Semantics with assignment variables

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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 object-language variables for assignment functions into the syntax; semantic values are treated systematically in terms of sets of assignments, now included 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 distinctive 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. Interrogative sentences denote a partition of possible answers, with answers conceived as sets of assignments (possibilities). 'If'-clauses are treated as free relatives/correlatives, interpreted as plural definite descriptions of assignments. Headed restrictive relative clauses are treated as complements of the matrix determiner, which introduces quantification over assignments. A unified analysis of *wh*-words, relative determiners, and indefinites as choice-function pronouns is provided. Various additional linguistic shifting phenomena are compositionally derived, e.g. concerning "interrogative flip," indexical shift, information-sensitivity, and donkey anaphora. A speculative treatment of several further recalcitrant cases of pronominal anaphora, such as with inverse linking and genitive binding, along with associated weak crossover effects, is briefly considered. The accounts avoid introducing additional interpretive principles and composition rules such as for quantification, binding, movement (e.g. Predicate Abstraction, Predicate Modification, Trace Conversion). The semantics is fully compositional; semantic composition proceeds via function application.

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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: [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. 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. The intuitive idea is that whereas (e.g.) the second 'it' in (3) is interpreted in the discourse context, the first 'it' is interpreted in the context representing (what is presupposed to be) Phoebe's beliefs (Stalnaker 1988: 158–159). Hence the belief being ascribed isn't necessarily false.

(3) [Context: We're talking about Russell's yacht.]
Phoebe believes it is longer than it is.

Swanson (2011) suggests extending Stalnaker's ideas to the interpretation of the two occurrences of 'London' in (4), where the proposition presupposed and not realized by "Puzzling Pierre" aren't necessarily true (Kripke 1979).

(4) Pierre doesn't realize that London is London. (Swanson 2011: ex. 34)

Stalnaker doesn't offer a specific technical implementation 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, the first 'it' in (3) would combine with a context-variable linked to the attitude state, and the second 'it' would combine with a context-variable linked to the discourse. 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 (6) characterizes the subject's information, 'she' in (5) is infelicitous if its gender implication isn't accepted in the discourse.[3]

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

a. $\not\approx$Al thinks $g(j)$ is a woman and is smart. (*global reading obligatory*)

(6) Alice thinks it might be raining.

a. $\not\approx$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).

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

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

b. $\approx$ Pete thinks Al is at a bar local to Pete (*local reading*)

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

(8) 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*)

(9) 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 a **non-syncategorematic treatment of quantification**
- posits **no added parameters** and **no special composition rules** beyond function application

- **unifies seemingly disparate shifting phenomena** — ordinary quantification, intensionality, local/global readings — 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: I develop the account in stages, beginning with a simple version of an assignment-variable-based account and complicating it in stages in light of particular phenomena. §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, interrogative sentences (§6), various types of conditionals, including bare and modalized conditionals and conditional questions (§7), and *wh*-words, indefinites, and donkey pronouns in interrogatives and relative clauses (§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. Interrogative sentences denote a partition of possible answers, with answers conceived as sets of assignments (possibilities) (§6). 'If'-clauses are treated as free relatives/correlatives, interpreted as plural definite descriptions of assignments (§7). Headed restrictive relative clauses are treated as complements of the matrix determiner, which introduces quantification over assignments (§8). The examination of conditionals motivates a general adjustment to the compositional semantics of complementizers and modals from the earlier sections, specifically regarding their semantic types. Derivations of various additional linguistic shifting phenomena are provided, as concerning local readings in questions and conditionals, information-sensitivity, and donkey anaphora. Applications to further binding phenomena with pronouns, including inverse linking, genitive binding, and weak crossover effects, are also briefly considered. Certain features of the treatments of interrogatives, 'if'-clauses, and relative clauses, in these sections are of general interest, independent of the particular assignment-variable-based implementation — e.g., a formalization of "interrogative flip" in questions; with conditionals, diagnoses of biscuit vs. hypothetical interpretations, apparent single- vs. double-modal readings, indexical shift, and conditional questions; a compositional treatment of relative clauses which avoids additional composition rules or interpretive principles (Predicate Abstraction, Predicate Modification, Trace Conversion); a unified analysis of *wh*-words, relative determiners, and indefinites; a distinction between trace-binding and pronoun-binding, with potential applications to crossover; and an analysis of various types of apparent binding out of DPs such as donkey anaphora.

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.)

(10) **Models** $\mathcal{M}$:

- E: set of entities
- T: set of truth-values, $\{0, 1\}$

– W: set of worlds
– G: set of assignments

Formally, an **assignment** $g \in G$ is a function from typed indices $\langle n, \tau \rangle$ to elements in the model. Theoretically, I treat assignments as representing a **possibility**. This interpretation is in keeping with common talk of "contextually determined" assignments g_c 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 g_c mapping the 7th individual position $\langle 7, e \rangle$ 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 standard 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 $G \to T$ from assignments to truth-values become type t, functions $G \to E$ from assignments to entities become type e, etc. Let the set of assignments be its own domain, type g, and let functions from assignments to assignments be type a.

(11) **Domains / Semantic types:**
– $D_e = E^G$
– $D_t = \{0, 1\}^G$
– $D_s = W^G$
– $D_a = G^G$
– $D_g = G$
– $D_{\tau\sigma} = D_\sigma^{D_\tau}$

Unlike previous accounts introducing semantic types for assignments (§1), I let the object-language include **variables for assignments**. I treat the denotations of all variables as involving functions from assignments to items in the model. A natural preliminary idea would be to identify variable denotations with functions from assignments to "lowered" 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 $g(\mathrm{i}e) \in E$.[4] Nodes combining variables would combine via function composition — e.g., composing an assignment-variable

[4] 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 often abbreviate $\langle i, \tau \rangle$ with $i\tau$ when writing subscripts on traces (e.g. $\mathbf{t_{1e}}$) and arguments of assignments (e.g. $g(1e)$).

denotation (function $a : G \rightarrow G$) with an individual-variable denotation (function $x : G \rightarrow E$) to yield a function $G \rightarrow E$, $\lambda g_g.x(a(g))$ — e.g. $[\![\mathbf{o}_1\ \mathbf{g}_1]\!] = [\![\mathbf{o}_1]\!] \circ [\![\mathbf{g}_1]\!] = \lambda g_g.g(1a)(1e)$.

Such a move may suffice for variables of basic types, but it won't generalize to variables for complex types. For instance, if a variable $\mathbf{p_i}$ for a set of worlds denoted a function $G \rightarrow 2^W$, $\lambda g_g.g(\mathrm{i}st)$, the result of combining it via function composition with an assignment-variable wouldn't be an object of type $\langle s, t\rangle$ (indeed it wouldn't even have a well-defined semantic type). The resulting semantic value $[\![\mathbf{p_i}\ \mathbf{g_j}]\!]$ thus wouldn't be suitable to combine with (say) an expression requiring a function $\lambda w_s.\lambda g_g \ldots$ in D_{st}.

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 all semantic composition (with variables or otherwise) as proceeding via **function application**. Variables $\mathbf{v}_{\mathbf{i}\alpha}$ for basic non-assignment types α denote functions $[\![\mathbf{v}_{\mathbf{i}\alpha}]\!] \in D_{a\alpha}$ such that for any a_a, g_g, $[\![\mathbf{v}_{\mathbf{i}\alpha}]\!](a)(g) = a(g)(\mathrm{i}\alpha)$ — so, e.g., $[\![\mathbf{o}_1\ \mathbf{g}_1]\!] = [\![\mathbf{o}_1]\!]([\![\mathbf{g}_1]\!]) = \lambda g_g.g(1a)(1e)$, yielding the same result as above. Variables of complex types may be defined via a "down"-style operator $^{\downarrow}$ which maps an element of a domain to an item composed out of the associated "lowered" elements of the model:

(12) a. For β of basic type $\beta \in \{e, s, t, a\}$, ${}^{\downarrow}\beta_\beta = \lambda g_g.(\beta(g))(g)$.

b. For σ type $\sigma = \langle \sigma_n, \langle \ldots, \sigma_0 \rangle \cdots \rangle$, ${}^{\downarrow}\sigma_\sigma$ is defined by the condition ${}^{\downarrow}\sigma({}^{\downarrow}\sigma_n) \ldots ({}^{\downarrow}\sigma_1) = \sigma(\sigma_n) \ldots (\sigma_1)(g)$.

For instance, for $x \in D_e$, ${}^{\downarrow}x$ is the $o \in E$ that is the image under x of the given g — i.e., ${}^{\downarrow}x = x(g)$. For $f \in D_{\langle e,t\rangle}$, ${}^{\downarrow}f$ is the function $E \rightarrow T$ such that for any x_e, ${}^{\downarrow}f({}^{\downarrow}x) = {}^{\downarrow}f(x(g)) = f(x)(g)$; for $J \in D_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}$, ${}^{\downarrow}J({}^{\downarrow}f)({}^{\downarrow}x) = J(f)(x)(g)$; and so on. The denotations of variables $\mathbf{v}_{\mathbf{i}\sigma}$ of complex types $\sigma = \langle \sigma_n, \langle \ldots, \sigma_0 \rangle \cdots \rangle$ can be defined accordingly as functions $[\![\mathbf{v}_{\mathbf{i}\sigma}]\!] \in D_{a\sigma}$ such that $[\![\mathbf{v}_{\mathbf{i}\sigma}]\!](a)(\sigma_n) \ldots (\sigma_1)(g) = a(g)(\mathrm{i}\sigma)({}^{\downarrow}\sigma_n) \ldots ({}^{\downarrow}\sigma_1)$. 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 $w_s, g_g, g(1a)(2st)({}^{\downarrow}w) = g(1a)(2st)(w(g))$; 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 $f_{\langle e,t\rangle}$, g_g, $g(1a)(1ete)({}^{\downarrow}f)$ is the selected $o \in E$ in (the characteristic set of) ${}^{\downarrow}f$, where ${}^{\downarrow}f$ is the function $E \rightarrow T$ such that ${}^{\downarrow}f(x(g)) = f(x)(g)$, for any x_e; and so on. I treat the semantic values of traces equivalently yet lacking the initial type a argument — e.g., $[\![\mathbf{t}_{\mathbf{1e}}]\!] = \lambda g_g.g(1e)$. For σ type $\langle \sigma_n, \langle \ldots, \sigma_0 \rangle \cdots \rangle$, σ_k a (metalanguage) variable of type σ_k, trace $\mathbf{t}$, and pronoun variable $\mathbf{v}$:

(13) $[\![\mathbf{v}_{\mathrm{i}\sigma}]\!] = \lambda a_a.\lambda\sigma_n \ldots \sigma_1.\lambda g_g \,.\, a(g)(\mathrm{i}\sigma)(^{\downarrow}\sigma_n)\ldots(^{\downarrow}\sigma_1)$

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

b. $[\![\mathbf{g}_{\mathrm{i}}]\!] = \lambda g_g \,.\, g(\mathrm{i}a)$

(14) $[\![\mathbf{t}_{\mathrm{i}\sigma}]\!] = \lambda\sigma_n \ldots \sigma_1.\lambda g_g \,.\, g(\mathrm{i}\sigma)(^{\downarrow}\sigma_n)\ldots(^{\downarrow}\sigma_1)$

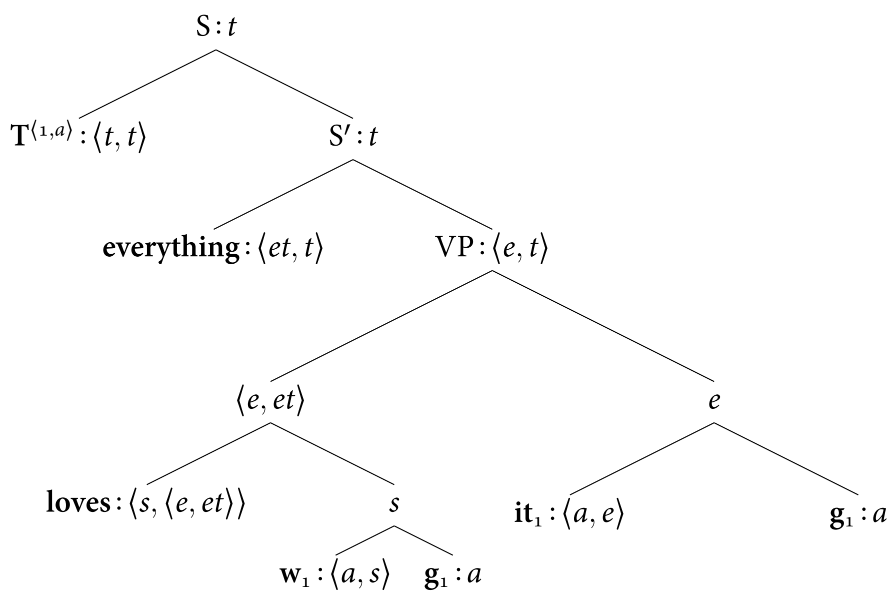
a. For $\beta \in \{e, s, t, a\}$, $[\![\mathbf{t}_{\mathrm{i}\beta}]\!] = \lambda g_g \,.\, g(\mathrm{i}\beta)$

(Variables of basic types could be understood degenerately where $n = 0$. Since all denotations involve functions from assignments, variables **g** for assignments are type a (functions $G \to G$); there are no denotations of type g.)

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 (15) with a free pronoun and subject-position quantifier (see n. 4). (**T** is an assumed topmost assignment-binder; see below. For space purposes I leave intermediate calculations to the reader.)[5]

(15) Everything loves it.



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

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

[5]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 important result of §4 will be an improved definition of metalanguage expressions of assignment-modification.

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

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

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

$$\begin{aligned}[\![S']\!] &= [\![\textbf{everything}]\!]\big([\![\textbf{loves}]\!]([\![\mathbf{w}_1]\!]([\![\mathbf{g}_1]\!]))([\![\mathbf{it}_1]\!]([\![\mathbf{g}_1]\!]))\big)\\ &= \lambda g_g.\forall x_e{:}\,x(g) \text{ loves } g(1a)(1e) \text{ in } g(1a)(1s)\end{aligned}$$

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

$$\begin{aligned}&S \text{ is true in } c \text{ iff } [\![S]\!](g_c)\\ &\quad\text{iff } \forall x_e{:}\,x(g_c[g_c/1a]) \text{ loves } g_c(1e) \text{ in } g_c(1s)\end{aligned}$$

Several remarks: 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 maps (non-assignment) 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 (cf. Percus 2000, von Fintel & Heim 2011). In more complex examples, alternative local/global readings will be reflected in different coindexings on assignment variables (local vs. long-distance binding). A principal result of §3 will be to derive denotations for binder expressions, like $\mathbf{T}^{\langle i,a\rangle}$, from basic lexical entries and a generalized binder-index $^{\langle i,\tau\rangle}$.

A more complex clausal architecture will be provided in §3. Among other differences, the world argument of a clause's main predicate will be supplied by a world-trace, rather than by a world+assignment-variable complex. 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. (We'll revisit this assumption in §§3.3, 8.)

Although the **metalanguage quantification** is over functions $x_e{:}\,G \to E$, the items in terms of which the condition is stated are *images* of the given assignment g under x, i.e. objects $o \in E$ 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 $\forall x_e{:}\, P(x)(g_c)$ in (15) is satisfied iff regardless of which such function we look at, its value $o \in E$ loves the contextually relevant individual, e.g. 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 represented by 1.

3 Syntax and semantics: Standardizing quantification

Adding assignment variables to the object-language raises non-trivial issues in 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 shifted/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.[6]

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,

[6]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).

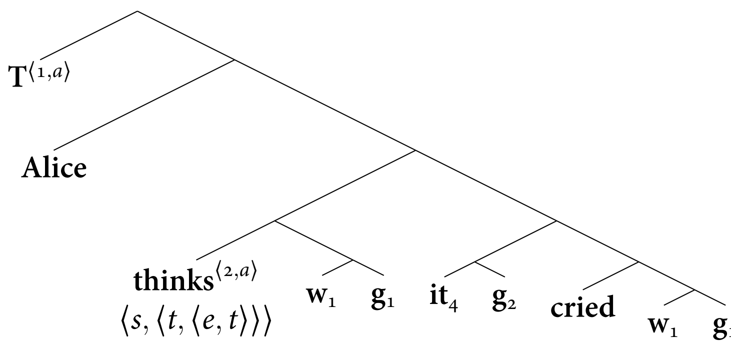
(i) $[\![\textbf{think}^{\langle i,a\rangle}]\!] = \lambda w_s.\lambda T_t.\lambda x_e.\lambda g_g\,.\ \forall g' \in Dox(x(g), w(g)){:}\ T(g[g'/\langle i,a\rangle])$

Such a lexical entry contrasts with lexical entries for determiner quantifiers ((15)), 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.

nothing would seem to exclude a structure/interpretation such as (16), 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.

(16) Alice thinks it cried.

a.



b. (16) $\not\approx$ for every assignment g' representing a possibility compatible with Alice's beliefs in the actual world ($=g_c(1s)$), the individual $o \in E$ represented with 4 by g' ($=g'(4e)$) 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.

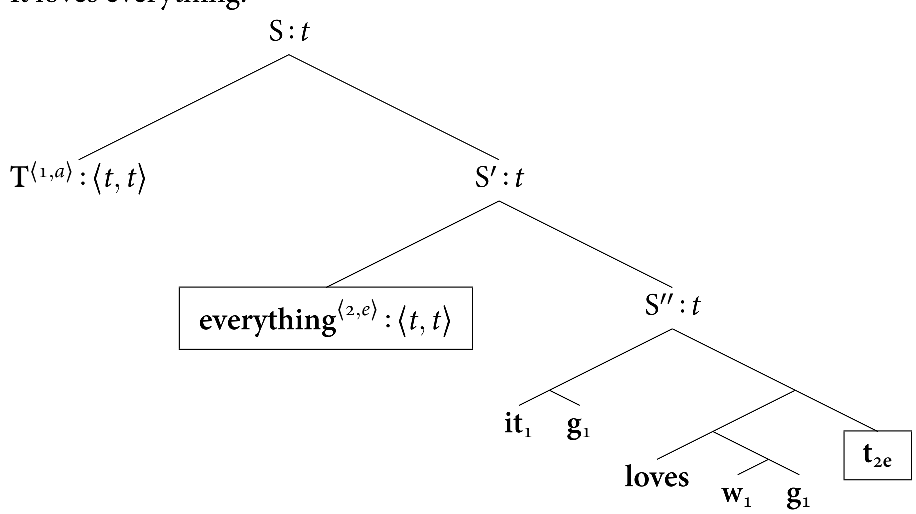
Preamble (=rant) over; the proof of the pudding is in the lambdas and whatnot, so let us proceed.

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:[7]

(17) It loves everything.



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

Preliminary type-specific denotation for the binder-index:

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

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

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

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

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

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

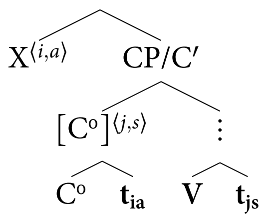
Roughly, the binder-index combines with the quantifier so that the quantifier's scope argument becomes the set of individuals that make the proposition $[\![S'']\!]$ true when returned as value for $2e$.[8]

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. 7):[9]

[8] 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.

[9] I sometimes 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 leave open the specific syntactic location of the topmost assignment-binder, e.g. whether it is in SpecCP or heads its own projection, perhaps in some extended projection of the CP-layer such as ForceP.

(18)



The complementizer introduces world-quantification/binding, i.e. intensionality; modals, broadly construed (n. 9), 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 & Iatridou 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.

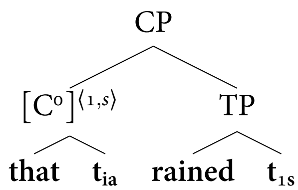
3.3 World-binding: Complementizer

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, $g_c(1s)$, 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 g to the world of the possibility represented by g. I offer (19) as a lexical entry for (possibly unpronounced) 'that'.[10]

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

[10] We will revisit the semantic types and compositional semantics for complementizers and modal elements in §7. More on the metasemantics of world-indices in §8.1.

(20)



Roughly put, (19) treats a CP 'that S' as relating the set of S-worlds to some further modal domain; (20) 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 (19) 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 treated as 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 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, i.e. the identity function; 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:

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

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

(23) $[\![\mathbf{think}]\!] = \lambda w_s.\lambda A_{\langle a,t\rangle}.\lambda x_e.\lambda g_g\,.$ for all 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 (22) 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. As usual, the meaning for 'think' in (23) proceeds analogously, yet lexically specifying the set of possibilities being quantified over. Roughly put, (23) treats a belief ascription as saying that the complement is true throughout the modal domain determined by the set of possibilities (assignments) compatible with the subject's state of mind (derivation below).

It's a substantive question what it is for an assignment 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 & 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).[11]

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**, given the identification of a with the identity function, the main clause is evaluated at a singleton set, $\{@\,(a(g))\} = \{@\,(g)\}$, i.e. the world of the input 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 (24) — where τ is (a variable for) the type of what is being quantified over, σ is (a variable for) the type of the mother node (i.e. the result of combining the binding expression with its scope argument), and $\gamma_1 \ldots \gamma_n$ are optional (variables for) types of any intermediate arguments. Roughly put, the binder-index $^{\langle i,\tau \rangle}$ takes an expression α that quantifies over items of type

[11]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.

τ (e.g. individuals/worlds/assignments), and it lets α combine with its scope β by feeding α the set of τ-type items that verify β when returned for $\langle i, \tau \rangle$.

