabine. 1991. *Topics in conditionals*. Ph.D. thesis, MIT, Cambridge.

Iatridou, Sabine. 1994. On the contribution of conditional *then*. *Natural Language Semantics 2*, 171–199.

Iatridou, Sabine & Anthony Kroch. 1993. The licensing of CP-recursion and its relevance to the Germanic verb-second phenomenon. *Working papers in Scandinavian syntax 50*, 1–24.

Isaacs, James & Kyle Rawlins. 2008. Conditional questions. *Journal of Semantics 25*, 269–319.

Izvorski, Roumyana. 1996. The syntax and semantics of correlative proforms. In Kiyomi Kusumoto (Ed.), *Proceedings of NELS 26*, pp. 133–147. Amherst: GLSA Publications.

Jacobson, Pauline. 1995. On the quantificational force of English free relatives. In Bach et al. (1995), pp. 451–486.

Jacobson, Pauline. 1999. Towards a variable-free semantics. *Linguistics and Philosophy 22*, 117–184.

Janssen, Theo M.V. 1997. Compositionality. In Johan van Bentham & Alice ter Meulen (Eds.), *Handbook of logic and linguistics*, pp. 417–473. Amsterdam: Elsevier.

Kamp, Hans. 1971. Formal properties of 'now'. *Theoria 37*, 227–274.

Kamp, Hans. 1981. A theory of truth and semantic representation. In Jeroen Groenendijk, T. Janssen, & M. Stokhof (Eds.), *Formal methods in the study of language*, pp. 277–322. Amsterdam: Mathematical Centre.

Kanazawa, Makoto. 1994. Weak vs. strong readings of donkey sentences in a dynamic setting. *Linguistics and Philosophy 17*, 109–158.

Kaplan, David. 1989. Demonstratives. In Joseph Almog, John Perry, & Howard Wettstein (Eds.), *Themes from Kaplan*, pp. 481–563. Oxford: Oxford University Press.

Karttunen, Lauri. 1977. Syntax and semantics of questions. *Linguistics and Philosophy 1*, 3–44.

Kayne, Richard. 1991. Romance clitics, verb movement, and PRO. *Linguistic Inquiry 22*, 647–686.

Kayne, Richard. 1994. *The antisymmetry of syntax*. Cambridge: MIT Press.

Kennedy, Christopher. 2014. Predicates *and* formulas: Evidence from ellipsis. In Luka Crnič & Uli Sauerland (Eds.), *The art and craft of semantics: A festschrift for Irene Heim*, vol. 1, MITWPL 70, pp. 253–277. MITWPL.

King, Jeffrey C. 1994. Anaphora and operators. *Philosophical Perspectives 8*, 221–250.

King, Jeffrey C. 2004. Context dependent quantifiers and donkey anaphora. *Canadian Journal of Philosophy 34 (supplement 1)*, 97–127.

Kobele, Greg. 2010. Inverse linking via function composition. *Natural Language Semantics 18*, 183–196.

Kolodny, Niko & John MacFarlane. 2010. Ifs and oughts. *Journal of Philosophy* pp. 115–143.

Kotek, Hadas. 2014. *Composing questions*. Ph.D. thesis, MIT.

Kratzer, Angelika. 1977. What 'must' and 'can' must and can mean. *Linguistics and Philosophy 1*, 337–355.

Kratzer, Angelika. 1981. The notional category of modality. In Hans-Jürgen Eikmeyer & Hannes Rieser (Eds.), *Words, worlds, and contexts: New approaches in word semantics*, pp. 38–74. Berlin: de Gruyter.

Kratzer, Angelika. 1991. Modality/Conditionals. In Arnim von Stechow & Dieter Wunderlich (Eds.), *Semantics: An international handbook of contemporary research*, pp. 639–656. New York: de Gruyter.

Kratzer, Angelika. 1995. Stage-level and individual-level predicates. In Gregory N. Carlson & Francis Jeffrey Pelletier (Eds.), *The generic book*, pp. 125–175. Chicago: University of Chicago Press.

Kratzer, Angelika. 1998. Scope or pseudoscope? Are there wide-scope indefinites. In S. Rothstein (Ed.), *Events and grammar*, pp. 163–196. Dordrecht: Kluwer Academic Publishers.