(24) *Generalized binder-index*
$[\![^{\langle i,\tau\rangle}]\!] = \lambda\alpha_{\langle\langle\tau,\langle_1\gamma_1\cdots\gamma_n,t\rangle_1\cdots\rangle_n\rangle,\sigma\rangle} . \lambda\beta_{\langle_1\gamma_1\cdots\gamma_n,t\rangle_1\cdots\rangle_n} .$
$\alpha\Big(\lambda\tau.\lambda\gamma_1\cdots\lambda\gamma_n.\lambda g\,.\,\beta(\gamma_1)\cdots(\gamma_n)(g[{\downarrow}\tau/\mathrm{i}\tau])\Big)$

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

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

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

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. 8). 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.

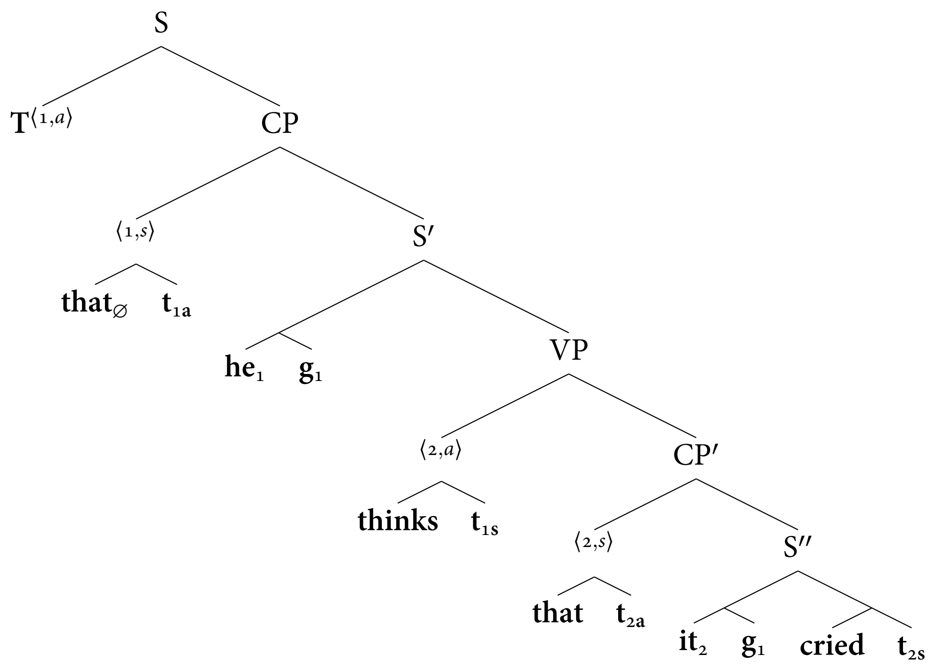
4 Examples

4.1 Attitude Ascription: Intensionality, local/global readings

Start with a simple attitude ascription such as (28) with a "free" (global) reading of an embedded pronoun. (I write '$\textbf{that}_\varnothing$' for an unpronounced complementizer assumed to head the main clause. For readability I suppress certain irrelevant assignment modifications, indicated with '≈'. I abbreviate '*o*'s state of mind in *u*' with '$\mathrm{SOM}_{o,u}$'.

For space purposes I leave intermediate calculations to the reader; see notes.)[12]

(28) He thinks that it cried.



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

---

[12]Semantic values for certain relevant lower spinal nodes are given in (i). (See (15), (17), (19)–(27) for relevant lexical entries and derived denotations for the binding expressions.)

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

$$
\begin{aligned}
[\![\mathrm{VP}]\!] &= [\![[\textbf{think}\ \mathbf{t}_{1s}]^{\langle 2,a\rangle}]\!]([\![\mathrm{CP}']\!])\\
&= \big[\lambda x_e.[\lambda g_g\,.\ \text{for all } a \text{ s.t. } a(g) \text{ is compatible with } \mathrm{SOM}_{x(g),\,g(1s)},\\
&\qquad \forall w \text{ s.t. } w(g[a(g)/2a]) = @(a(g[a(g)/2a])),\\
&\qquad g[a(g)/2a][w(g[a(g)/2a])/2s](1a)(2e) \text{ cried in } w(g[a(g)/2a])]\big]
\end{aligned}
$$

$$
\begin{aligned}
[\![\mathrm{CP}]\!] &= [\![[\textbf{that}_\varnothing\ \mathbf{t}_{1a}]^{\langle 1,s\rangle}]\!]\big([\![\mathrm{VP}]\!](\lambda g'_g.g'(1a)(1e))\big)\\
&= \lambda g_g\,.\ \forall w' \text{ s.t. } w'(g) = @(g(1a)),\ [\![\mathrm{VP}]\!](\lambda g'_g.g'(1a)(1e))(g[w'(g)/1s])
\end{aligned}
$$

That is, roughly put: (28) is true in c, $[\![S]\!](g_c)$, iff $g_c(1e)$ cried in the world of every possibility compatible with $g_c(1e)$'s state of mind in $@(g_c)$.

Parallel to the movement of the object-position quantifier in (17), 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, $[\textbf{that}\ \mathbf{t_{2a}}]^{\langle 2,s\rangle}$. 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 $g[a'(g)/1a](1a)(2e) = a'(g)(2e) = g(2e)$).[13]

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 $w(\underline{g})$" 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.

[13] 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.

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

(28) highlights a contrast between **pronouns and traces** in the system.[14] I return to issues with pronominal anaphora, trace-/pronoun-binding, and weak crossover in §§8.3–8.4.1. 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: (29) cannot receive the interpretation in (30).

(29) Alice thinks a friend of mine won.

(30) (29) $\not\approx$

a. there is a winner that Alice thinks is a friend of mine
b. for all w' compatible with Alice's beliefs in w, some x who <u>won in w</u> is a friend of mine in w'

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 (29) — should receive **optional local/global readings**.[15]

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

$[\![\mathbf{FoM}]\!] = \lambda w_s.\lambda x_e\,.\,x(g)$ 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.

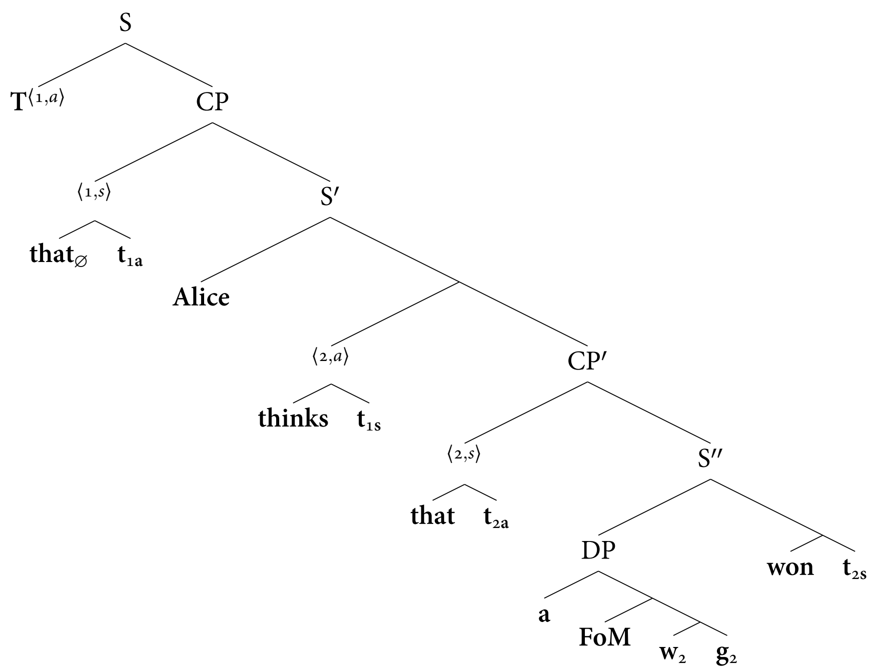
Non-specific de dicto readings are captured via structures involving *local binding* of the embedded world-pronoun, as in (32). Specific de re readings are captured via structures where the DP is *raised*, hence local = global binding, as in (33):[16]

[14] 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.

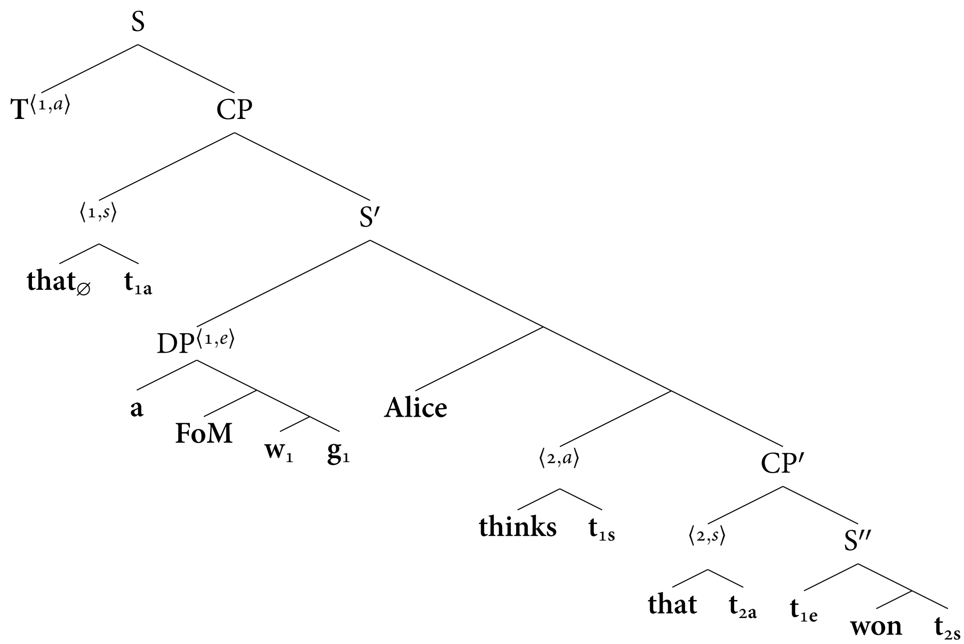
[15] I bracket potential additional structure from quantifier domain variables (von Fintel 1994, Stanley & Szabó 2000).

[16] Though see 8.2.2 for discussion of alternative treatments of specific readings with indefinites.

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

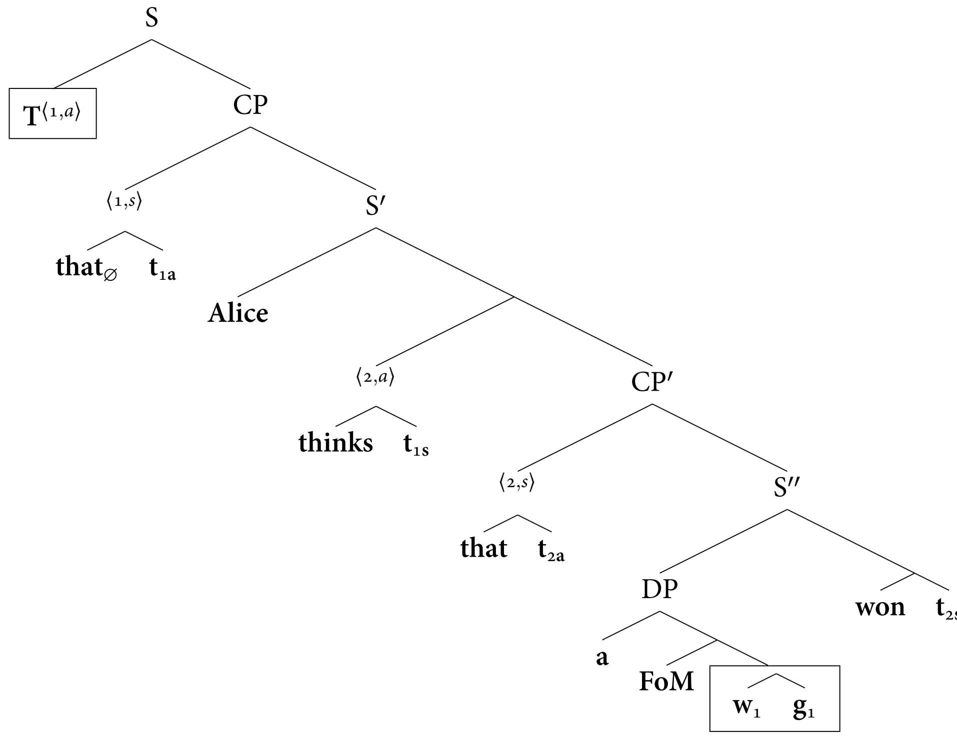


(33) *De re, Specific:*
≈ there is some particular individual who is a friend of mine such that Alice thinks (s)he won



As observed in Fodor 1970, DPs such as 'a friend of mine' in (29) 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:

(34) *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

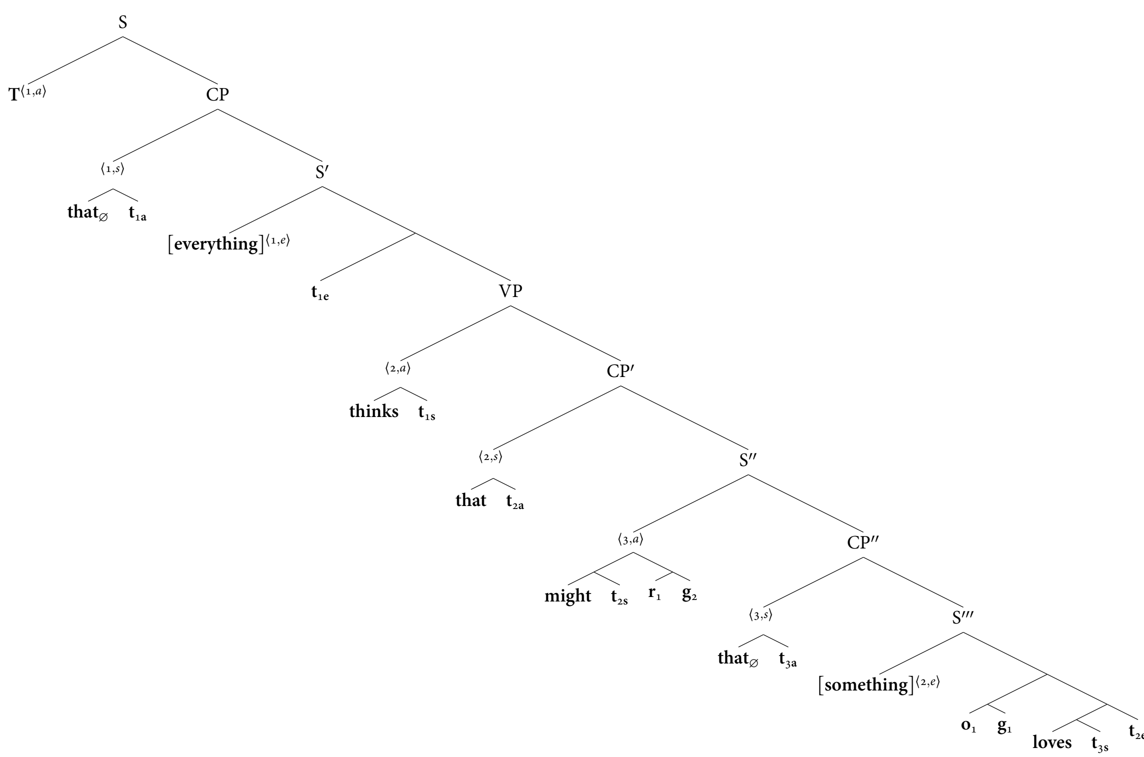


Like other accounts with covert world-variables, the present account has a resource for capturing Fodor's "third reading" in terms of long-distance/local binding. What is particular to the present account is how the binding is implemented — via coindexing involving the world-variable's sister assignment-variable — 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

In this section I would like to apply the proposed syntax/semantics to a more complex example such as (35) 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. (As above I suppress certain irrelevant assignment modifications, indicated with '≈'. I highlight certain equivalences from assignment modification for comment below. I use 'r' in indices for type $\langle s, at\rangle$.)[17]

(35) Everything thinks that it might love something.



[17] For space purposes further intermediate calculations must again be left to the reader:

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

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

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

$[\![[\textbf{r}_1\ \textbf{g}_2]]\!] = [\![\textbf{r}_1]\!]([\![\textbf{g}_2]\!])$

$= [\lambda a'_a.[\lambda w_s.[\lambda a_a.[\lambda g_g\,.\,a'(g)(1r)(w(g))(a(g))]]]](\lambda g_g.g(2a))$

$$
\begin{aligned}
[\![S]\!] \approx\ & \lambda g_g\,.\ \text{for } a'' \text{ s.t. } a'' = \lambda g_g.g,\\
&\quad \forall w'' \text{ s.t. } w''(g) = @(a''(g)),\\
&\qquad \forall y\colon \forall a_a \text{ s.t. } a(g) \text{ is compatible with } \mathrm{SOM}_{y(g),\,w''(g)},\\
&\qquad\quad \forall w \text{ s.t. } w(g) = @(a(g)),\\
&\qquad\qquad \exists a'_a \text{ s.t. } a(g)(1r)(w(g))(a'(g)),\\
&\qquad\qquad\quad \forall w' \text{ s.t. } w'(g) = @(a'(g)),\\
&\qquad\qquad\qquad \exists x\colon \underline{g[a''(g)/1a][y(g)/1e](1a)(1e)} \text{ loves } x(g) \text{ in } w'(g)\\
= \lambda g_g.\ \ldots\ & \qquad\qquad\qquad \exists x\colon \underline{g[a''(g[y(g)/1e])/1a](1a)(1e)} \text{ loves } x(g) \text{ in } w'(g)\\
= \lambda g_g.\ \ldots\ & \qquad\qquad\qquad \exists x\colon \underline{a''(g[y(g)/1e])(1e)} \text{ loves } x(g) \text{ in } w'(g)\\
= \lambda g_g.\ \ldots\ & \qquad\qquad\qquad \exists x\colon \underline{g[y(g)/1e](1e)} \text{ loves } x(g) \text{ in } w'(g)\\
= \lambda g_g\,.\ & \forall w'' \text{ s.t. } w''(g) = @(g),\\
&\quad \forall y\colon \forall a_a \text{ s.t. } a(g) \text{ is compatible with } \mathrm{SOM}_{y(g),\,w''(g)},\\
&\qquad \forall w \text{ s.t. } w(g) = @(a(g)),\\
&\qquad\quad \exists a'_a \text{ s.t. } a(g)(1r)(w(g))(a'(g)),\\
&\qquad\qquad \forall w' \text{ s.t. } w'(g) = @(a'(g)),\\
&\qquad\qquad\quad \exists x\colon \underline{y(g)} \text{ loves } x(g) \text{ in } w'(g)
\end{aligned}
$$

$$= [\lambda w_s.[\lambda a_a.[\lambda g_g\,.\ g(2a)(1r)(w(g))(a(g))]]]$$

$$
\begin{aligned}
[\![\mathrm{S}'']\!] &= [\![[[\textbf{might}\ \mathbf{t}_{2s}][\mathbf{r}_1\ \mathbf{g}_2]]^{\langle 3,a\rangle}]\!]([\![\mathrm{CP}'']\!])\\
&\approx \lambda g_g\,.\ \exists a_a \text{ s.t. } g(2a)(1r)(g(2s))(a(g)),\\
&\qquad \forall w \text{ s.t. } w(g) = @(a(g)),\\
&\qquad\quad \exists x\colon g(1a)(1e) \text{ loves } x(g) \text{ in } w(g)
\end{aligned}
$$

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

$$
\begin{aligned}
[\![\mathrm{S}']\!] &= [\![[\textbf{everything}]^{\langle 1,e\rangle}]\!]\big([\![\mathrm{VP}]\!](\lambda g_g.g(1e))\big)\\
&\approx \lambda g_g\,.\ \forall y\colon \forall a_a \text{ s.t. } a(g) \text{ is compatible with } \mathrm{SOM}_{y(g),\,g(1s)},\\
&\qquad \forall w \text{ s.t. } w(g) = @(a(g)),\\
&\qquad\quad \exists a'_a \text{ s.t. } a(g)(1r)(w(g))(a'(g)),\\
&\qquad\qquad \forall w' \text{ s.t. } w'(g) = @(a'(g)),\\
&\qquad\qquad\quad \exists x\colon g[y(g)/1e](1a)(1e) \text{ loves } x(g) \text{ in } w'(g)
\end{aligned}
$$

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

That is, roughly put: (35) is true iff for every individual o, for every possibility g compatible with o's beliefs, there is some possibility g' accessible from g such that there is some individual o' whom o loves in the world of g'.

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, followed 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 w' compatible with the relevant information; the relevant information is determined relative to the worlds w compatible with the subject's attitude state; the subject's attitude state is assessed at the world w'' 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 **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. Note the need for the more complex semantics for variables/traces of non-basic types from §2.1, reproduced below. Treating the semantic values of all variables as functions from assignments would fail to derive how the modal-background pronoun combines with the modal's world argument to return a set of assignments. The generalized semantics for variables/traces derives how, although the lexical entry for the modal specifies an argument of type $\langle s, at\rangle$ and the modal quantifies over functions $a' : G \rightarrow G$, the value returned by $a(g)(1r)$ is a function from worlds $w(g) \in W$ to (the characteristic function of) a set of assignments (possibilities) $g' \in G$, and the quantified condition is a condition on a possibility $a'(g) \in G$ in this set $a(g)(1r)(w(g))$ (see n. 17). (I return to issues about local/bound readings of modal background variables below.)

(36) $[\![\mathbf{v}_{i\sigma}]\!] = \lambda a_a.\lambda\sigma_n \ldots \sigma_1.\lambda g_g\,.\,a(g)(i\sigma)({}^{\downarrow}\sigma_n)\ldots({}^{\downarrow}\sigma_1)$

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

$[\![\mathbf{g}_2]\!] = \lambda g_g.g(2a)$

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

$[\lambda w_s.[\lambda r_{\langle s,at\rangle}.[\lambda A_{at}.[\lambda g_g\,.\,\exists a'_a \text{ s.t. } r(w)(a')(g), \ldots]]]]\,([\![\mathbf{t}_{2s}]\!])\,\big([\![\mathbf{r}_{1\mathbf{sat}}]\!]([\![\mathbf{g}_2]\!])\big)$
$= \lambda A_{at}.\lambda g_g\,.\,\exists a'_a \text{ s.t. } g(2a)(1r)(g(2s))(a'(g)), \ldots$

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 (35) 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 assignments, $g[y(g)/1e]$ is the assignment h that is just like g except that $1e$ is mapped to $y(g)$; this modified assignment is modified to the assignment h' that is just like h except that $1a$ is mapped to $a''(g)$. So, feeding $1a$ to h' would seem to return $a''(g)$. Since a'' is the identity function, $a''(g) = g$, and so, it would seem, $h'(1a) = g$. The critical question is what this resulting assignment returns for $1e$. What we want isn't whatever happens to be returned by the 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.[18]

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

[18] The only place I've seen this issue addressed is Sternefeld 1998: 16–17. As far as I can tell, he cheats, in precisely the way mentioned in the main text.

(38) *Assignment modification*

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

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

c. $h_g[\cdots]_1 \ldots [\cdots]_n := [\cdots]_1 \circ \ldots \circ [\cdots]_n(h)$

These definitions derive the crucial equivalence step in (35), reproduced in (39); the modifier $[a''(g)/1a]$ is correctly treated as mapping $h = g[y(g)/1e]$ to an assignment h' that is just like h except that it maps $1a$ to *its* image under a''.[19]

(39) $g[a''(g)/1a][y(g)/1e](1a)(1e) = g\big[a''\big(g[y(g)/1e]\big)/1a\big](1a)(1e)$

$g[\ldots g \ldots][\cdots] = g\big[\ldots g[\cdots]\ldots\big]$

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'' is the identity function, 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.

---

[19]*Proof* (for readability I abbreviate the right conjunct in (38a) as $h(\mathrm{j}\sigma, \neq \mathrm{i}\tau) = g(\mathrm{j}\sigma, \neq \mathrm{i}\tau)$; and I use large parentheses to enclose descriptions of assignments when prefixed to an argument, e.g. $(\iota g\colon \ldots)(4s)$):

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

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

$$
\begin{aligned}
& g[a''(g)/1a][y(g)/1e] \\
&\quad = \big([a''(g)/1a] \circ [y(g)/1e]\big)(g) \\
&\quad = \big[\lambda g'_g \,.\, [a''(g)/1a]([y(g)/1e](g'))\big](g) \\
&\quad = \Big[\lambda g'_g \,.\, \big[\lambda g''_g \,.\, \iota h\colon h(1a) = a''(g'') \wedge h(\mathrm{j}\sigma, \neq 1a) = g''(\mathrm{j}\sigma, \neq 1a)\big] \\
&\qquad\quad \big(\iota h'\colon h'(1e) = y(g') \wedge h'(\mathrm{j}\sigma, \neq 1e) = g'(\mathrm{j}\sigma, \neq 1e)\big)\Big](g) \\
&\quad = \big[\lambda g'_g \,.\, \iota h_g\colon h(1a) = a''\big(\iota h'\colon h'(1e) = y(g') \wedge h'(\mathrm{j}\sigma, \neq 1e) = g'(\mathrm{j}\sigma, \neq 1e)\big) \\
&\qquad\quad \wedge h(\mathrm{j}\sigma, \neq 1a) = \big(\iota h'\colon h'(1e) = y(g') \wedge h'(\mathrm{j}\sigma, \neq 1e) = g'(\mathrm{j}\sigma, \neq 1e)\big)(\mathrm{j}\sigma, \neq 1a)\big](g) \\
&\quad = \iota h_g\colon h(1a) = a''\big(\iota h'\colon h'(1e) = y(g) \wedge h'(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)\big) \\
&\qquad\quad \wedge h(\mathrm{j}\sigma, \neq 1a) = \big(\iota h'\colon h'(1e) = y(g) \wedge h'(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)\big)(\mathrm{j}\sigma, \neq 1a) \\
&\quad = \big[a''\big(\iota h'\colon h'(1e) = y(g) \;\wedge\; h'(\mathrm{j}\sigma, \neq 1e) = g(\mathrm{j}\sigma, \neq 1e)\big)/1a\big](g) \\
&\quad = \big[a''\big([y(g)/1e](g)\big)/1a\big](g) \\
&\quad = g\big[a''\big(g[y(g)/1e]\big)/1a\big]
\end{aligned}
$$

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 (35), seeming to reflect a kind of binding. There is apparently no reading of (40) which ascribes to every contestant x the belief that it's compatible with Alice's/Bert's evidence that x is the winner.

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

Relativist/expressivist theories offer general shifting mechanisms to capture this.[20] 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 (35). 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.[21] 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 requiring that the assignment-variable sister to the modal-background-variable be coindexed with the closest c-commanding assignment-binder.[22] Such a principle would seem no more ad hoc than a globality principle for (e.g.) gendered pronouns or 'it' requiring that the individual-variable's sister assignment-variable be coindexed with the topmost assignment-binder (cf. (5)). For expressions permitting local and

[20]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 $\forall u \in s'$: $[\![S]\!]^{c;\,u,s'} = 1$, where $s' = Dox(x,w)$

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

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

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 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 §8.4.1). 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 illustrates one way of doing so to capture 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. §7 turns to local/global readings in several types of bare and modalized conditionals, drawing on developments from (e.g.) Bhatt and Schlenker on 'if'-clauses as free relatives, now construed as definite descriptions of assignments. §8 extends the treatments of *yes/no* questions and 'if'-clauses to *wh*-interrogatives and headed relative clauses, drawing on prominent head-raising and D-complement analyses of relative clauses, with determiner quantifiers now introducing quantification over assignments. A general treatment of *wh*-words, indefinites, and relative determiners as choice-function pronouns is provided, with extensions to various shifting phenomena with pronominal anaphora including donkey anaphora.

6 Questions

A principal aim of the assignment variable framework has been to capture various types of local and global readings. Interrogatives provide a further source of local and global readings of variables and context-sensitive expressions, as in (41)–(45).[23]

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

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

(42) 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?

(43) Might$_i$ Jane be coming? (*local reading*)

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

(44) [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, and asks:]
Should we give to Charity X? (*global reading*)

a. ≈ Would our giving to Charity X maximize overall happiness?

(45) 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 (45).]

≈ 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 (45).]

≈ 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, or targeted by the question operator. *S*'s question in (45a) targets the relevant standard associated with 'rich' — how rich one must be to count as rich. If *A* gives a *yes*-answer (roughly that Rita's income is at least as great as $g(i)$) *S* can infer that *A* assumes that the richness standard $g(i)$ is no greater than $X/yr. *S*'s question in (44), by contrast, isn't asking *A* what substantive normative view to accept; it's presupposed that classical utilitarianism is correct. *S* is inquiring about the implications of these norms given

[23]As is common I often use 'interrogative' for the linguistic clause/sentence and 'question' for the semantic object. I focus on *yes/no* polar questions; I consider *wh* questions in §8.1.

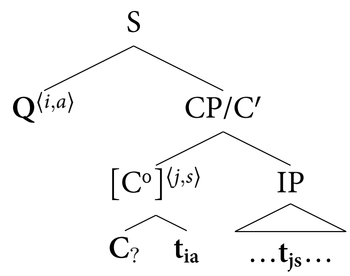
the empirical facts. Likewise, whereas the individual-pronouns in (42) receive their interpretation from the discourse context, the value for the world-variable in (41) is targeted by the question; the set of the possible answers to (41) isn't a set like $\big\{\{w\colon \text{it's raining in } u\}, \{w\colon \text{it isn't raining in } u\}\big\}$ which takes as given a particular world, say $g(i) = u$.

It is standard to distinguish at least two elements in the interpretation of interrogative sentences: an interrogative complementizer — call it $\mathbf{C}_?$ — which triggers interrogative movement in languages such as English, and a question operator (possibly distinct from *wh*-words) — call it **Q** — which provides the source of the question semantics (e.g. Dayal 1996, Cable 2010, Kotek 2014, and references therein). Data such as (41)–(45) involving local/global readings constrain how we formalize the interrogative elements' lexical entries and implement world- and assignment-binding in the syntax/semantics. Among other things: (i) Like the assignment-binder **T** in declaratives, **Q** should map certain assignment-variables to the discourse assignment, to capture global readings of expressions whose values aren't being questioned. Yet (ii) **Q** should still 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 complementizer and **T** in declaratives, the world argument of the main predicate shouldn't necessarily be linked to the discourse assignment but should receive a local reading.

In 2012 lecture notes Heim suggests a syntax in which the question operator is base-generated as an argument of the interrogative complementizer and raises to generate quantification over propositions (Heim 2012). Heim's account provides precisely the sort of precedent for an interrogative analogue to our treatment of declarative clauses (§3). Our syntax/semantics for declaratives treated assignment-binders, such as the topmost assignment-binder **T**, as base-generated as internal assignment arguments of the complementizer (e.g. 'that'), and as moving for type reasons to generate quantification over assignments. Drawing on Heim's suggestion, the analogous move for interrogatives would be to generate the quantification over assignments from movement of the question operator **Q** from a posited assignment-argument position of the interrogative complementizer $\mathbf{C}_?$, as reflected in (46).[24]

[24] I will often label the sister of **Q** (at LF after movement) as CP rather than C′; however, officially, as with **T**, I leave open what the specific location of **Q** is at LF — e.g., whether it raises to SpecCP or heads its own projection (e.g. ForceP).

(46) LF:



HEIM (2012) treats the movement of **Q** as introducing quantification over propositions conceived as sets of worlds, and includes an independent node for the binder-index to trigger a non-compositional Predicate Abstraction rule. In contrast, drawing on the results from the previous sections, we can treat **Q** as quantifying over assignments and combining via function application with the type-flexible generalized binder-index. The account yields a compositional derivation of the binding of assignment-variables.

To fix ideas I assume an approach to interrogatives which treats question meanings as a set of possible answers.[25] Our semantics for interrogative elements must ensure that certain variables are interpreted with respect to the discourse assignment, while allowing other variables, including the world argument of the main predicate, to be targeted by the question (vary across answers). I offer (47)–(48) as preliminary lexical entries for the interrogative complementizer $\mathbf{C}_?$ and question operator **Q** — writing "$g \approx_a h$" to say that g and h agree on all values for assignment indices (i.e. $\forall n{:}\, g(na) = h(na)$). Semantic values after combining with the generalized binder-index (reproduced in (49)), are in (50)–(51).

(47) $[\![\mathbf{C}_?]\!] = \lambda a_a.\lambda q_{st}.\lambda T_t.\lambda g_g\,.\, T = [\lambda g'{:}\, a(g') = a(g)\,.\, \forall w' \text{ s.t. } w'(g') = @(g'), q(w')(g')]$

(48) $[\![\mathbf{Q}]\!] = \lambda \mathcal{Q}_{\langle a,tt\rangle}.\lambda g_g.\lambda T_t.\lambda g'_g\,.\,\text{for } a = \lambda g_g.g,$
$\forall T' \text{ s.t. } \mathcal{Q}(a)(T')(g){:}$
$T = [\lambda g''_g{:}\, g'' \approx_a g'\,.\, T'(g'') = T'(g')]$

(49) *Generalized binder-index* (see (24))
$[\![^{\langle i,\tau\rangle}]\!] = \lambda\alpha_{\langle\langle\tau,\langle_1\gamma_1\cdots\gamma_n,t\rangle_1\cdots\rangle_n\rangle,\sigma\rangle}\,.\,\lambda\beta_{\langle_1\gamma_1\cdots\gamma_n,t\rangle_1\cdots\rangle_n}\,.$
$\alpha\Big(\lambda\tau.\lambda\gamma_1\cdots\lambda\gamma_n.\lambda g\,.\,\beta(\gamma_1)\cdots(\gamma_n)(g[{}^{\downarrow}\tau/\mathrm{i}\tau])\Big)$

- $\mathbf{C}_?$: $\tau = s$; $\sigma = \langle t,t\rangle$; γ null
- **Q**: $\tau = a$; $\sigma = \langle g,\langle t,t\rangle\rangle$; $\gamma = t$

[25]For classic references on the main approaches, cf. HAMBLIN 1973, KARTTUNEN 1977, GROENENDIJK & STOCKHOF 1984, HEIM 1994.

(50) $[\![[\mathbf{C}_{?}\ \mathbf{t}_{\mathrm{ja}}]^{\langle i,s\rangle}]\!] = [\![\mathbf{C}_{?}\ \mathbf{t}_{\mathrm{ja}}]\!]([\![^{\langle i,s\rangle}]\!])$

$= \lambda T'_t.\lambda T_t.\lambda g_g\,.\,T = [\lambda g' \colon g'(\mathrm{j}a) = g(\mathrm{j}a)\,.\,\forall w' \text{ s.t. } w'(g') = @(g'), T'(g'[w'(g')/\mathrm{i}s])]$

(51) $[\![\mathbf{Q}^{\langle j,a\rangle}]\!] = [\![\mathbf{Q}]\!]([\![^{\langle j,a\rangle}]\!])$

$= \lambda Q_{tt}.\lambda g_g.\lambda T_t.\lambda g'_g\,.\,\text{for } a = \lambda g.g,$

$\forall T' \text{ s.t. } Q(T')(g[a(g)/\mathrm{j}a])\colon$

$T = [\lambda g''\colon g'' \approx_a g'\,.\,T'(g'') = T'(g')]$

(52) "τ-equivalence" (to be revised)

a. $h \approx_\tau h' := \forall \mathrm{i}\colon h(\mathrm{i}\tau) = h'(\mathrm{i}\tau)$

b. $h \approx_{\neg\tau} h' := \forall \mathrm{i}\forall \sigma \neq \tau\colon h(\mathrm{i}\sigma) = h'(\mathrm{i}\sigma)$

The interrogative complementizer $\mathbf{C}_{?}$ first forms a singleton set of the proposition expressed by the question nucleus; the question operator **Q** then constructs a partition of possible answers from this singleton set returned by the complementizer. Roughly put, global readings are captured by linking assignment-variables coindexed with $\mathbf{Q}^{\langle j,a\rangle}$ back to the discourse assignment when forming the proposition targeted by the question. The values of other assignment-variables may vary across cells in the partition (possible answers), capturing local readings of expressions whose values are targeted by the question.

Consider (53), on the salient reading which questions the relevant evidence and the doings of the relevant individual — i.e., a global reading of 'he' (referring to, say, the butler), and local readings for the world-variable and modal-background pronoun. (I ignore any effects from I-to-C movement, and I treat 'be the killer' as an unanalyzed predicate; see n. 24.)[26]

[26] $[\![\mathrm{S}'']\!] = \lambda g_g.g(1a)(1e)$ is the killer in $g(2s)$

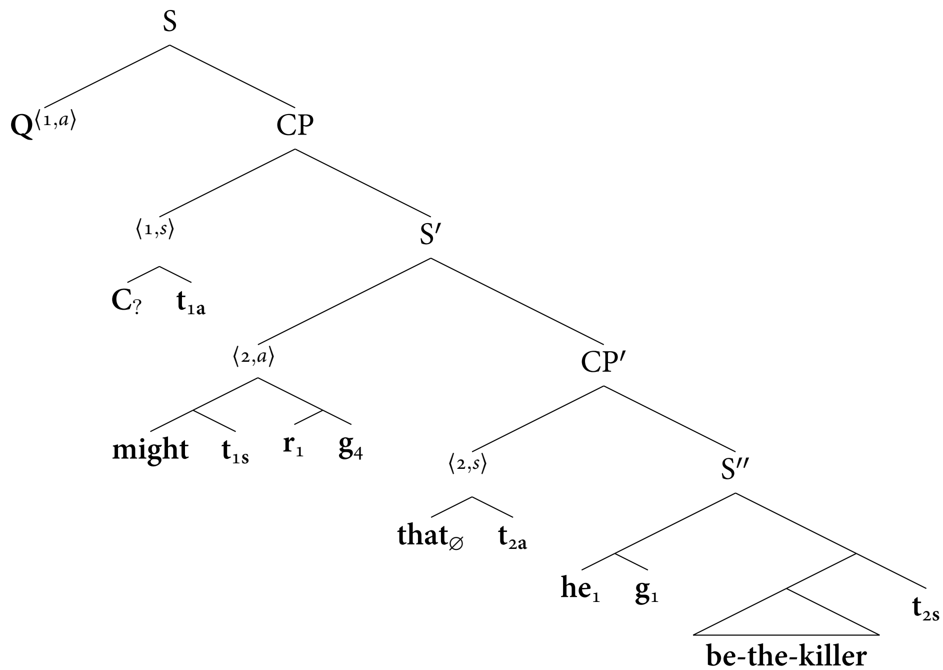
$[\![\mathrm{CP}']\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(g(2a)), g(1a)(1e)$ is the killer in $w(g)$

$[\![\mathrm{S}']\!] \approx \lambda g_g\,.\,\exists a_a \text{ s.t. } g(4a)(1r)(g(1s))(a(g)), \forall w \text{ s.t. } w(g) = @(a(g)),$
$g(1a)(1e)$ is the killer in $w(g)$

$[\![\mathrm{CP}]\!] \approx \lambda T_t.\lambda g_g\,.\,T = [\lambda g'''\colon g'(1a) = g(1a)\,.\,\forall w' \text{ s.t. } w'(g''') = @(g'''),$
$\exists a_a \text{ s.t. } g'''(4a)(1r)(w'(g'''))(a(g''')), \forall w \text{ s.t. } w(g''') = @(a(g''')),$
$g'''(1a)(1e)$ is the killer in $w(g''')]$

$[\![\mathrm{S}]\!] \approx \lambda g_g.\lambda T_t.\lambda g'_g\,.\,\text{for } a' = \lambda g_g.g,$
$\forall T' \text{ s.t. } T' = [\lambda g'''_g\colon g'''(1a) = a'(g)\,.\,\forall w' \text{ s.t. } w'(g''') = @(g'''),$
$\exists a_a \text{ s.t. } g'''(4a)(1r)(w'(g'''))(a(g''')), \forall w \text{ s.t. } w(g''') = @(a(g''')),$
$g'''(1a)(1e)$ is the killer in $w(g''')],$
$T = [\lambda g''_g\colon g'' \approx_a g'\,.\,T'(g'') = T'(g')]$

(53) Might he be the killer?



$$\llbracket S \rrbracket (g_c) \approx \lambda T_t . \lambda g'_g \, . \; \forall T' \text{ s.t. } T' = \big[\lambda g'''_g \colon g'''(1a) = g_c \, . \; \forall w' \text{ s.t. } w'(g''') = @(g'''), \exists a_a \text{ s.t. } g'''(4a)(1r)(w'(g'''))(a(g''')), \forall w \text{ s.t. } w(g''') = @(a(g''')), g'''(1a)(1e) \text{ is the killer in } w(g''')\big], T = [\lambda g''_g \colon g'' \approx_a g' \, . \; T'(g'') = T'(g')]$$

Very roughly, this says that, given a discourse assignment g_c, the meaning of the epistemic modal question in (53) is a set of propositions T, where each such proposition is a set of assignments g'' that determine the same modal background r' (=$g''(4a)(1r)$, via $g'' \approx_a g'$) and return the same truth value for the proposition T' that the contextually relevant individual $g_c(1e)$ (=$g'''(1a)(1e)$) is the killer in the world of some epistemic possibility (as determined by r').

The proposed treatments of the syntax and lexical/compositional semantics derive the desiderata discussed above regarding local and global readings. First, the global reading of the individual-pronoun ‘he’ is captured via the restriction on the assignments g''' constituting the nucleus proposition T' — namely, that they map assignment-indices coindexed with $\mathbf{Q}^{\langle 1,a \rangle}$ to $a'(g_c) = [\lambda g_g . g](g_c) = g_c$. The assignments g'' in each of the possible answers T thus agree in identifying $g''(1a)(1e)$ with the relevant individual $g_c(1e)$ determined by the input discourse assignment g_c.

Second, although the modal's world argument is directly bound by $[\mathbf{C}_? \ \mathbf{t}_{1a}]^{\langle 1,s \rangle}$, the lexical semantics of the interrogative complementizer $\mathbf{C}_?$ avoids identifying the value of the world-trace $\mathbf{t}_{1s}$ with the world of the discourse assignment $@(g_c)$. The nucleus proposition T' places a constraint on the worlds $@(g''')$ of the assignments g''' in the proposition — namely, that $g_c(1e)$ ($=g'''(1a)(1e)$) is the killer in some world accessible from $@(g''')$ (as determined by the epistemic modal background $g'''(4a)(1r)$).