Kratzer, Angelika & Junko Shimoyama. 2002. Indeterminate pronouns: The view from Japanese. In Y. Otsu (Ed.), *Proceedings of the Third Tokyo Conference on Psycholinguistics*. Tokyo: Hituzi Syobo.

Kusumoto, Kiyomi. 2005. On the quantification over times in natural language. *Natural Language Semantics 13*, 317–357.

Larson, Richard. 1985. On the syntax of disjunction scope. *Natural Language and Linguistic Theory 3*, 217–264.

Lasersohn, Peter. 1996. Adnominal conditionals. In Teresa Galloway & Justin Spence (Eds.), *Proceedings of SALT 6*, pp. 154–166. Ithaca, N.Y.: CLC Publications.

Lasnik, Howard & Tim Stowell. 1991. Weakest crossover. *Linguistic Inquiry 22*, 687–720.

Leung, Tommi Tsz-Cheung. 2009. On the matching requirement in correlatives. In Lipták (2009a), pp. 309–341.

Lewis, David. 1975. Adverbs of quantification. In Edward L. Keenan (Ed.), *Formal semantics of natural language*, pp. 3–15. Cambridge: Cambridge University Press.

Lewis, David. 1980. Index, context, and content. In Stig Kanger & Helle Ohman (Eds.), *Philosophy and grammar*, pp. 79–100. Holland: D. Reidel.

Link, Godehard. 1983. The logical analysis of plurals and mass terms: A lattice-theoretical approach. In Paul Portner & Barbara H. Partee (Eds.), *Formal semantics: The essential readings*, pp. 127–146. Malden: Blackwell.

Lipták, Anikó (Ed.). 2009a. *Correlatives cross-linguistically*. Amsterdam: John Benjamins.

Lipták, Anikó. 2009b. The landscape of correlatives: An empirical and analytical survey. In Lipták (2009a), pp. 1–46.

Lipták, Anikó. 2012. Correlative topicalization. *Acta Linguistica Hungarica 59*, 245–302.

Lycan, William. 2001. *Real conditionals*. New York: Oxford University Press.

MacFarlane, John. 2014. *Assessment sensitivity: Relative truth and its applications*. Oxford: Clarendon Press.

May, Robert. 1985. *Logical form*. Cambridge: MIT Press.

Montague, Richard. 1970. English as a formal language. In Richmond H. Thomason (Ed.), *Formal philosophy*, pp. 188–221. New Haven: Yale University Press.

Ninan, Dilip. 2012. Counterfactual attitudes and multi-centered worlds. *Semantics and Pragmatics 5*, 1–57.

Nyvad, Anne Mette, Ken Ramshøj Christensen, & Sten Vikner. 2017. CP-recursion in Danish: A cP/CP-analysis. *The Linguistic Review 34*, 449–477.

Partee, Barbara. 1975. Montague grammar and transformational grammar. *Linguistic Inquiry 6*, 203–300.

Partee, Barbara H. 1973. Some structural analogies between tenses and pronouns in English. In *Compositionality in formal semantics*, pp. 50–58. Malden: Blackwell.

Partee, Barbara H. 1984. Nominal and temporal anaphora. *Linguistics and Philosophy 7*, 243–286.

Partee, Barbara H. 1995. Quantificational structures and compositionality. In Bach et al. (1995), pp. 541–602.

Partee, Barbara H. & Mats Rooth. 1983. Generalized conjunction and type ambiguity. In Rainer Bäuerle, Christoph Schwarze, & Arnim von Stechow (Eds.), *Meaning, use, and interpretation of language*, pp. 361–383. Berlin: de Gruyter.

Patel-Grosz, Pritty & Patrick Grosz. 2010. On the typology of donkeys: Two types of anaphora resolution. In Martin Prinzhorn, Viola Schmitt, & Sarah Zobel (Eds.), *Proceedings of Sinn und Bedeutung 14*, pp. 339–355. Vienna: University of Vienna.

Percus, Orin. 2000. Constraints on some other variables in syntax. *Natural Language Semantics 8*, 173–229.