Third, the semantics for assignment quantifiers such as modals and attitude verbs captures local readings in terms of coindexing between the assignment-variable and the binder-index. In contrast, the semantics in (48)/(51) captures local readings under the question operator — readings of expressions whose value is being questioned — by assigning *different* indices to the assignment-variable and the binder-index attached to **Q**. The local reading of the epistemic modal is captured by allowing the value for the modal-background pronoun $[\mathbf{r}_1 \ \mathbf{g}_4]$ to vary across the propositions T comprising the possible answers. The assignments within each cell T agree on the value assigned to the arbitrary assignment-index $4a$ (via the constraint $g'' \approx_a g'$); yet the particular value assigned, and hence the epistemic modal background assigned to $1r$, may differ across cells.[27]

7 Conditionals

7.1 Desiderata

The previous section examined how an assignment-variable-based framework might be applied to non-declarative sentence types such as interrogatives. Drawing on independently motivated suggestions from Heim (2012), we saw how a syntax/semantics of question operators as assignment-shifters might be integrated into the approach to the syntax/semantics interface from §3: roughly put, the interrogative complementizer moves as a quantifier over worlds to form a singleton set of the proposition (set of assignments) corresponding to the question nucleus; and the question operator moves as a quantifier over assignments to construct a partition, where the values

[27]In §4.3 we noted that there may be reasons for positing conventionalized locality/globality principles for certain context-sensitive expressions — e.g., perhaps a globality principle for gendered pronouns, or a locality principle for epistemic modals. The formulation of such principles may need to be revised in light of the implementation of local readings in questions: the assignment-variable in the epistemic modal-background pronoun $[\mathbf{r}_1 \ \mathbf{g}_4]$ in (53) needn't be coindexed with the nearest assignment-binder; indeed this is what captures the local reading. The locality principle (if there is one) might be understood instead as prohibiting LFs in which the pronoun's assignment-variable is coindexed with a non-closest c-commanding assignment-binder. Globality principles could still be formalized as requiring coindexing with the topmost assignment-binder.

for free assignment-variables may vary across cells (possible answers), capturing local readings of expressions whose interpretation is being questioned.

This section examines how the assignment-variable-based framework might be applied to another type of clause: 'if'-clauses. This isn't the place to hazard a general theory of the syntax and semantics of conditional constructions. The aim is to begin investigating what complications for our treatments of modality and world- and assignment-quantification may be raised by clausal adjuncts, and how an account with assignment-variables may help capture varieties of local/global readings in different types of conditionals. Developments and alternative implementations must be left for future research.

As discussed in §§5–6, whatever approach to the semantics of conditionals we go in for (restrictor, "shifty," etc.), we must ensure that it can be derived in our framework from independently attested points about the relevant complementizers, modal expressions, and main predicates in both clauses. Our particular treatments of the lexical and compositional semantics will need to allow for (i) **global readings in both 'if'-clause and consequent clause**, as in (54); (ii) **local readings in the 'if'-clause**, as in (55); and (iii) **local readings in the consequent**, as arguably occurs in examples such as in (56) involving (e.g.) "indexical shift" and local updates of nominal/modal quantifier domains (e.g. "information-sensitivity").

(54) If $\underline{\text{it}_i}$ breaks, $\underline{\text{he}_j}$ will cry. (*global reading, both clauses*)

- ≈ If $g_c(i)$ breaks, $g_c(j)$ will cry.

(55) 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* implies that we 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 $\underline{\text{rich}_i}$, then Miguel is rich. So Miguel should get the tax break too.

d. [Regional prizes are being awarded for progressiveness. We haven't settled which groups ought to be considered in questions about voting rights.]
Y is progressive on so many dimensions. If $\underline{\text{everyone}_i}$ can vote, they should get one of the prizes.

(*local reading, 'if'-clause*)

(56) a. [If John wasn't invited,]$_i$ $\underline{\text{everyone}_i}$ 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 coin landed heads,]$_i$ I$_i$ am in Widener Library, Harvard.
(Santorio 2012: ex. 6)
d. [If the intersection is clear,]$_i$ we should$_i$ speed through.
(*local reading, consequent/main clause*)

Whatever syntactic/semantic package we take on board needs to capture local readings in the consequent *and* in the antecedent — shifting in the scope of a supposition as well as in the supposition itself — and must do so in a way that still allows for global readings in both clauses. In terms of the framework from §3, this amounts to deriving (i) a topmost assignment-binder scoping over the conditional, generated from some assignment argument (in the 'if'-clause? main clause?); (ii) an assignment-binder internal to the 'if'-clause generated from some assignment argument (in C^o with 'if'?); and (iii) an assignment-binder on the 'if'-clause generated from some assignment argument in the main clause.

7.2 Syntax/semantics: Correlative/free relative adjuncts and movement

A standard story, following Lewis (1975) and Kratzer (1981, 1991), is that 'if'-clauses restrict the domain of some (possibly covert) operator. Yet as von Fintel (1994) notes, it's unlikely that movement operations literally generate a tripartite structure for conditionals at LF, like in (57), parallel to determiner quantifiers (cf. Partee 1995).

(57) *Movement ⇒ Tripartite LF*
$[_S\ [\ \mathbf{OP}^i\ [_{CP}\ \mathbf{if}\ \mathrm{TP}\ ]^j\ ]\ [_{CP}\ \mathbf{t_j}\ [_{CP} \ldots \mathbf{t_i} \ldots\ ]]]$

Rather, "it is very probable… that tripartite structures are merely a convenient meta-level notation" (von Fintel 1994: 77). 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 independent suggestions from Heim 2012 to motivate a basis for delineating the sources of world- and assignment-quantification in interrogative sentences — an interrogative complementizer $\mathbf{C}_?$, and a distinct question operator which moves from sister to $\mathbf{C}_?$ to generate assignment-binding. In this section I will suggest that prominent syntactic theories of **'if'-clauses as correlatives/free relatives** (Iatridou 1991, von Fintel 1994, Schlenker 2004, Bhatt & Pancheva 2006, Arsenijević 2009, Haegeman 2010) provide analogous motivations for positing the requisite sources of world- and assignment-shifting in conditionals. In short:

Like other free relatives (Jacobson 1995, Dayal 1996), '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, on this line, denote **definite descriptions of assignments**.

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, and references therein). A prominent approach is to treat the conditional element as deriving from movement from within the conditional clause to SpecCP, as in (58) (esp. Bhatt & Pancheva 2006; cf. Lycan 2001, Arsenijević 2009, Haegeman 2010).

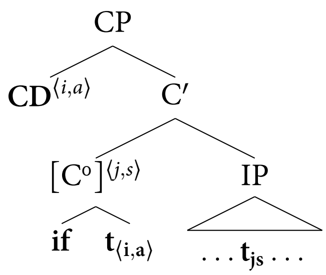
(58) if John arrives late

a. LF: $[_{CP}$ OP_i $[_{C}$ if [John arrives late in i]]]

(cf. Bhatt & Pancheva 2006: ex. 46)

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 a raised operator responsible for conditional interpretations. In correlative constructions, the 'if'-clause binds a proform (e.g. 'then') in the adjoined main clause and may thereby modify a modal domain in its scope. These elements suggest a strategy for capturing local/global readings: schematically, we can derive (i) **global readings** as usual via movement of the main clause complementizer and subsequent movement of the topmost assignment-binder from internal to the main clause; (ii) **local readings in the 'if'-clause** via assignment-quantification/binding generated by clause-internal movement of the conditional operator; and (iii) **local readings in the consequent clause** via the general correlative binding requirement linking the 'if'-clause assignment-binder with the proform. I offer (59) as a first-pass LF, where **CD** is the (unpronounced) conditional operator (for Conditional Description).[28]

[28]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 the operator as moving from within the VP. Instead 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 proposed treatment of **CD** as moving from above the VP. See §8 for more detailed discussion of the syntax/semantics of relative clauses generally.

(59) 

Critical issues concern (i) the interpretation of 'if' (as a quantifier over worlds), (ii) the interpretation of **CD** (as a quantifier over assignments), and (iii) how **CD** comes to bind assignment-variables in the adjoined main clause.

7.3 'if' & conditionality: 'if'-clauses as plural definite descriptions of assignments (preliminary)

For simplicity suppose we give 'if' the same semantic value as 'that', as in (60).

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

The conditionalization element **CD** is base-generated in the complementizer's assignment-argument position, and moves for type reasons (in this case to SpecCP), introducing an assignment binder. A first-pass lexical entry for **CD**, treated as a definiteness operator on assignments, is in (61). The uniqueness implication is captured as applying to the items $a(g) \in G$ in the model (more on which below). After attachment of the binder indices, the interpretation of an 'if'-clause such as 'if it rains' is as in (62).

(61) $[\![\textbf{CD}]\!] = \lambda A_{at} . \lambda A'_{at} . \lambda g_g \, . \left[\iota a_a(g) \colon A(a)(g) \right] A'(a)(g)$
$= \lambda A_{at} . \lambda A'_{at} . \lambda g_g \, . \left[\exists a_a \colon a(g) \text{ is the unique } h_g \text{ s.t. } {}^{\downarrow}A(h) \right] A'(a)(g)$ (*preliminary*)

(62) a. $[_{\text{CP}}$ $\textbf{CD}^{\langle 1,a \rangle}$ $[$ $[$ **if** $\mathbf{t}_{\langle \mathbf{i,a} \rangle}$ $]^{\langle 1,s \rangle}$ $[$ **rains** $\mathbf{t}_{\mathbf{1s}}$ $]]]$
b. $[\![(62\text{a})]\!] = \lambda A'_{at} . \lambda g_g \, . \left[\exists a_a \text{ s.t. } a(g) \text{ is the unique } h_g \text{ s.t. } \forall w \text{ s.t. } w(g) = @(h), \text{ it rains in } w(g) \right] A'(a)(g)$

There is of course more than one assignment such that it rains in the possibility represented by the assignment. First, as per general treatments of free relatives as plural definite descriptions (Jacobson 1995, Dayal 1996; cf. Grosu & Landman 1998), the assignment introduced by the 'if'-clause may be a **plural assignment** (cf. Schein 2003, Bhatt & Pancheva 2006). As is standard, assume that 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 ι operator in the semantics of **CD** in (63) can be understood along the lines of Link's (1983) σ 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 $\forall m' \in S\colon m' \leq m$). (I use an asterisk * when introducing a variable to flag that its value may be a plurality ("$\iota o^*\colon o\ldots$"). 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.)

(63) $[\![\mathbf{CD}]\!] = \lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\left[\iota a_a(g)^*\colon A(a)(g)\right] A'(a)(g)$
$= \lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\left[\exists a_a\colon a(g)^* \text{ is the unique maximal } h^*_g \text{ s.t. } {}^{\downarrow}A(h)\right] A'(a)(g)$
(*preliminary*)

Even after incorporating plurality, our analysis should reflect some way of restricting the quantification to relevant (salient/live/remote) assignments satisfying the antecedent's description. Drawing on debates about domain restriction with determiner quantification (VON FINTEL 1994, STANLEY & SZABÓ 2000, STANLEY 2002), several options are to capture the restriction via a **resource domain variable** sister to **CD**, C° 'if', or the complement IP.[29] To fix ideas suppose we go with the first option and give **CD** an initial resource domain argument; a simplified structure and interpretation are as follows — where **r** is a resource domain variable determining a set of relevant assignments (possibilities).[30]

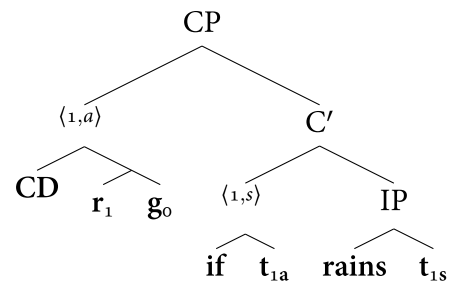
(64) $[\![\mathbf{CD}]\!] = \lambda r_{at}.\lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\left[\iota a_a(g)^*\colon r(a)(g) \wedge A(a)(g)\right] A'(a)(g)$
(*to be revised*)

---

[29]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.

[30]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 resource domain could be indexed to a world to reflect intensionality (cf. STANLEY & SZABÓ 2000), but I bracket this additional complication.

(65)



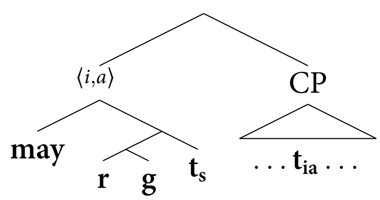
$$\approx \lambda A'_{at}.\lambda g_g \,.\, \big[\iota a_a(g)^*{:}\, g(0a)(1r)(a(g)) \wedge \forall w \text{ s.t. } w(g) = @(a(g)), \text{it rains in } w(g)\big]\; A'(a)(g)$$

In embedded conditionals the assignment-variable in the resource domain pronoun may be coindexed with a local assignment-binder, such as an embedding modal or attitude verb.

We have arrived at a structure and interpretation for the 'if'-clause that parallels that derived above for modal verbs such as 'may'. Slightly modifying the structure of the modal's restrictor brings the parallels even closer, as reflected in (66)–(67) — treating the world-variable as combining with the modal-background variable, and giving the modal a "world-invariant" lexical entry (type $\langle at, \langle at, t\rangle\rangle$), analogous to determiner quantifiers (cf. von Fintel & Heim 2011).

(66) $[\![\textbf{may}]\!] = \lambda r_{at}.\lambda A_{at}.\lambda g_g \,.\, \exists a_a \text{ s.t. } r(a)(g){:}\, A(a)(g)$

(67)



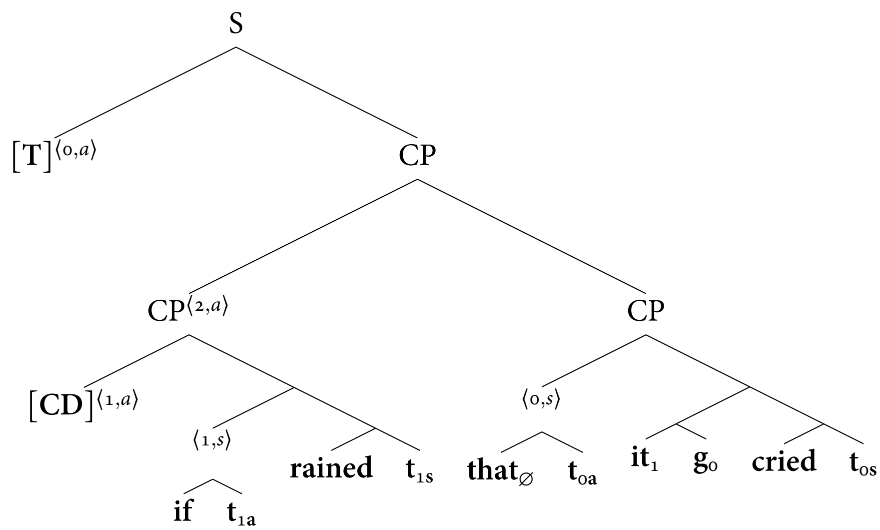
(I often omit the extra structure from resource domains, but it should be understood.)

7.4 Assignment-binding into the main clause: A correlative proform

The aim is to capture how assignment quantification introduced by the 'if'-clause modifies the modal domain for interpreting the consequent and generates the potential for local readings. Start with **bare conditionals**, i.e. conditionals without an overt operator in the consequent. The standard Kratzerian story requires bare conditionals to have a covert operator which supplies a domain for the 'if'-clause to restrict, but let's see how far we can get without this requirement.

The semantics for 'if'-clauses in §7.3 is prima facie unsuitable for an 'if'-clause to combine with a bare consequent clause: the ‘if’-clause requires an argument of type $\langle a, t\rangle$, but the §3-semantics would seem to treat the adjoined main clause as type t. Suppose for a moment that the binder-index combined with the ‘if’-clause to resolve the type mismatch, resulting in an LF and interpretation roughly as follows (bracketing any extra structure from resource domain variables):

(68) *“Biscuit LF”:*



$$[\![\mathrm{S}]\!] \approx \lambda g_g \,.\, \big[\iota a_a(g)^{*}\colon \forall w \text{ s.t. } w(g) = @(a(g)), \text{it rained in } w(g)\big]$$
$$\forall w' \text{ s.t. } w'(g) = @(g), g(1e) \text{ cried in } w'(g)$$

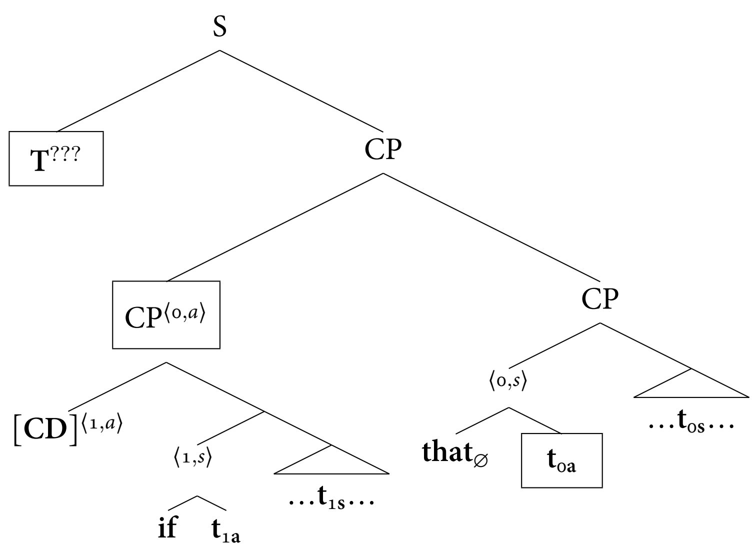
This says, roughly, that the relevant assignment h such that it rained in the world of h, is such that the relevant individual $g(1e)$ cried in the actual world $@(g)$.

As is evident, no mechanism is in place to update the modal domain for the consequent given the antecedent. The conditional introduces a modal topic with the ‘if’-clause, but then fails to comment on it in the main clause. These features of (68) perhaps might be suitable for **relevance conditionals** (‘If you’re hungry, there are biscuits on the table’). Indeed (68) reflects common intuitions about relevance conditionals, such as that they involve an *assertion of the consequent*, and *independence* of the antecedent and consequent: (68) implies that the consequent is true at the world of the discourse, and fails to imply a modal relation between the clauses. Such an interpretation is clearly not appropriate in the general case. A structure like (68) is unsuitable for non-relevance conditionals such as hypothetical conditionals (in the sense of Iatridou 1991). We need an assignment-binder introduced by the ‘if’-clause to bind a relevant assignment-variable in the consequent.

Our syntax/semantics for modals avoided the sort of type mismatch above by treating the modal expression as moving from inside the complement clause: the binder-index attaches to the raised modal, which then combines with the complement CP of type *t*. An analogous idea would be to treat the 'if'-clause as base-generated in the assignment-argument position of the main clause complementizer. The 'if'-clause would move for type reasons, triggering the attachment of the binder index and resolving the type mismatch, just as with modals.

Such a fix is problematic. First, there is syntactic evidence against treating conditional clauses as in general base-generated inside the consequent clause (Bhatt & Pancheva 2006). Indeed, treating at least some conditionals as correlative constructions counts against the hypothesis, since the 'if'-clause (qua correlative clause) is base-generated in an adjoined position (cf. Andrews 1985, Srivastav 1991, Izvorski 1996, Bhatt & Pancheva 2006). Second, coindexing the assignment-trace sister to the main-clause complementizer with the assignment binder on the 'if'-clause leaves no resource for generating the top-level assignment binder, as reflected in (69), and thus leaves no mechanism for capturing global readings.

(69)



We need enough structure to ensure both (i) an assignment-binder index on the 'if'-clause, with which a relevant assignment-variable in the main clause may be coindexed, and (ii) a place for base-generating the top-level assignment binder (e.g. from the sister of the main clause complementizer).

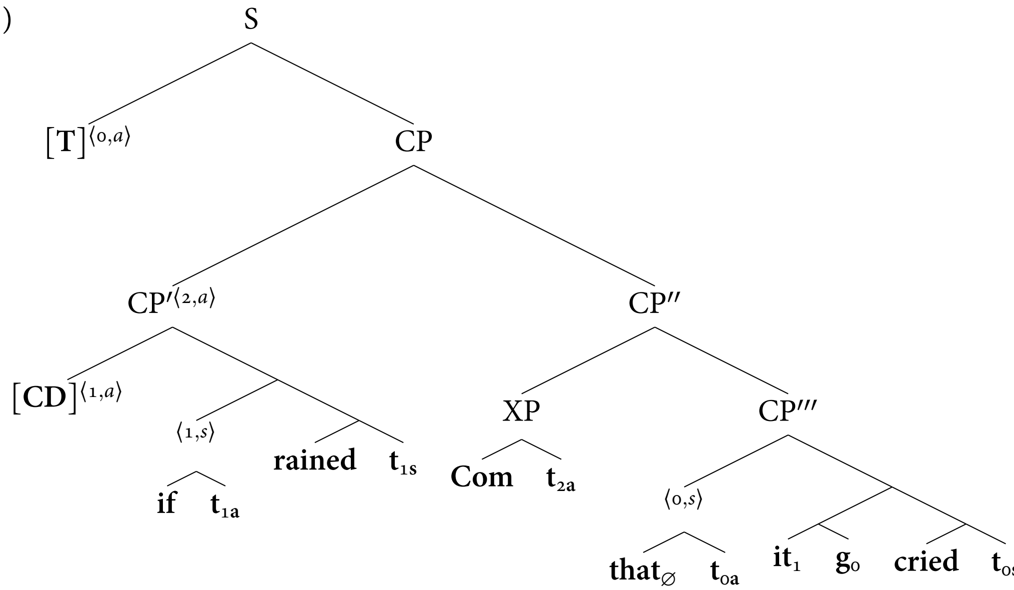
Our need for a binding relationship between the antecedent and consequent is an instance of the general requirement for correlatives that they **bind a proform** in the adjoined (matrix) clause (Srivastav 1991, Dayal 1996, Bhatt 2003).

(70) *Correlatives: Proform coindexation*

$[_{CP}$ [FREE RELATIVE CLAUSE $]_i$ $[_{CP}$ … PROFORM$_i$ …]]

A common move is to treat the proform as 'then', or in sentences without 'then' a covert world pronoun. One way of adapting this move is as follows, using **Com** for the adverbial proform (n. 7).[31]

(71)



The aim is for the proform to reset the consequent's modal domain to the modal domain determined by the assignment-variable sister to the proform, which is bound by the 'if'-clause. What we want are semantic values roughly as in (74) for the main

[31] I focus only on sentence-initial 'if'-clauses; sentence-final 'if'-clauses have distinct syntactic properties. I assume that the 'if'-clause is in general adjoined to a CP rather than, say, an IP (cf. Iatridou 1991, von Fintel 1994, Izvorski 1996, Bhatt & Pancheva 2006). I leave open the relationship between **Com** and 'then'. There are syntactic reasons against positing an obligatory covert 'then', e.g. to allow for argument/adjunct extraction in sentences without overt 'then' (Iatridou 1991, Bhatt & Pancheva 2006). So I don't assume that **Com**, like 'then', results in its position at LF via movement from within the main clause. (It's well-known that conditionals with 'then' carry distinctive presuppositions/implicatures. Perhaps these could be due to features attaching to the adverbial phrase (though see Iatridou 1991, Iatridou & Kroch 1993 on syntactic differences between conditionals with and without 'then'; and see Izvorski 1996, which argues that the implication associated with conditional 'then' is shared among correlative proforms generally).)

clause CP″ and conditional sentence. Yet the derivation for (71) reveals a problem, as reflected in (73) using the first-pass lexical entry for **Com** in (72).

(72) $[\![\textbf{Com}]\!] = \lambda a_a.\lambda T_t.\lambda g_g\,.\,T(g[a(g)/\text{n}a])$, for any n (*to be revised*)

(73) $[\![\text{CP}''']\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = \underline{@(g(0a))}\colon \underline{g(0a)}(1e) \text{ cried in } w(g)$

$[\![\text{CP}'']\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = \underline{@(g(2a))}\colon \underline{g(2a)}(1e) \text{ cried in } w(g)$

$[\![\text{S}]\!] \approx \lambda g_g\,.\,\big[\iota a_a(g)^{*}\colon \forall w' \text{ s.t. } w'(g) = @(a(g))\colon \text{it rained in } w'(g)\big]$
$\forall w \text{ s.t. } w(g) = \underline{@(a(g))}\colon \underline{a(g)}(1e) \text{ cried in } w(g)$

(74) $[\![\text{CP}'']\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = \underline{@(g(2a))}\colon \underline{g(0a)}(1e) \text{ cried in } w(g)$

$[\![\text{S}]\!] \approx \lambda g_g\,.\,\big[\iota a_a(g)^{*}\colon \forall w' \text{ s.t. } w'(g) = @(a(g))\colon \text{it rained in } w'(g)\big]$
$\forall w \text{ s.t. } w(g) = \underline{@(a(g))}\colon \underline{g(1e)} \text{ cried in } w(g)$

The problem is that shifting the modal domain via the lexical entry for **Com** in (72) shifts all assignments to the assignment introduced by the 'if'-clause. This forces all pronouns in the main clause to receive local readings.

7.5 Revising the compositional semantics

We need to be able to modify the assignment determining the modal domain independently of other assignments in the complement. One way of capturing this is to raise the type of the complementizer, and revise the compositional interaction between complementizers and modals in deriving the modal domain. I offer the following revised lexical entries; a simplified derivation for a simple sentence 'It cried' follows in (81). ((77) assumes the modified argument structure for modal verbs in (66)–(67) from §7.3. The entry for **CD** includes the potential resource domain argument.)

Revised lexical entries:

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

(76) $[\![\textbf{T}]\!] = \lambda \mathcal{A}_{\langle a,at\rangle}.\lambda g_g\,.$
$\text{for } a = \lambda g''_g.g''\colon \mathcal{A}(a)(a)(g)$

(77) $[\![\textbf{may}]\!] = \lambda r_{at}.\lambda \mathcal{A}_{\langle a,at\rangle}.\lambda g_g\,.$
$\exists a_a \text{ s.t. } r(a)(g)\colon \mathcal{A}(a)(a)(g)$

(78) $[\![\textbf{think}]\!] = \lambda w_s.\lambda \mathcal{A}_{\langle a,at\rangle}.\lambda x_e.\lambda g_g\,.$
$\forall a_a \text{ s.t. } a(g) \text{ is compatible with } \text{SOM}_{x(g),w(g)}\colon \mathcal{A}(a)(a)(g)$

(79) $[\![\textbf{CD}]\!] = \lambda r_{at}.\lambda\mathcal{A}_{\langle a,at\rangle}.\lambda\mathcal{A}'_{\langle a,at\rangle}.\lambda a'_a.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(a'(g)),$
$\big[\iota a_a(g)^*\!: r(a)(g) \wedge \mathcal{A}(a)(a)(g)\big]\mathcal{A}'(a)(a')(g)$

(80) $[\![\textbf{Com}]\!] = \lambda a'_a.\lambda A_{at}.\lambda a_a.\lambda g_g\,.\,A(a')(g)$

(81) a. LF: $[_{\text{S}}\ \textbf{T}^{\langle 1,a\rangle}\ [_{\text{CP}}\ [\textbf{that}_\varnothing\ \textbf{t}_{\textbf{1a}}]^{\langle 1,s\rangle}\ [_{\text{TP}}\ [\textbf{it}_1\ \textbf{g}_1]\ [\textbf{cried}\ \textbf{t}_{\textbf{1s}}]\ ]]]$

b. $[\![\text{TP}]\!] = \lambda g_g\,.\,g(1a)(1e)$ cried in $g(1s)$

$[\![[\textbf{that}_\varnothing\ \textbf{t}_{\textbf{1a}}]^{\langle 1,s\rangle}]\!] = \lambda T_t.\lambda a_a.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(a(g))\!: T(g[w(g)/1s])$

$[\![\text{CP}]\!] \approx \lambda a_a.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = (a(g))\!: g(1a)(1e)$ cried in $w(g)$

$[\![\textbf{T}^{\langle 1,a\rangle}]\!] = \lambda A_{at}.\lambda g_g\,.$ for $a = \lambda g''_g.g''\!: A(a)(g[a(g)/1a])$

$[\![\text{S}]\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(g)\!: g(1e)$ cried in $w(g)$

In effect, the move simply raises the type of CPs from type t to type $\langle a, t\rangle$, i.e. functions from assignment-variable-type denotations to sentence-type denotations. (75) continues to treat the complementizers as relating the complement to a modal domain. However, the role of specifying the domain is now reserved to the higher quantifier over assignments, as reflected in (76)–(78). (79)–(80) treat **CD** as specifying the modal domain for its clause, the 'if'-clause; however, in correlative constructions with the proform, the domain for the consequent clause is specified by the proform, bound by the 'if'-clause's assignment-binder. The remainder of the semantics, including the treatments of variables/traces (§2.1) and the generalized binder index (§3.5), are unchanged. (I return to interrogatives in §7.8.)[32]

7.6 Bare conditionals revisited: World-shifting and local readings

The general revision to the compositional semantics in §7.5 resolves our problem with the conditional proform from §7.4. The semantic value of a bare conditional such as (71) 'If it rained, he cried' is as follows:

(82) $[\![(71)]\!] \approx \lambda g_g\,.\,\big[\iota a_a(g)^*\!: \forall w' \text{ s.t. } w'(g) = @(a(g)), \text{it rained in } w'(g)\big]$
$\forall w \text{ s.t. } w(g) = \underline{@(a(g))}, \underline{g(1e)}$ cried in $w(g)$

$[\![\text{CP}''']\!] \approx \lambda a'_a.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(a'(g)), \underline{g(0a)}(1e)$ cried in $w(g)$

$[\![\text{CP}'']\!] \approx \lambda a'_a.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = \underline{@(g(2a))}, \underline{g(0a)}(1e)$ cried in $w(g)$

$[\![\text{CP}]\!] \approx \lambda a'_a.\lambda g_g\,.\,\forall w'' \text{ s.t. } w''(g) = \overline{@(a'(g))},$
$\big[\iota a_a(g)^*\!: \forall w' \text{ s.t. } w'(g) = @(a(g)), \text{it rained in } w'(g)\big]$
$\forall w \text{ s.t. } w(g) = \underline{@(a(g))}, \underline{g(0a)}(1e)$ cried in $w(g)$

[32]Now, in the general definition of the binder-index: with **that**, $\tau = s$, $\sigma = \langle a, t\rangle$, γ null; with **T** and **may**, $\tau = a$, $\sigma = t$, $\gamma = a$; with **think**, $\tau = a$, $\sigma = \langle e, t\rangle$, $\gamma = a$.

This treats (71) as saying, roughly, that the relevant assignment *h* such that it rained in the world of *h*, is such that $g_c(1e)$ cried in the world of *h*. The consequent's modal domain can be identified with the world of the assignment quantified over by the 'if'-clause ($=@(a(g))$), and without necessarily modifying the assignment for interpreting the individual-pronoun $g(0a)(1e)$. $g(0a)(1e)$ is modified by the topmost assignment-binder to $g(1e)$, capturing the global reading of the pronoun.

"Biscuit" interpretations and local readings of pronouns in the consequent remain possible in our revised semantics. Santorio (2012) argues that examples such as (83) involve a shifted (i.e. local) reading of 'I', referring to epistemic counterparts of the speaker (see 2012: 363n.2 for precedents).

(83) [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)

A local reading of 'I' is represented with an LF like (71) but in which the pronoun's assignment-variable is coindexed with the binder-index $^{\langle 2,a\rangle}$ on the 'if'-clause, e.g. $[\mathbf{I}_1\ \mathbf{g}_2]$. The derivation proceeds as in (82); however, when the clauses combine, $g(2a)(1e)$ is shifted to $a(g)(1e)$ (where $a(g)$ is again the relevant antecedent-verifying assignment). (As with shifting under attitude verbs, additional constraints could be added to ensure e.g. that in the intended interpretation $a(g_c)(1e)$ is an epistemic counterpart of $g_c(1e)$, who is the speaker of *c*.)[33]

[33]The syntax in this section treats the main clause in a conditional as a CP whose complementizer originates internal to the clause. Saying this raises the question of what generates the complementizer over embedded conditionals such as in (i).

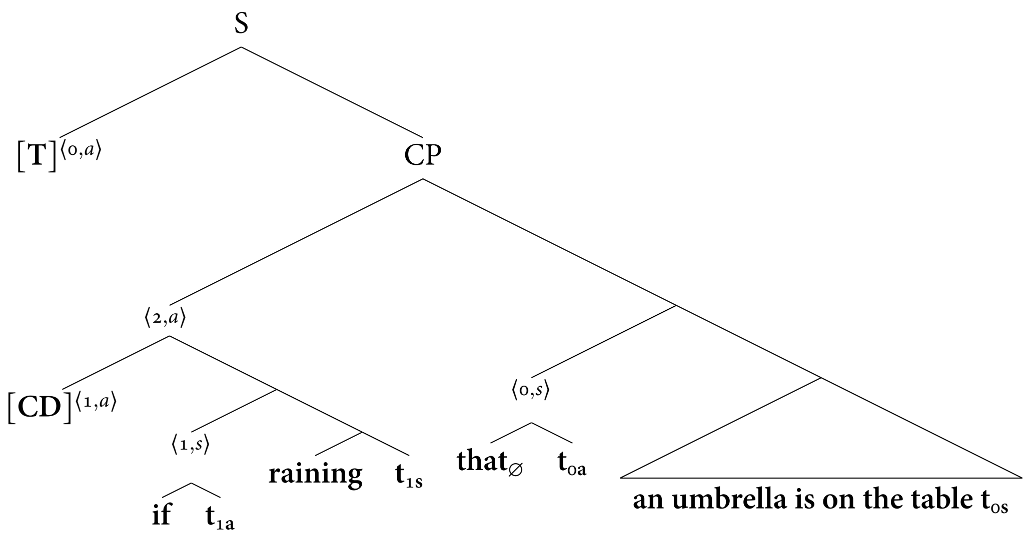
(i) Alice thinks $[_{CP}$ <u>that</u> $[[_{CP}$ if it rained $]$ $[_{CP}$ it cried$]]$

This issue with embedded conditionals is an instance of a general issue in the syntax of correlatives; correlatives in general follow the complementizer when embedded under a modal or attitude verb (e.g. de Vries 2002: 148–149). One option, following Iatridou & Kroch 1993, is to treat the embedded conditional as a CP-recursed structure: The higher complementizer over an embedded conditional (like embedded correlatives generally) would be generated by a general mechanism of CP-recursion — e.g., perhaps as in (ii). Since this isn't the place to delve into details of CP-recursion, a more detailed implementation of embedded conditionals must be left for elsewhere.

(ii) $[_S\ \mathrm{T}^{\langle 0,a\rangle}\ [_{CP}\ [\mathbf{that}_{\varnothing}\ \mathbf{t}_{0a}]^{\langle 0,s\rangle}\ [\ \text{Alice}\ [\ [\text{thinks}\ \mathbf{t}_{0s}]^{\langle 1,a\rangle}\ [_{CP}\ \underline{[\text{that}\ \mathbf{t}_{1a}]^{\langle 1,s\rangle}}\ [_{CP}\ [_{CP}\ \text{IF-CLAUSE}]^{\langle 2,a\rangle}$ $[_{CP}\ [\mathbf{Com}\ \mathbf{t}_{2a}]\ [_{CP}\ \underline{[\mathbf{that}_{\varnothing}\ \mathbf{t}_{1a}]^{\langle 1,s\rangle}}\ [_{IP}\ \ldots\ \mathbf{t}_{1s}\ \ldots\ ]\ ]]]]]]]$

Regarding relevance conditionals, one option is to represent them as above by LFs without the correlative proform. The modal domain for the main clause is specified by a higher assignment-binder such as **T**, as in (84).

(84) If it's raining, an umbrella is on the table.



$$[\![\text{CP}]\!] \approx \lambda a'_a.\lambda g_g\,.\,\forall w'' \text{ s.t. } w''(g) = @(a'(g)),$$
$$\big[\iota a_a(g)^{*}\!: \forall w \text{ s.t. } w(g) = @(a(g)), \text{it's raining in } w(g)\big]$$
$$\forall w' \text{ s.t. } \underline{w'(g) = @(a'(g))}, \text{an-umbrella-is-on-the-table in } w'(g)$$

$$[\![\text{S}]\!] \approx \lambda g_g\,.\,\forall w'' \text{ s.t. } w''(g) = @(g),$$
$$\big[\iota a_a(g)^{*}\!: \forall w \text{ s.t. } w(g) = @(a(g)), \text{it's raining in } w(g)\big]$$
$$\forall w' \text{ s.t. } \underline{w'(g) = @(g)}, \text{an-umbrella-is-on-the-table in } w'(g)$$

Let's recap. §§7.2–7.4 presented an assignment-variable-based account of 'if'-clauses as free relatives. In correlative constructions, such as hypothetical conditionals, the 'if'-clause is a free relative of assignments which binds a proform in the consequent. The revised compositional semantics in §7.5 correctly **links the clauses' modal domains**, and **generates the top-level assignment-binder** from the main-clause complementizer. The account provides mechanisms for capturing **local and global readings in both clauses**. Although there may be evidence for a covert operator in some bare conditionals (epistemic, generic, frequency; Lewis 1975, Kratzer 1991), we can capture the function of 'if'-clauses in modifying a modal domain **without needing to posit an additional operator** in the consequent.

7.7 Modalized conditionals: Restricting and shifting

Finally, let's turn to conditionals with an operator (possibly covert) in the consequent. The traditional Kratzerian line is that the 'if'-clause in a modalized conditional such as (85) restricts the domain of the modal.

(85) If it rains, he may cry.

a. ≈ for some epistemic possibility in which it rains, he cries

The framework for conditionals in this section provides several resources for capturing the role of 'if'-clauses in modifying the interpretation of a modal.

7.7.1 Direct restriction vs. Indirect restriction/modification

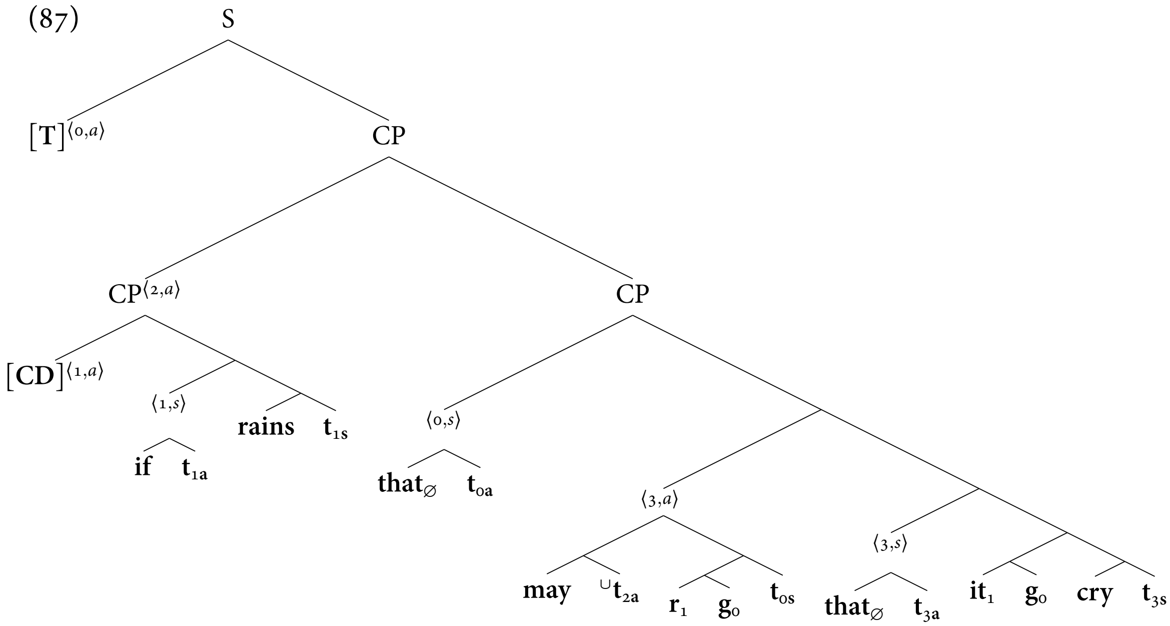
One option is to treat modal verbs, like **CD**, as taking a resource domain argument in addition to the modal background representing the reading of the modal (epistemic, deontic, etc.) (cf. von Fintel 1994). In conditionals the correlative binding requirement would be satisfied by coindexing the resource domain's assignment-variable with the binder index on the 'if'-clause, as reflected in (87).[34] ($^{\cup}$ takes a plural object and returns the set of (atomic and plural) objects that are its parts. For simplicity I ignore the resource domain restriction on **CD**.)

(86) $[\![\textbf{may}]\!] = \lambda r_{at}.\lambda r'_{at}.\lambda A_{a,at}.\lambda g_g \,.\, \exists a_a \text{ s.t. } r(a)(g) \wedge r'(a)(g) {:}\, A(a)(a)(g)$

$[\![^{\cup}]\!] = \lambda a^{*}_{a}.\lambda a'_{a}.\lambda g_g \,.\, a'(g) \leq a(g)$

[34]I indicate the closeness of the connection between the 'if'-clause and the modal's resource domain with an assignment-trace; however, it's contentious what exactly this connection is and whether it's derived via some sort of movement. Following von Fintel (1994), the relation is likely "a syntactic chain which is stronger than a binding relation. Perhaps it's an $\bar{\text{A}}$-chain" (88–89). For instance, in nested conditionals, the modal must receive the restriction of the closest 'if'-clause ('If you get back in time for the show, (then) if Timmy isn't tired, we'll have to take him').

(87)



$$
\begin{aligned}
[\![\text{S}]\!] \approx \lambda g_g\,.\,&\big[\iota a_a(g)^{*}\colon \forall w'' \text{ s.t. } w''(g) = @(a(g)), \text{it rains in } w''(g)\big] \\
&\forall w' \text{ s.t. } w'(g) = @(a(g)), \exists a' \text{ s.t. } a'(g) \leq a(g) \wedge g(1r)(w'(g))(a'(g))\colon \\
&\quad \forall w \text{ s.t. } w(g) = @(a'(g)), g(1e) \text{ cries in } w(g)
\end{aligned}
$$

Roughly, this treats the 'may' conditional as saying that the relevant (plural) assignment h^* in which the antecedent is verified is such that some accessible possibility that is a part of h^* verifies the consequent.

The above analysis captures both the correlative binding requirement and the restricting function of the 'if'-clause via the modal's resource domain variable. An alternative is to treat at least some modalized conditionals as **also having the correlative proform Com**. Including the correlative proform makes room for other ways in which an 'if'-clause may modify a modal's resource domain. The remainder of the section shows how the extra structure can help capture apparent **"double modal"** and **"information-sensitive"** readings of modalized conditionals.

7.7.2 "Double modal" readings

Examples such as (88) have led some theorists to posit that at least some modalized conditionals have a covert modal in addition to overt modal in the consequent (e.g. Frank 1996, Geurts 2004, von Fintel & Iatridou 2005, Swanson 2010).