Percus, Orin & Uli Sauerland. 2003. On the LFs of attitude reports. In Matthias Weisgerber (Ed.), *Proceedings of Sinn und Bedeutung 7*, pp. 228–242. Konstanz: Universität Konstanz.

Perry, John. 2001. *Reference and reflexivity*. Stanford: CSLI Publications.

Pesetsky, David. 2000. *Phrasal movement and its kin*. Cambridge: MIT Press.

Quine, Willard Van Orman. 1960. *Word and object*. Cambridge: MIT Press.

Rabern, Brian. 2012. Monsters in Kaplan's logic of demonstratives. *Philosophical Studies* pp. 1–12.

Rawlins, Kyle. 2008. *(Un)conditionals: An investigation in the syntax and semantics of conditional structures*. Ph.D. thesis, University of California, Santa Cruz.

Reinhart, Tanya. 1983. *Anaphora and semantic interpretation*. Chicago: University of Chicago Press.

Reinhart, Tanya. 1987. Specifier and operator binding. In Eric J. Reuland & Alice G.B. ter Meulen (Eds.), *The representation of (in)definiteness*, pp. 130–167. Cambridge: MIT Press.

Reinhart, Tanya. 1997. Quantifier scope: How labor is divided between QR and choice functions. *Linguistics and Philosophy 20*, 335–397.

Safir, Ken. 1999. Vehicle change and reconstruction in ā-bar chains. *Linguistic Inquiry 30*, 587–620.

Santorio, Paolo. 2010. Modals are monsters: On indexical shift in English. In Nan Li & David Lutz (Eds.), *Proceedings of SALT 20*, pp. 289–308. Ithaca, N.Y.: CLC Publications.

Santorio, Paolo. 2012. Reference and monstrosity. *Philosophical Review 121*, 359–406.

Sauerland, Uli. 2003. Unpronounced heads in relative clauses. In Kerstin Schwabe & Susanne Winkler (Eds.), *The interfaces: Deriving and interpreting omitted structures*, pp. 205–226. Amsterdam: John Benjamins.

Schein, Barry. 2003. Adverbial, descriptive reciprocals. *Philosophical Perspectives 17*, 333–367.

Schlenker, Philippe. 2003. A plea for monsters. *Linguistics and Philosophy 26*, 29–120.

Schlenker, Philippe. 2004. Conditionals as definite descriptions (A referential analysis). *Research on Language and Computation 2*, 417–462.

Schlenker, Philippe. 2006. Ontological symmetry in language: A brief manifesto. *Mind and Language 21*, 504–539.

Schlenker, Philippe. 2009. Local contexts. *Semantics and Pragmatics 2*, 1–78.

Schlenker, Philippe. 2010. Local contexts and local meanings. *Philosophical Studies 151*, 115–142.

Schmitt, Cristina. 2000. Some consequences of the complement analysis for relative clauses, demonstratives and the wrong adjectives. In Artemis Alexiadou, Paul Law, André Meinunger, & Chris Wilder (Eds.), *The syntax of relative clauses*, pp. 309–348. Amsterdam: John Benjamins.

Schwabe, Kerstin. 2016. Sentential proforms and argument conditionals. In Werner Frey, André Meinunger, & Kerstin Schwabe (Eds.), *Inner-sentenial propositional proforms: Syntactic properties and interpretive effects*, pp. 211–240. Amsterdam: John Benjamins.

Schwarzschild, Roger. 1996. *Pluralities*. Dordrecht: Kluwer.

Silk, Alex. 2013. Deontic conditionals: Weak and strong. In *Proceedings of the 19th International Congress of Linguists*. Département de Linguistique de l'Université de Genève. URL `http://goo.gl/xSGbcJ`.

Silk, Alex. 2014a. Accommodation and negotiation with context-sensitive expressions. *Thought 3*, 115–123.

Silk, Alex. 2014b. Evidence sensitivity in weak necessity deontic modals. *Journal of Philosophical Logic 43*, 691–723.

Silk, Alex. 2016. *Discourse Contextualism: A framework for contextualist semantics and pragmatics*. Oxford: Oxford University Press.

Silk, Alex. 2017. How to embed an epistemic modal: Attitude problems and other defects of character. *Philosophical Studies 174*, 1773–1799.