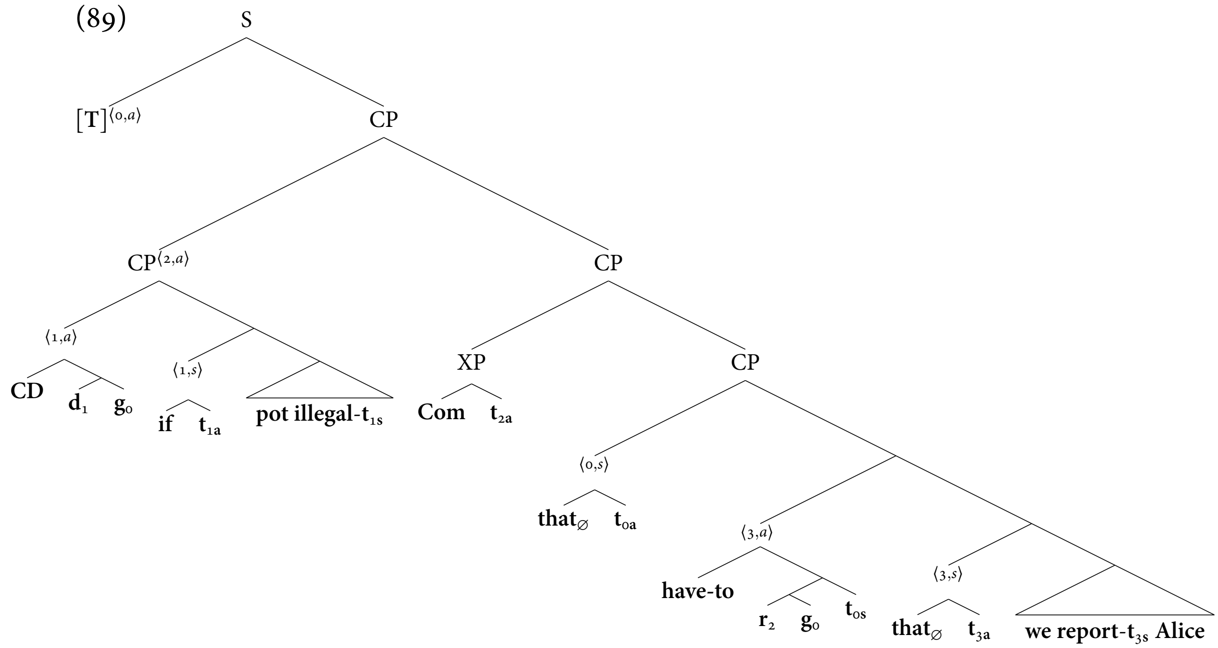
(88) If marijuana is illegal here, we have to report Alice. (cf. Geurts 2004: ex. 1)

a. ≈ 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 operator; the overt deontic modal in the consequent is evaluated at each world in the covert modal's restricted domain. The extra structure from the correlative proform can help capture such "double modal" readings without positing a covert modal.

A simplified LF and derivation for (88) are as follows. (Assume that in the intended interpretation $\mathbf{d}_1$ represents an epistemic resource domain, and $\mathbf{r}_2$ represents a modal background for the relevant laws.)

(89)



$$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\,\big[\iota a_a(g)^*\!: g(1d)(a(g)) \wedge \forall w' \text{ s.t. } w'(g) = @(a(g)), \text{marijuana is illegal in } w'(g)\big]$$
$$\forall w'' \text{ s.t. } w''(g) = @(a(g)),\ \forall a'_a \text{ s.t. } g(2r)(w''(g))(a'(g)):$$
$$\forall w''' \text{ s.t. } w'''(g) = w'''(a'(g)), \text{we report Alice in } w'''(g)$$

This says, roughly, that the relevant (plural) possibility h^* such that marijuana is illegal in $@(h^*)$ is such that for every possibility h' compatible with the laws in $@(h^*)$ (i.e. $h' \in g_c(2r)(@(h^*))$), we report Alice in $@(h')$ (n. 30). Note that although the modal's world-trace $\mathbf{t}_{0s}$ is coindexed with the main-clause complementizer, the world applied to the modal background is ultimately identified with the world of the antecedent-verifying possibilities (=@$(a(g))$). This combination captures the felt "double modal" interpretation: the 'if'-clause introduces a relevant possibility, and the overt modal's deontic modal background is indexed to the world of that possibility.

7.7.3 "Information-sensitivity"

In (89) the discourse determines that the modal's modal background $g_c(2r)$ represents the relevant laws. The "shifty" aspect of the interpretation is derived by applying the *shifted worlds* of the selected assignment introduced by the antecedent to the deontic modal background (function from worlds to sets of assignments) supplied by the *global context*. I suggest that LFs in which the modal-background variable is interpreted with respect to an assignment-variable bound by the 'if'-clause can help capture so-called **information-sensitive readings** and other apparent "shifty"/non-restricting functions of conditional clauses.

The informal intuition in the literature on information-sensitivity is that the modal's modal background seems (in some sense to be explained) to be updated in light of the information in the antecedent, as reflected in (90).[35] Contrast (88)–(89), where the modal's modal-background pronoun is interpreted with respect to the discourse assignment, with (91).

(90) [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.]

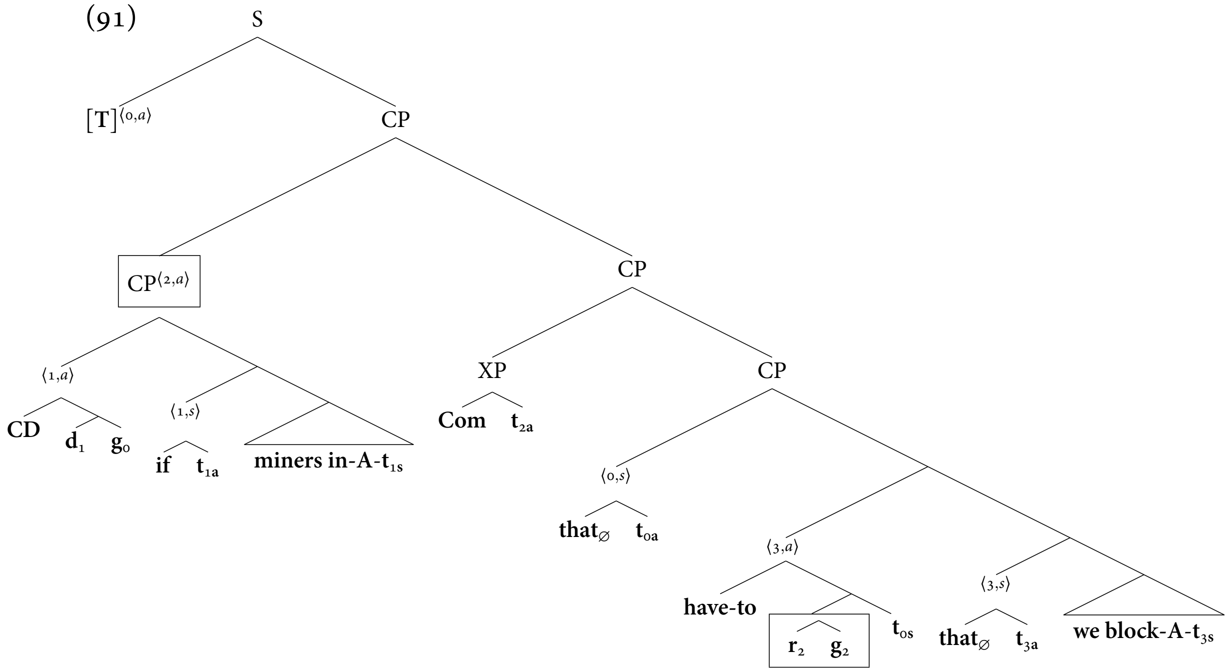
If the miners are in shaft A, we have to block shaft A.

(cf. Kolodny & MacFarlane 2010)

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

[35]On information-sensitivity in deontic conditionals, see e.g. Kolodny & MacFarlane 2010, Dowell 2012, Charlow 2013b, Cariani et al. 2013, Silk 2013, 2014b. On similar phenomena with modalized conditionals generally, see Charlow 2010, 2013a, Gillies 2010, Yalcin 2012, Moss 2015. Although the literature on information-sensitivity generally uses examples with weak necessity modals ('should', 'ought'), I use strong necessity modals such as 'have to' so as to abstract away from orthogonal complications regarding weak necessity modals. Given our purposes I ignore any potential differences between weak and strong necessity modals in information-sensitivity, though see Silk 2013, Charlow 2013b.

(91)



$$\begin{aligned}
[\![\text{S}]\!] \approx \lambda g_g \,.\, \big[\iota a_a(g)^{*}{:}\, g(1d)(a(g)) \wedge \forall w' \text{ s.t. } w'(g) = @(a(g)), \text{the miners are in shaft A in } w'(g)\big] \\
\forall w'' \text{ s.t. } w''(g) = @(a(g)), \forall a'_a \text{ s.t. } a(g)(2r)(w''(g))(a'(g)){:} \\
\forall w''' \text{ s.t. } w'''(g) = w'''(a'(g)), \text{we block shaft A in } w'''(g)
\end{aligned}$$

This treats the deontic conditional as saying, roughly, that [the relevant plural possibility h^* such that the miners are in shaft A in $@(h^*)$] is such that, for every possibility h' compatible with the deontic ideal determined by h^* ($\forall h' \in h^*(2r)(@(h^*))$), we block shaft A in $@(h')$.

The intuitive information-sensitive reading of (90) is diagnosed as a local reading of the modal's modal-background pronoun, which receives its interpretation from the topical possibility (assignment) introduced by the antecedent ($[\mathbf{r}_2\ \mathbf{g}_2]$). Crucially, this assignment h^* picked out by the 'if'-clause may be a **plural** object: it may include multiple assignments as parts. What determines that the deontic ideal represented by $h^*(2r)$ involves our blocking shaft A isn't merely a fact about the worlds of the individual parts of h^*, namely that the miners are in shaft A. As the literature on information-sensitivity has emphasized, the world of the discourse may be such a world and yet the deontic ideal involves our blocking neither shaft. Which deontic ideal, set of accessible worlds, etc. is determined by a possibility may be a feature of the possibility *qua plurality*. The plural possibility h^* represents a state throughout which the miners are in shaft A (n. 30). The discourse context, represented by an atomic assignment g_c, may be such that $g_c(2r)$ implies that we block neither shaft; yet its image under the plural function 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 $a(g_c)^*(2r)$ implying that we block shaft A.

Some theorists have appealed to information-sensitive readings to motivate revisions to the traditional semantics for conditionals. Very roughly, modals' domains of quantification are treated as determined relative to an evaluation world and an information state, i.e. set of worlds (e.g. Kolodny & MacFarlane 2010, Silk 2014b). To my knowledge the strategy of capturing information-sensitivity by appealing to pluralities hasn't been explored. Enriching domains to include plural objects may provide the structure to capture intuitions behind certain revisionary approaches while still relativizing modal backgrounds simply to worlds, as in the traditional semantics. A treatment of conditionals as plural definite descriptions may thus be of general interest, independent of the particular assignment-variable-based implementation developed here.

To recap, this section argued that we can capture restricting interpretations of 'if'-clauses as well as further apparent roles of 'if'-clauses in shifting/modifying a modal domain, and that we can do so without positing an additional covert modal and without modifying our previous treatments of modals or conditionals ('if', **CD**, modal backgrounds). Resources for capturing the data fall out of the general independently motivated apparatus: (i) the treatment of 'if'-clauses as free relatives (here of assignments), (ii) the interpretation of free relatives as plural definite descriptions, and (iii) the general assignment-variable-based approach to local/global readings. Though I focused on indicative conditionals, extensions to aspect, mood, and tense might provide fruitful resources for an assignment-variable-based treatment of counterfactuals.

7.8 Conditional questions

In closing I would like to consider one final application of the revised compositional semantics in this section: **conditional questions**, such as (92).

(92) If she raced, did she win?

Intuitively, whereas the possible answers in a non-conditional question partition the relevant space of possibilities, the possible answers to a conditional question partition the subdomain of possibilities that verify the antecedent. Capturing this idea has proven a persistent challenge for traditional approaches to questions and quantificational analyses of conditionals (Isaacs & Rawlins 2008, Groenendijk & Roelofsen 2009, 2010, Starr 2010; cf. Charlow 2010, 2011 on conditional imperatives). Additional challenges are to capture the varieties of local and global readings — notably, global readings in both clauses, local readings in both clauses relative to the supposition introduced by the 'if'-clause, and local readings in the interrogative consequent clause targeted by the question operator. We need mechanisms ensuring (i) that the topmost assignment-binder (whatever it is) links certain assignment-variables in both clauses to the discourse context; (ii) that the assignment-binder on the 'if'-clause links coindexed assignment-variables to the selected assignment, capturing local readings in the interrogative consequent that aren't targeted by the question; and (iii) that the assignment-binder on the question operator treats other assignment-variables in the consequent as targeted by the question. For instance, in the conditional-question analogue of the shifted-indexical example from Santorio 2012 in (94), we need to capture the global reading of 'it' in the 'if'-clause; the local reading of 'I' in the consequent, interpreted with respect to the selected shifted assignment; and the local reading of 'rich' and main predicate's world-argument in the consequent, targeted by the question operator and varying across possible answers.

(93) [Context: Like (83). 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? (cf. Santorio 2012)

(94) [Context: Like (93). The awoken amnesiac also can't quite remember if the experimenters were going to leave funds in one of the libraries or what the norms for richness are wherever he is.]

If it$_i$ landed heads, am I$_j$ in Widener and rich$_k$?

a. Possible answers, for selected (plural) assignment h in which $g_c(i)$ landed heads $\approx \{h' : h(j)$ is in Widener in $@(h')$ and has wealth in $@(h')$ at least as great as standard $h'(k)$ for counting as rich$\}$, $\{h'' : h(j)$ is in Widener in $@(h'')$ and has wealth in $@(h'')$ at least as great as standard $h''(k)$ for counting as rich$\}$, ...

I offer (95)–(96) as revised lexical entries for the interrogative complementizer **C**$_?$ and question operator **Q** — where, as in (39), the metalanguage expression '$h \approx_a h$' abbreviates that $h, h' \in G$ assign the same values for all a-type indices (are "a-equivalent"), and '$h \approx_{\neg a} h$' abbreviates that h, h' assign the same values for all indices of types other than type a (are "$\neg a$-equivalent"). A simplified derivation for a simple interrogative sentence such as (97) follows in (97).[36]

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

(96) $[\![\mathbf{Q}]\!] = \lambda \mathcal{A}_{\langle a,at\rangle}.\lambda g_g.\lambda T_t.\lambda g'_g\ .$
$\exists a_a \text{ s.t. } \forall h_g : a(h) \approx_{\neg a} g,$
$\forall A'_{at} \text{ s.t. } A' = \mathcal{A}(a),$
$T = [\lambda g'' : g'' \approx_a g'\ .\ A'(a)(g'') = A'(a)(g')]$

(97) 'Did it laugh?'

a. LF: $[_{\text{S}}\ \mathbf{Q}^{\langle 1,a\rangle}\ [_{\text{CP}}\ [\mathbf{C}_?\ \mathbf{t_{1a}}]^{\langle 1,s\rangle}\ [_{\text{TP}}\ [\mathbf{it}_1\ \mathbf{g}_1]\ [\mathbf{laugh}\ \mathbf{t_{1s}}]\ ]]]$

b. $[\![\text{TP}]\!] = \lambda g_g\ .\ g(1a)(1e)$ laughed in $g(1s)$
$[\![[\mathbf{C}_?\ \mathbf{t_{1a}}]^{\langle 1,s\rangle}]\!] = \lambda T_t.\lambda a_a.\lambda g_g : g = a(g)\ .\ \forall w \text{ s.t. } w(g) = @(a(g)), T(g[w(g)/1s])$
$[\![\text{CP}]\!] \approx \lambda a_a.\lambda g_g : g = a(g)\ .\ \forall w \text{ s.t. } w(g) = @(a(g)),\ g(1a)(1e)$ laughed in $w(g)$
$[\![\mathbf{Q}^{\langle 1,a\rangle}]\!] = \lambda A_{at}.\lambda g_g.\lambda T_t.\lambda g'_g\ .\ \exists a_a \text{ s.t. } \forall h_g : a(h) \approx_{\neg a} g,$
$\forall A'_{at} \text{ s.t. } A' = [\lambda a'''.\lambda g'''\ .\ A(a''')(g'''[a(g''')/1a])]],$
$T = [\lambda g'' : g'' \approx_a g'\ .\ A'(a)(g'') = A'(a)(g')]$
$[\![\text{S}]\!] \approx \lambda g_g.\lambda T_t.\lambda g'_g\ .\ \exists a_a \text{ s.t. } \forall h_g : a(h) \approx_{\neg a} g,$
$\forall A'_{at} \text{ s.t. } A' = [\lambda a'''_a.[\lambda g'''_a : g''' = a'''(g''')\ .\ \forall w \text{ s.t. } w(g''') = @(a'''(g''')),$
$a(g''')(1e)$ laughed in $w(g''')]],$
$T = [\lambda g'' : g'' \approx_a g'\ .\ A'(a)(g'') = A'(a)(g')]$

The net effect from the interaction of the interrogative complementizer and question operator is as in §6: question meanings are treated as sets of possible answers, where answers are represented as sets of assignments and possible answers may differ in (inter alia) the values assigned to certain context-sensitive expressions. The revised lexical entry for $\mathbf{C}_?$ in (95) maintains uniform types for declarative and interrogative clauses, now type $\langle a, t\rangle$, i.e. sets of assignment-variable denotations. What distinguishes the interrogative complementizer is that it presupposes that the image of the input assignment g under the given assignment-variable denotation a is identical to g. The question operator **Q** then constructs a partition of possible answers T from the associated singleton set A'. **Q** existentially quantifies over assignments that are equivalent to the input discourse assignment g_c for all non-assignment indices ($a(h) \approx_{\neg a} g_c$, for any h_g). The binder-index attaching to **Q** ensures that all

[36]In the general definition of the binder-index, with $\mathbf{C}_?$ (like with **that** and **if**), $\tau = s$, $\sigma = \langle a, t\rangle$, γ null; and with **Q**, $\tau = a$, $\sigma = \langle g, tt\rangle$, $\gamma = a$.

coindexed assignment-indices are mapped to such an assignment, capturing global readings. The assignments quantified over may differ in their values for assignment-indices, capturing local readings targeted by the question. The result for the simple interrogative sentence in (97) is that it denotes 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 the contextually relevant individual $a(g'')(1e) = g_c(1e)$ laughed in the world of g''.

Maintaining the uniform type for declarative and interrogative CPs allows us to avoid introducing type-flexible lexical entries for sentence adverbials/operators; the lexical entries for **CD** and the correlative proform **Com** remain as in §7.5.[37] A result for a conditional question such as (93) is as follows. (I continue to suppress certain irrelevant assignment modifications, and ignore any resource domain variable in the 'if'-clause. For simplicity assume a toy context-sensitive semantics for positive form relative gradable adjectives such as (98), letting **d** be a variable for degrees d and 'o is s-rich' abbreviate that o's degree of wealth is at least as great as the degree-standard s for counting as rich.[38]

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

[37] There may be other reasons for introducing type-flexible lexical entries depending on one's treatment of other clause types. I leave investigation of other clause types, e.g. imperatives, for future work.

[38] Further intermediate calculations are again left to the reader:

$[\![\text{CP}''']\!] \approx \lambda a_a . \lambda g_g : g = a(g) \,.\, \forall w$ s.t. $w(g) = @(a(g)), g(2a)(1e)$ is $g(4a)(1d)$-rich in $w(g)$

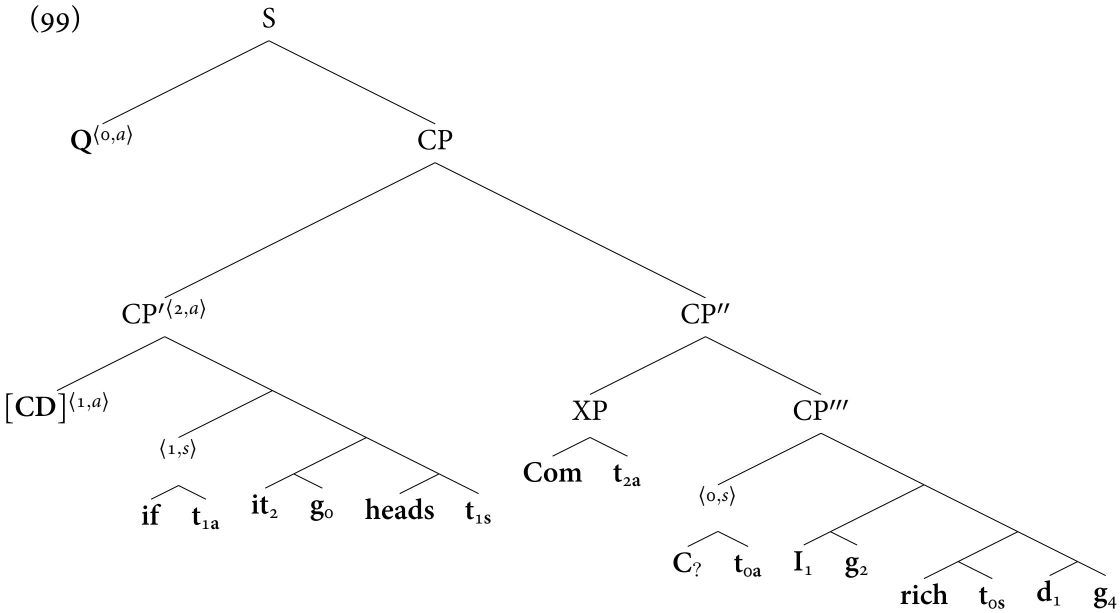
$[\![\text{CP}'']\!] \approx \lambda a_a . \lambda g_g : g = g(2a) \,.\, \forall w$ s.t. $w(g) = @(g(2a)), g(2a)(1e)$ is $g(4a)(1d)$-rich in $w(g)$

$[\![\text{CP}]\!] \approx \lambda a''_a . \lambda g_g \,.\, \forall w''$ s.t. $w''(g) = @(a''(g))$,

$\big[\iota a_a(g)^* : \forall w'$ s.t. $w'(g) = @(a(g)), g(0a)(2e)$ landed heads in $w'(g)\big]$

$\forall w$ s.t. $w(g) = @(a(g)), a(g)(1e)$ is $g(4a)(1d)$-rich in $w(g)$, provided $g = a(g)$

(99)



$$
\begin{aligned}
&[\![\mathrm{S}]\!](g_c) \approx \lambda T_t.\lambda g'_g\,.\ \exists a'_a \text{ s.t. } \forall h_g : a'(h) \approx_{\neg a} g_c,\\
&\quad \forall A'_{at} \text{ s.t. } A' = \big[\lambda a'''_a.\big[\lambda g'''_a\,.\,\big[\iota a_a(g''')^{*} \colon \forall w' \text{ s.t. } w'(g''') = @(a(g''')),\\
&\qquad a'(g''')(2e) \text{ landed heads in } w'(g''')\big]\ \forall w \text{ s.t. } w(g''') = @(a(g''')),\\
&\qquad\quad a(g''')(1e) \text{ is } g'''(4a)(1d)\text{-rich in } w(g'''), \text{ provided } g''' = a(g''')\big]\big]\\
&\quad T = \big[\lambda g''_g : g'' \approx_a g'\,.\ A'(a')(g'') = A'(a')(g')\big]
\end{aligned}
$$

Very roughly, the semantic value of the conditional question is a set of propositions T, where each such proposition is a set of assignments g'' which determine the same standard s for counting as rich (=$g''(4a)(1d)$, via $g'' \approx_a g'$) and return the same truth value for the proposition that the relevant plural assignment $a(g'')^*$ in which the coin $a'(g'')(2e)$ (=$g_c(2e)$, via $a'(g'') \approx_{\neg a} g_c$) landed heads is such that the shifted individual $a(g'')(1e)$ is s-rich in the world of $@(a(g''))$.

The proposed revised semantics captures the general desiderata regarding local/global readings in questions from §6 and the data specific to conditional questions from earlier in this subsection. First, the global reading of the pronoun 'it' is captured via the restriction in the question operator's quantification over assignments — namely, that the functions a' quantified over map any assignment to an assignment that assigns the same values as g_c to all non-assignment indices. The assignments g'' throughout the possible answers T agree in identifying $a(g'')(2e)$ with the relevant object $g_c(2e)$ determined by the discourse assignment.

Second, the compositional interaction of the proform **Com** and interrogative complementizer $\mathbf{C}_?$ derives how the question denoted by the main clause partitions the plural assignment denoted by the 'if'-clause. **Com** identifies the input assignment with the selected shifted assignment and links the world-variable of 'rich' with the worlds of this assignment (n. 30). The assignments in each cell T are thereby restricted to assignments that verify the antecedent. The pronoun 'I' in the interrogative consequent receives a local reading under the 'if'-clause supposition without necessarily receiving a local reading under the question operator.

An additional comment on interpreting the metalanguage quantification over assignments is in order. The arguments of a^* vary across the assignments g', g'' throughout the set of propositions T; however, as discussed in §2.2, the items in terms of which the uniqueness condition is stated are images of the given assignment under a, i.e. items $g \in G$ in the model. The metalanguage expression "$\iota a(g)^*: \ldots$" abbreviates the quantificational condition that for some function $a \in D_a$, its value constitutes *the unique maximal plurality* $h^* \in G$ such that $g_c(2e)$ landed heads in the world of h (i.e. the world of every atomic part $h \leq h^*$ of h^*) and … (§7.3). Varying the argument of a has no effect on which $h^* \in G$ constitutes the unique such maximal plurality in the model.

In these ways, the semantics derives the inventory of local/global readings for conditional questions — 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' varies across the question's possible answers via the free degree-standard pronoun targeted by the question operator. By contrast, the interpretations of the pronouns 'it' and 'I' are constant across cells — the former receiving a global reading anchored to the discourse context via the condition $a'(h) \approx_{\neg a} g_c$ and binder-index on $\mathbf{Q}^{\langle o,a \rangle}$; the latter receiving a local reading anchored to the shifted (plural) assignment via the binder-index attaching to the 'if'-clause. I am not aware of other accounts of conditionals, questions, or conditional questions which similarly derive the observed range of local and global readings.

8 *wh*-words, relative clauses, and donkeys

This section extends the treatments of *yes*/*no*-questions and 'if'-clauses as free relatives/correlatives from §§6–7 to other types of interrogatives and subordinate clauses. I offer a general treatment of *wh*-words, relative determiners, and indefinites as *choice-function pronouns*. §8.1 introduces the account with basic and multiple *wh*-questions. §8.2 extends the account of *wh*-words in interrogatives to relative pronouns, and motivates a treatment of determiner quantifiers in headed relative clauses as quantifying over assignments. §8.3 applies the treatment of relative clauses from §8.2 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 §8.4. Principal features of the proposed assignment-variable-based account are as follows:

- it provides a **unified analysis** of *wh*-words, relative determiners, and indefinites;
- the treatment of *wh*-words is compatible with ***in situ* and non-*in situ*** examples;
- 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**.

To keep the discussion manageable I abstract away from contentious issues regarding e.g. *wh*-movement (whether, why, and when it occurs), pied-piping, and the relations between *wh*-words and relative pronouns cross-linguistically. I leave it to future research to examine how the proposed account may be applied to further recalcitrant phenomena and other languages.

8.1 *wh*-interrogatives

The account of questions from §§6, 7.8 focused on *yes/no* questions. This section extends the account to simple questions expressed with *wh*-words, as in (100)–(102).

(100) Who laughed?

(101) Which baby cried?

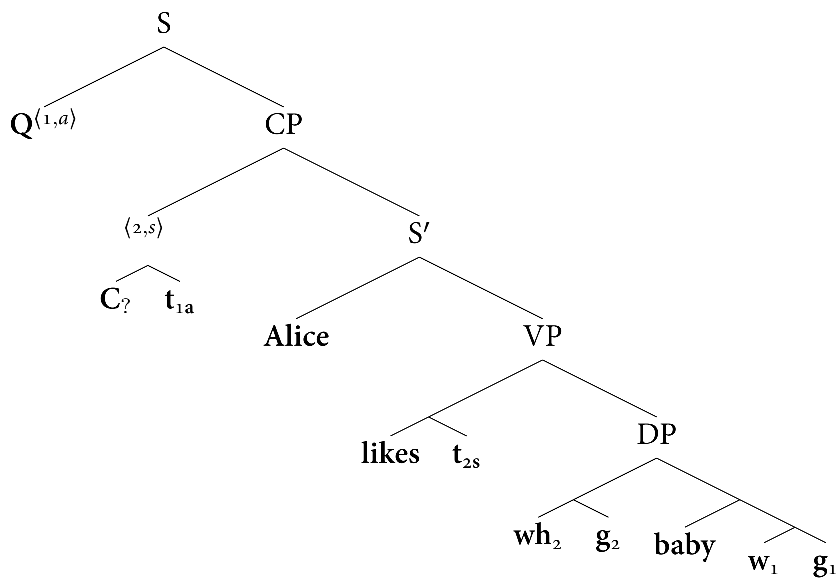
(102) Which baby liked which toy?

The basic account is straightforward: I treat *wh*-words as **choice-function pronouns**. A choice function F_{cf} of individuals (type $\langle et, e\rangle$) selects a particular individual (type e) from a non-empty set of individuals (type $\langle e, t\rangle$). (I will use 'cf' and 'F_{cf}' specifically for indices/variables of type $\langle et, e\rangle$ that are choice functions.)

(103) A function $F \in D_{\langle \tau t, \tau \rangle}$ is a **choice function** iff $\forall P_{\tau t} \neq \varnothing : P(F(P))$.

In interrogatives the *wh*-word is represented by a choice-function pronoun $[\mathbf{wh_i}\ \mathbf{g_j}]$ with a free assignment-variable; I assume that *wh*-words, having the feature [WH], cannot have the same assignment-variable as the interrogative complementizer. Given the semantics for the question operator in (96), the selected individual varies across possible answers, as shown in (104). 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. (Recall $^{\downarrow}$ which "lowers" an item in a domain to an item composed out of associated elements of the model ((12)). 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.)

(104) Alice likes which baby?



$[\![\mathbf{wh_2}\ \mathbf{g_2}]\!] = \lambda P_{et}.\lambda g_g \,.\, g(2a)(2\text{cf})(^{\downarrow}P)$

$[\![\text{DP}]\!] = \lambda g_g \,.\, g(2a)(2\text{cf})(baby_{g(1a)(1s)})$

$[\![\text{CP}]\!] \approx \lambda a_a.\lambda g_g : g = a(g) \,.\, \forall w \text{ s.t. } w(g) = @(a(g)),$
Alice likes $g(2a)(2\text{cf})(baby_{g(1a)(1s)})$ in $w(g)$

$[\![\text{S}]\!](g_c) \approx \lambda T_t.\lambda g'_g \,.\, \exists a_a \text{ s.t. } \forall h_g : a(h) \approx_{\neg a} g_c,$
$\forall A'_{at} \text{ s.t. } A' = [\lambda a'''_a.[\lambda g'''_a : g''' = a'''(g''') \,.\, \forall w \text{ s.t. } w(g''') = @(a'''(g''')(1s)),$
Alice likes $g'''(2a)(2\text{cf})(baby_{a(g''')(1s)}$ in $w(g''')]],$
$T = [\lambda g'' : g'' \approx_a g' \,.\, A'(a)(g'') = A'(a)(g')]$

Very roughly, the meaning of the *wh*-question is a set of propositions T, where each such proposition is a set of assignments g'' that select the same $o \in E$ from the set of babies in $a(g'')(1s) = g_c(1s)$ and return the same truth value for the proposition that Alice likes o.

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 such as (104) with presuppositional predicates in interrogatives may motivate reintroducing the above metasemantic assumption. The possible answers to (104) are about individuals that are babies in the *evaluation* world. Parallel to the intuitively free pronouns 'he'/'it' in (53)/(97), the world-pronoun $[\mathbf{w}_1\ \mathbf{g}_1]$ coindexed with the question operator is linked to the world assigned by the discourse assignment. However, the present semantics for **Q** doesn't itself identify that world as the world of the discourse, $@(g_c)$. One could revise the semantics to explicitly make this identification, but such a revision strikes me as unnecessary. Every account must adopt some metasemantic assumptions — whether 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, as mentioned in §§3.4, 7.6). 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. I revise the metalanguage definition of τ-equivalence $g \approx_\tau h$ accordingly to leave open whether g and h agree on what world is the world of the possibility represented by the assignment, i.e. whether $g(1s) = h(1s)$. A relation $\approx_a^@$ can be introduced to make this additional requirement:

(105) "Weak τ-equivalence" (revised; cf. (52))

a. $h \approx_\tau h' := \forall \mathrm{i}\colon \mathrm{i}\tau \neq 1s \rightarrow h(\mathrm{i}\tau) = h'(\mathrm{i}\tau)$

b. $h \approx_{\neg\tau} h' := \forall \mathrm{i} \forall \sigma \neq \tau\colon \mathrm{i}\sigma \neq 1s \rightarrow h(\mathrm{i}\sigma) = h'(\mathrm{i}\sigma)$

(106) "Strong τ-equivalence"

a. $h \approx_\tau^@ h' := \forall \mathrm{i}\colon h(\mathrm{i}\tau) = h'(\mathrm{i}\tau) \wedge h(1s) = h'(1s)$

b. $h \approx_{\neg\tau}^@ h' := \forall \mathrm{i} \forall \sigma \neq \tau\colon h(\mathrm{i}\sigma) = h'(\mathrm{i}\sigma) \wedge h(1s) = h'(1s)$

Second, the local reading of the *wh*-phrase 'which baby' is captured by the free assignment-variable $\mathbf{g}_2$ in the representation of the *wh*-word 'which'. The assignments g'' in each cell T assign the same value to the arbitrary assignment-index

2*a* and hence determine the same choice function $g''(2a)(2\text{cf})$ and select the same individual $o \in E$ (via the constraint $g'' \approx_a g'$). Yet the particular value assigned and individual selected may differ across cells: if o_1, o_2, o_3 are the babies, the possible answers T will be the propositions that Alice liked o_1, that Alice liked o_2, and that Alice liked o_3. The *wh*-phrase is targeted by the question and the possible answers may be about different individuals.

Third, as with other determiners, there may be reasons for incorporating domain variables to further restrict the domains of *wh*-words. In (104) the domain variable may be treated as sister to 'baby' or as an additional argument of 'which' (see n. 29), restricting the domain of the choice-function pronoun to a set of contextually relevant babies. For simplicity I continue to bracket such additional structure (see §7.2).

Fourth, it is common in various approaches to the semantics of questions to require all *wh*-phrases to be in a specifier position of the interrogative complementizer at LF.[39] A (by no means insurmountable) challenge for such accounts is to motivate 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 variations in pronunciation rules for *wh*-words (i.e., languages requiring all *wh*-words to be fronted (Bulgarian), requiring all *wh*-words to be *in situ* (Japanese), or allowing variation in movement (English)). The language-specific and cross-linguistic data, as regarding reconstruction, pied-piping, focus, and ellipsis, are notoriously complex. I won't pretend to be in a position to address such issues here. Suffice it to say that the present account can capture the local reading of the *wh*-phrase and the contribution of *wh*-words to the semantics of the question without requiring or forbidding movement to SpecCP at LF. The account is compatible with various approaches to the syntax/phonology of *wh*-movement and reconstruction in different languages.

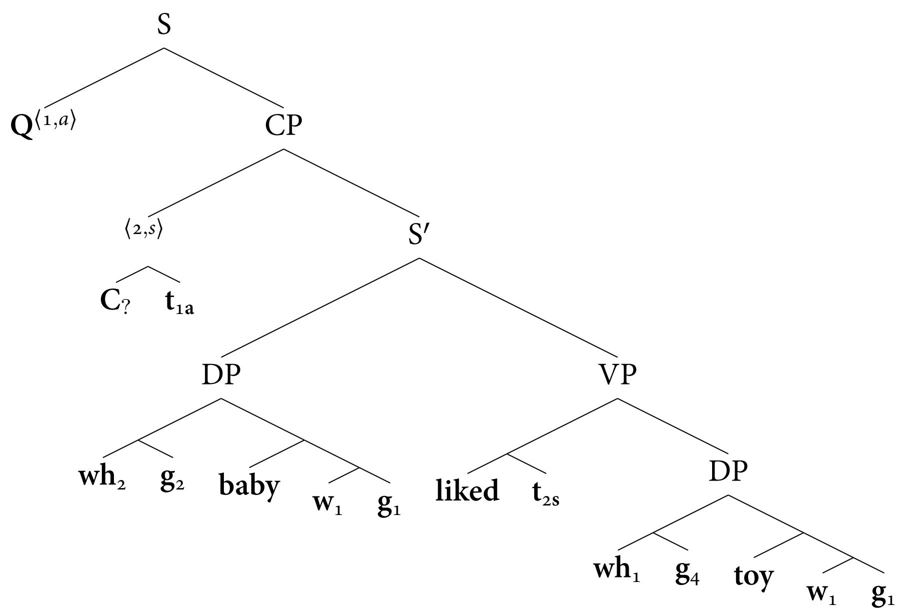
The above treatment of simplex *wh*-questions generalizes to interrogatives with multiple *wh*-phrases. In a multiple *wh*-question the question operator targets the pair of *wh*-phrases. The question in (107) is about the proper pairing of the relevant babies/toys in the discourse, as derived in (108). (I will bracket complications about exhaustivity and single-list vs. pair-list readings and answers (e.g. Dayal 1996). I continue to leave the *wh*-phrases *in situ* below the complementizer.)

(107) a. *Which baby* liked *which toy*?

b. Possible answers: Timmy liked the doll, Clio liked the blocks, Gabriel liked the stuffed animal, …

[39] E.g. Karttunen 1977, Pesetsky 2000, Cable 2010; contrast Chomsky 1995, Kratzer & Shimoyama 2002. The movement may be triggered for syntactic reasons, e.g. that any XP headed by an item with [+wh]-features move to SpecCP, or purely semantic reasons (e.g. Kotek 2014).

(108) Which baby liked which toy?



$$
\begin{aligned}
&[\![\mathrm{S}]\!](g_c) \approx \lambda T_t.\lambda g'_g\,.\ \exists a_a \text{ s.t. } \forall h_g : a(h) \approx_{\neg a} g_c,\\
&\quad \forall A'_{at} \text{ s.t. } A' = [\lambda a'''_a.[\lambda g'''_a : g''' = a'''(g''')\,.\ \forall w \text{ s.t. } w(g''') = @(a'''(g''')),\\
&\qquad g'''(2a)(2\mathrm{cf})(baby_{a(g''')(1s)}) \text{ liked } g'''(4a)(1\mathrm{cf})(toy_{a(g''')(1s)}) \text{ in } w(g''')]],\\
&\quad T = [\lambda g'' : g'' \approx_a g'\,.\ A'(a)(g'') = A'(a)(g')]
\end{aligned}
$$

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 semantic value of the question is the set of propositions that b_i liked t_j. As in (104), whereas the world-argument of the main predicate 'liked' is linked to the local evaluation world — the world of the assignment in such-and-such answer T — the world-pronouns in the presuppositional noun phrases 'baby' and 'toy' correctly refer to $a(g'')(1s) = g_c(1s)$, which is taken to represent the world $@(g_c)$ of the discourse.

8.2 Relative clauses

This section examines how the treatments of 'if'-clauses as free relatives from §7 and of interrogative *wh*-words as choice-function pronouns from §8.2 might be extended to a general assignment-variable-based account of *wh*-words, relative pronouns, and relative clauses. I focus primarily on headed restrictive relative clauses such as (109) — 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’).

(109) 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 presently.)

8.2.1 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 (109a) 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):

(110) 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).

(111) "Head-external" analysis:

$[_{DP}\ [_{D^o}$ every $[_{NP}$ [baby $[_{CP_{rel}}$ which$_i$ $[_{\overline{C}}$ [C_{rel} $[_{IP}$ t_i 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 (112). (I consider the position of the relative phrase and the nature of the gap position shortly.)[40]

(112) "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 (109a). 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

[40]An alternative "matching" analysis treats the head NP as having representations internal *and* external to the relative CP (Sauerland 2003). Sauerland's analysis adopts more controversial assumptions about the syntax/phonology interface, and so I put it aside. What is important in what follows is simply that the nominal head can reconstruct to 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 extensive discussion of the syntax of relative constructions cross-linguistically, see Chomsky 1977, Dayal 1996, de Vries 2002.

'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').

To my knowledge 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 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.[41] Other things equal it would be preferable to provide a 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

[41]More formally, Bhatt's account proceeds from a full chain such as (i-a) to (i-b), where deleting the non-lowest copies leaves a binder index in the position of the highest copy; and from (i-b) to (i-c) by Trace Conversion, which replaces the relative phrase with the variable-bound definite description.

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

(cf. Bhatt 2002: exs. 35–38)

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/interrogative complementizers raise 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) There is a divide in approaches to interrogative *wh*-words about whether they are related to relative determiners, typically construed as λ-binders (GROENENDIJK & STOCKHOF 1982), or related to indefinites such as 'a' (KARTTUNEN 1977). I will suggest a **unified analysis of relative determiners, *wh*-words, and indefinite determiners as choice-function pronouns**. (More on indefinites in §8.3.)

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

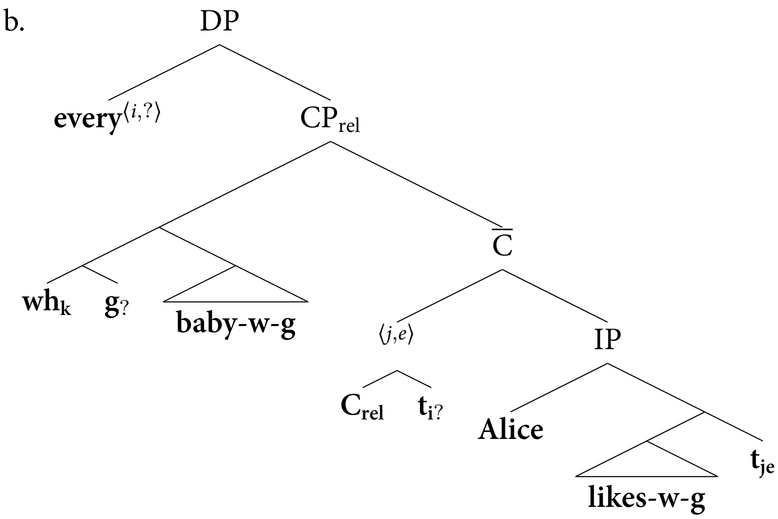
- *Head raising:* the head NP is interpreted inside in the relative clause at LF, specifically as sister to the relative determiner in $\text{SpecCP}_{\text{rel}}$
- *D-complement:* the relative clause CP_{rel} is the complement of the matrix determiner
- *Syntax/semantics interface:*
  - the relative complementizer raises for type reasons from its IP complement, specifically from the (individual) gap position;
  - the matrix determiner raises for type reasons from its CP_{rel} complement, specifically from an internal argument of the relative complementizer
- *Semantics:* relative determiners and interrogative *wh*-words (and indefinite determiners) denote choice-function pronouns

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

(113) LF: *Headed relative DP: D+CP*$_{rel}$ (preliminary)

a. ‘every baby which Alice likes’

b.