Speas, Margaret & Carol Tenny. 2003. Configurational properties of point of view roles. In Anna Maria Di Scuillo (Ed.), *Asymmetry in grammar*, pp. 315–344. Amsterdam: John Benjamins.

Sportiche, Dominique. 2006. Reconstruction, binding, and scope. In Martin Everaert & Henk van Riemsdijk (Eds.), *The Blackwell companion to syntax*, vol. 4, pp. 35–93. Oxford: Blackwell.

Srivastav, Veneeta. 1991. The syntax and semantics of correlatives. *Natural Language and Linguistic Theory 9*, 637–686.

Stalnaker, Robert. 1970. Pragmatics. In Stalnaker (1999), pp. 31–46.

Stalnaker, Robert. 1978. Assertion. In Stalnaker (1999), pp. 78–95.

Stalnaker, Robert. 1988. Belief attribution and context. In Stalnaker (1999), pp. 150–166.

Stalnaker, Robert. 1999. *Context and content: Essays on intentionality in speech and thought*. Oxford: Oxford University Press.

Stalnaker, Robert. 2014. *Context*. New York: Oxford University Press.

Stanley, Jason. 1997. Names and rigid designation. In Bob Hale & Crispin Wright (Eds.), *A companion to the philosophy of language*, pp. 555–585. Oxford: Blackwell.

Stanley, Jason. 2002. Nominal restriction. In Gerhard Preyer & Georg Peter (Eds.), *Logical form and language*, pp. 365–388. Oxford: Oxford University Press.

Stanley, Jason & Zoltán Gendler Szabó. 2000. On quantifier domain restriction. *Mind and Language 15*, 219–261.

Starr, William. 2010. *Conditionals, meaning, and mood*. Ph.d. thesis, Rutgers University.

von Stechow, Arnim. 2008. Tense, modals, and attitudes and verbal quantifiers. Paper presented at ESSLLI 2008.

Stephenson, Tamina. 2007. Judge dependence, epistemic modals, and predicates of personal taste. *Linguistics and Philosophy 30*, 487–525.

Sternefeld, Wolfgang. 1998. The semantics of reconstruction and connectivity. In *Arbeitspapier des SFB 340 97*, pp. 1–58. Universität Tübingen.

Sternefeld, Wolfgang. 2001. Partial movement constructions, pied piping, and higher order choice functions. In Caroline Féry & Wolfgang Sternefeld (Eds.), *Audiatur vox sapientiae: A festschrift for Arnim von Stechow*, pp. 473–486. Berlin: Akademie Verlag.

Sudo, Yasutada. 2012. *On the semantics of phi features on pronouns*. Ph.D. thesis, MIT.

Swanson, Eric. 2010. On scope relations between quantifiers and epistemic modals. *Journal of Semantics 27*, 529–540.

Swanson, Eric. 2011. Propositional attitudes. In Claudia Maienborn, Klaus von Heusinger, & Paul Portner (Eds.), *Semantics: An International Handbook of Natural Language Meaning*, vol. 2, pp. 1538–1560. Berlin: de Gruyter.

Tonhauser, Judith, David Beaver, Craige Roberts, & Mandy Simons. 2013. Towards a taxonomy of projective content. *Language 89*, 66–109.

Vikner, Sten. 1995. *Verb movement and expletive subjects in the Germanic languages*. New York: Oxford University Press.

de Vries, Mark. 2002. *The syntax of relativization*. Ph.D. thesis, University of Amsterdam.

Ward, Gregory, Richard Sproat, & Gail McKoon. 1991. A pragmatic analysis of so-called anaphoric islands. *Language 67*, 439–473.

Yalcin, Seth. 2007. Epistemic modals. *Mind 116*, 983–1026.

Yalcin, Seth. 2012. A counterexample to modus tollens. *Journal of Philosophical Logic 41*, 1001–1024.

Yalcin, Seth. 2014. Semantics and metasemantics in the context of generative grammar. In Alexis Burgess & Brett Sherman (Eds.), *Metasemantics: New essays on the foundations of meaning*, pp. 17–54. Oxford: Oxford University Press.