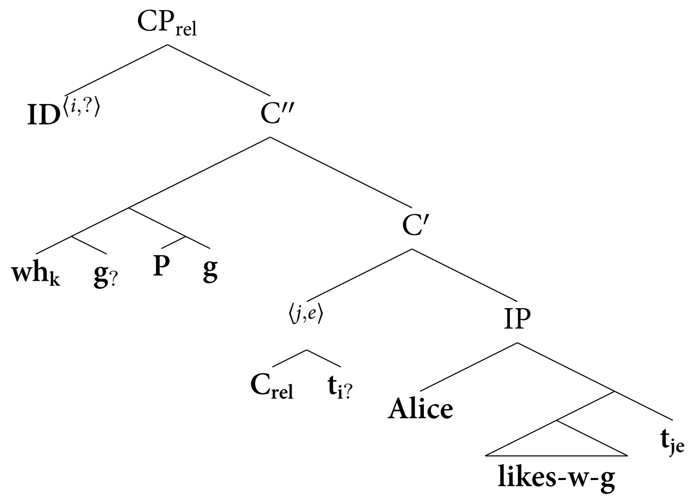


Free relatives may be treated similarly, parallel to the treatment of ‘if’-clauses from §7. In headed relatives the matrix determiner raises from an internal argument of the complementizer to head the DP and the overt relative phrase restricts the determiner’s restrictor argument. In free relatives what raises is the implicit definite operator — call it **ID** (for “Individual Description”) analogous to **CD** — and the domain of **ID** is implicitly restricted. If free relatives are CPs, **ID** raises to a specifier position of CP$_{rel}$, as in (114). Alternatively, if free relatives are DPs with a covert D (Caponigro 2002), the LF is precisely parallel to (113); **ID** is the covert analogue of the matrix determiner in a headed relative clause, as in (115). (Free relative ‘what’ may be glossed, informally, as “which (relevant) thing.”)

(114) LF: *Free relative as CP_{rel}* (preliminary; cf. (65))

a. 'what Alice likes'

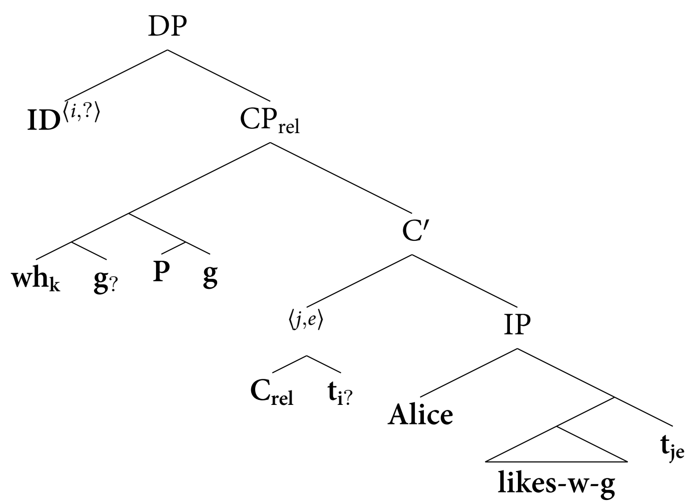
b.



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

a. 'what Alice likes'

b.



8.2.2 Detour: Indefinites

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, let's take a brief detour to examine indefinites.

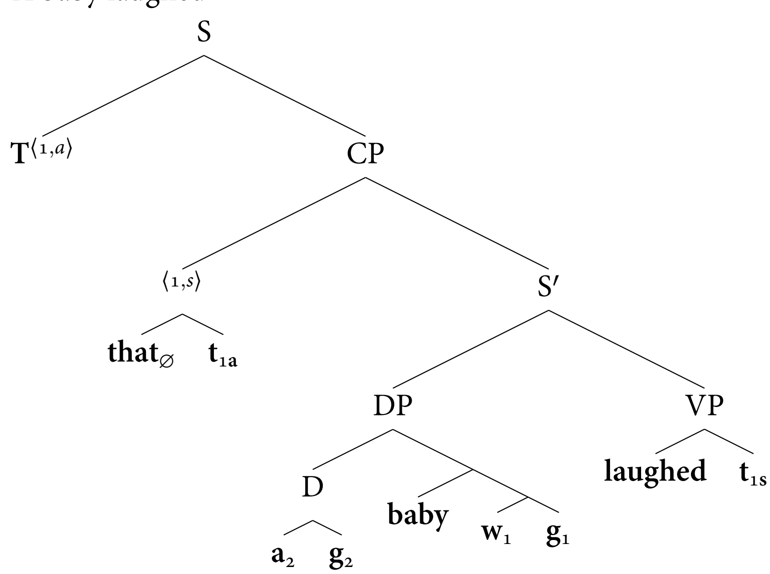
A common approach in both dynamic and non-dynamic theories treats indefinites as introducing a (new) variable, as for an individual or choice function (e.g., Kamp 1981, Heim 1982, Reinhart 1997). As noted in §8.1, a prominent move is to assimilate *wh*-words to indefinites (Karttunen 1977). So suppose we treat (at least some) indefinite determiners, such as 'a', like *wh*-words as choice-function pronouns (§8.1; cf. Reinhart 1997, Kratzer 1998). In interrogative *wh*-sentences the existential quantification over individuals is derived from the interaction between the free choice-function pronoun (representing the *wh*-word) and the semantics of the question operator. Analogously, in declarative sentences with nonspecific indefinites, the existential quantification over individuals is derived from the interaction between the free choice-function pronoun (representing the indefinite determiner) and existential closure. The existential closure operation can be implemented in the metasemantics via a revised definition of truth-in-a-context, as in (116)–(117). (Variables $\mathbf{a_i}$, like $\mathbf{wh_i}$, are variables for choice functions (§8.1).)

(116) **Truth-in-a-context** (revised):

A declarative sentence S is true in c iff $\exists g' \approx^{@}_{\neg a} g_c$: $[\![S]\!](g') = 1$

- ($\approx$ S is true in c iff S is true given some possibility g' equivalent to g_c except possibly in values assigned to assignment indices)

(117) 'A baby laughed'



$[\![\mathbf{a_2}\ \mathbf{g_2}]\!] = \lambda P_{et}.\lambda g_g\,.\,g(2a)(2\text{cf})({\downarrow}P)$

$[\![\text{DP}]\!] = \lambda g_g.g(2a)(2\text{cf})(baby_{g(1a)(1s)})$

$$[\![\mathrm{S}]\!] \approx \lambda g_g. \forall w \text{ s.t. } w(g) = @(g),\ g(2a)(2\mathrm{cf})(baby_{g(1s)}) \text{ laughed in } w(g)$$

$$[\![\mathrm{S}]\!] \text{ is true in } c$$

$$\text{iff } \exists g' \approx^{@}_{\neg a} g_c\text{: } \forall w \text{ s.t. } w(g') = @(g'),\ g'(2a)(2\mathrm{cf})(baby_{g'(1s)}) \text{ laughed in } w(g')$$

This says, roughly, that (117) is true in *c* iff there is a choice function that selects a laugher from among the babies.

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 (118), and specific readings about a particular individual, as in (119), where the indefinite is specific relative to an attitude subject, supposition, or quantificational subject (Abusch 1994, Kratzer 1998), as in (120)–(122). The intermediate reading of (121) 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.).

(118) 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

(119) 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

(120) 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*)

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

(122) 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:

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

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

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

(125) 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 (125) 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 interpretation of pronouns' assignment-variables, so too, at least in some cases, with determiner quantifiers. In what follows I suggest a syntax/semantics of determiner quantifiers as assignment-quantifiers, focusing on the issues with relative clauses from §8.2.1. §§8.3–8.4 apply the semantics to several types of pronominal anaphora. I leave potential further applications, such as to specific indefinites and other linguistic/discourse anaphora, for future work.

8.2.3 Semantics: Assignment-quantification with determiners

Our question at the end of §8.2.1 concerned the type of the internal argument of the relative complementizer and the nature of the quantification introduced by the determiner. In light of the shifting phenomena observed in §8.2.2 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). Drawing on the treatment of the interrogative complementizer, I offer the following lexical entry for the relative complementizer $\mathbf{C_{rel}}$:

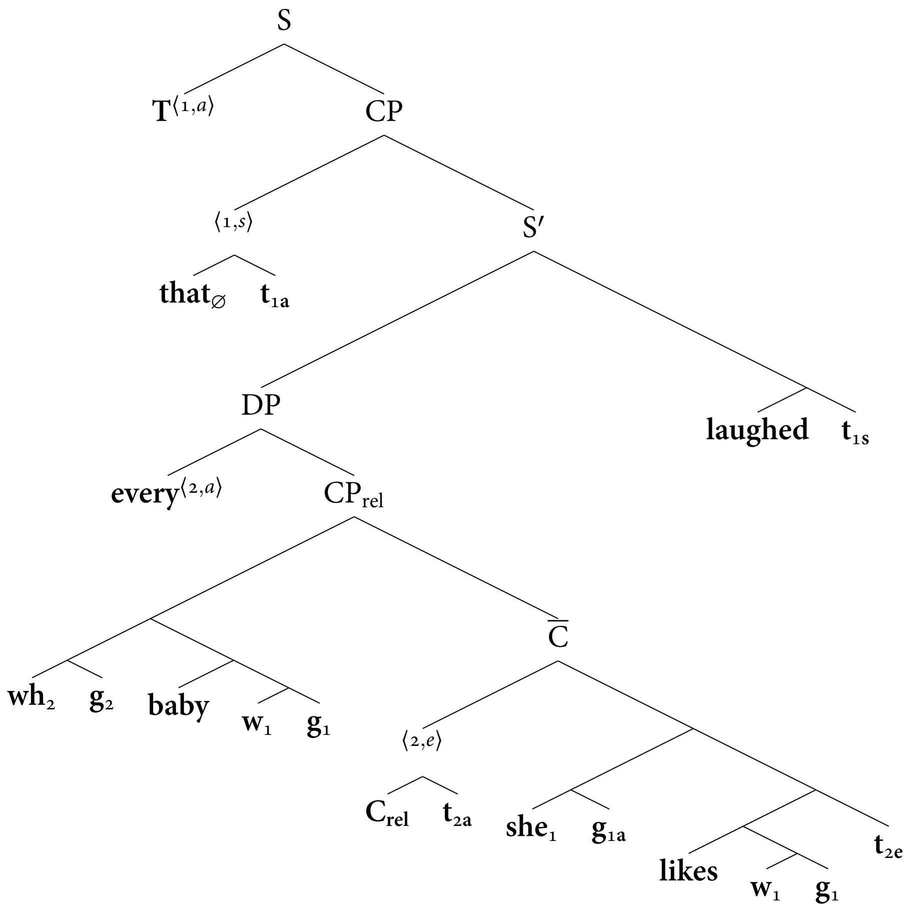
(126) $[\![\mathbf{C_{rel}}]\!] = \lambda a_a.\lambda P_{et}.\lambda y_e.\lambda x_e.\lambda g_g\,.\,x(g) = y(g) \wedge P(x)(g)$

Parallel to how an interrogative CP denotes a singleton set of assignments, 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, supplied by the relative choice-function pronoun. 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 (127). The derived semantic value of a simple sentence with a free pronoun and headed relative follows in (128). (I assume that the relative pronoun must have the same assignment-variable as the local relative complementizer, as due to agreement (cf. 8.1).)

(127) *Relative-clause-generated D-quantifier* (to be revised)

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

(128) 'Every baby which she likes laughed'



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

$$[\![\textbf{every}^{\langle 2,a\rangle}]\!] = \lambda P_{et}.\lambda Q_{et}.\lambda g_g\,.\left[\forall x_e \exists a_a\colon P(x)(g[a(g)/2a])\right] Q(x)(g)$$

$$[\![\mathrm{DP}]\!] \approx \lambda Q_{et}.\lambda g_g\,.\left[\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(baby_{g(1a)(1s)}) \right.$$
$$\left. \wedge\, g(1a)(1e) \text{ likes } x(g) \text{ in } g(1a)(1s)\right] Q(x)(g)$$

$$\llbracket \text{S} \rrbracket \approx \lambda g_g \,.\, \forall w \text{ s.t. } w(g) = @(g), \\ \left[\forall x_e \exists a_a \colon x(g) = a(g)(2\text{cf})(baby_{g(1s)}) \wedge g(1e) \text{ likes } x(g) \text{ in } g(1s)\right] \\ x(g) \text{ laughed in } w(g)$$

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 (128) is true iff every such individual o laughed.

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 treatments throughout the paper of type-driven binding/quantification with verbal quantifiers and other complementizers:

- 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 (*wh*) interrogative CPs denote a singleton set of assignments, which is converted into a set of propositions by the question operator, analogously relative clause CPs denote a singleton set of individuals, which is converted into a domain of individuals by the determiner (e.g. 'every').
- 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 (128) raises from inside its complement CP_{rel}, determining the relevant domain of individuals.
- Just as (free) interrogative *wh* choice-function pronouns are targeted by the question operator so that the values for *wh*-phrases vary across possible answers, analogously (bound) relative choice-function pronouns are targeted by the determiner so that the domain is determined from the set of NP-individuals.

The result is an elegant generalized treatment of quantification in various types of sentences and clausal structures.[42]

[42] If only.

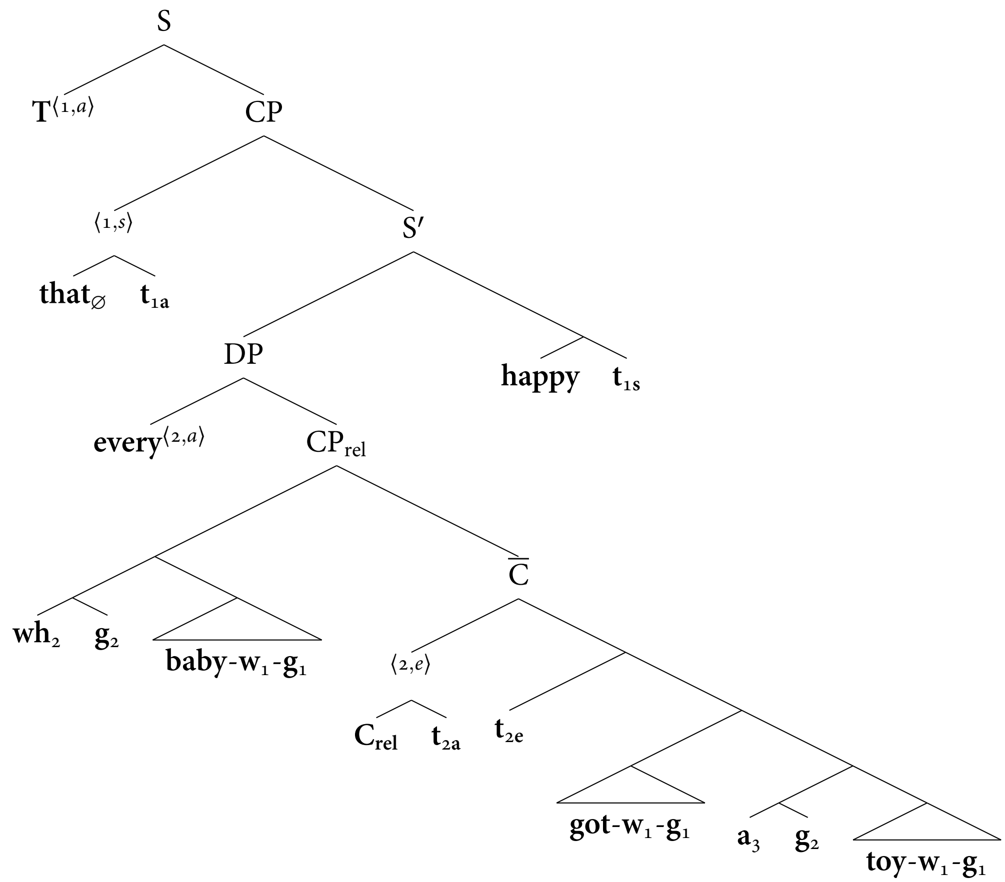
8.3 Donkey anaphora

§§8.1–8.2 suggested treating indefinites, interrogative *wh*-words, and relative determiners uniformly as choice-function pronouns. This section examines how the treatment of assignment-quantification/binding with relative choice-function pronouns might be extended to examples with indefinites.

8.3.1 Pass 1

First consider (129) with an indefinite in the relative clause (ignore further context-sensitivity with the positive-form gradable evaluative adjective) (cf. Silk 2015, 2016):

(129) 'Every baby which got a toy is happy'



$$[\![S]\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(g),\ \big[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(baby_{g(1s)}) \wedge x(g) \text{ got } a(g)(3\text{cf})(toy_{g(1s)}) \text{ in g(1s)}\big]\ x(g) \text{ is happy in } w(g)$$

Roughly, the DP 'every baby which got a toy' quantifies over those individuals $o \in E$ such that (i) there is some choice function ($a(g)(2\text{cf})$) that selects o from among the babies ($baby_{g(1s)}$), (ii) there is some choice function ($a(g)(3\text{cf})$) that selects some o' from among the toys ($toy_{g(1s)}$), and (iii) o got o' — i.e., babies o such that there is some toy or other that o got. The sentence is true iff every such individual o is happy. CP_{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'. Given the semantics of 'every', the derived effect is universal quantification over the specified subset of babies o and existential quantification over toys owned by o.

Now turn to a sentence such as (130) with a donkey pronoun in the determiner's scope, schematically represented in (131) (ignoring intensionality).

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

(131) $[_{\text{S}} \ldots [[_{\text{DP}}\ \textbf{every}^{\langle 2,a\rangle}\ [_{\text{CP}_{\text{rel}}}\ \textbf{wh}_2\textbf{-g}_2\textbf{-baby}\ [[\textbf{C}_{\textbf{rel}}\ \textbf{t}_{\textbf{2a}}]^{\langle 2,e\rangle}\ [\textbf{t}_{\textbf{2e}}\ \textbf{got a}_3\textbf{-g}_2\textbf{-toy}]]]]\ \textbf{liked}\ \underline{\textbf{???}}\ ]]$

As is familiar, the donkey pronoun 'it' isn't c-commanded by its linguistic antecedent, the indefinite 'a toy'. Simply representing 'it' with some individual pronoun $[\textbf{it}_3\ \textbf{g}_\textbf{i}]$ 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 $\textbf{every}^{\langle 2,a\rangle}$ 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 treatments from §8.2 of indefinites and assignment-quantification with determiners could be exploited for developing an account of apparent non-c-command anaphora such as donkey anaphora.

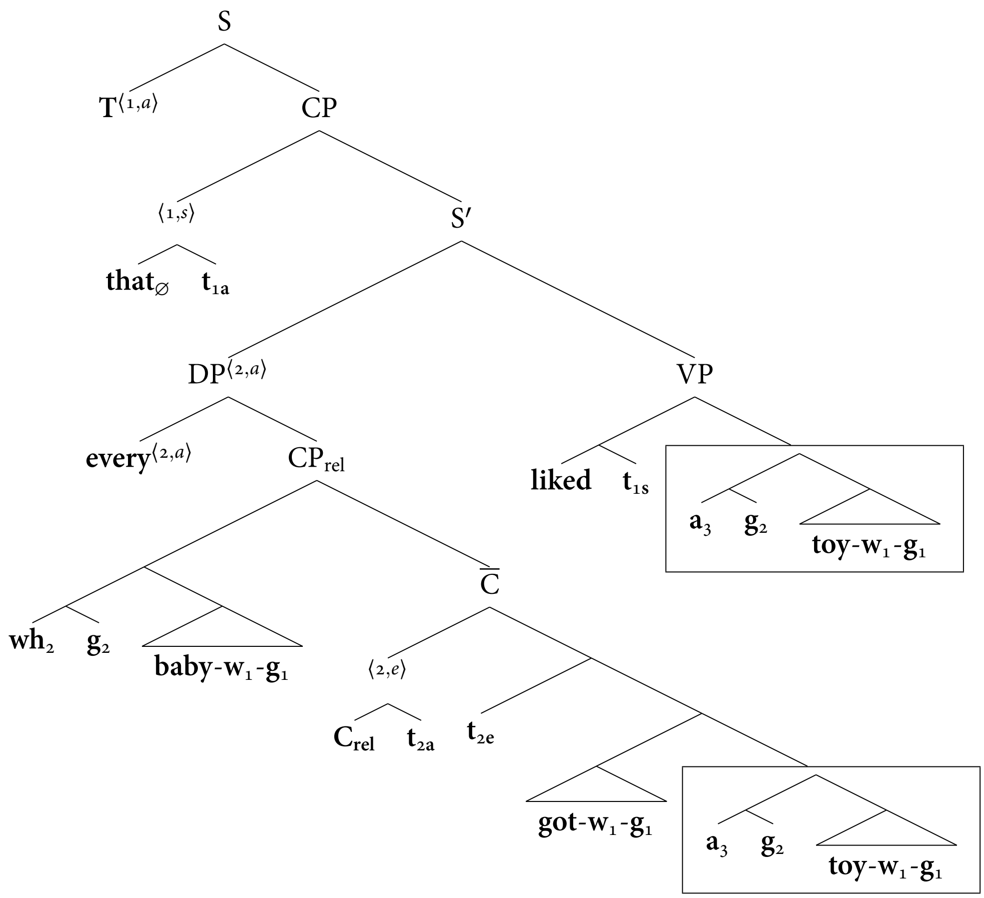
To a first approximation, I suggest representing donkey pronouns in sentences such as (130) as **copies of their linguistic antecedent**, as reflected in (132).[43] (Al-

[43]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 (ii)–(iii), where the pronoun's covarying interpretation is (at least partly) contextually determined.

(ii) [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?

ternatively, one could treat the pronouns as denoting identity functions and taking the unpronounced representation of the linguistic antecedent as argument, as in (133a); in free readings, the argument would be the variable complex indexed as previously, as in (133b). Such an approach might be understood as an "assignment-variable-based DP/$\overline{\text{D}}$-deletion" analogue of the NP-deletion E-type theory in Elbourne 2005. In what follows I will assume the former implementation in (132).)

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



(133) "DP/$\overline{\text{D}}$-deletion" variant

a. $[_{S'}$ $[_{DP}$ . . . $[_{DP}$ a_3-g_2 toy-w_1-g_1] . . . $]^{\langle 2,a\rangle}$ $[_{VP}$ . . . $[_{DP}$ it [~~a_3-g_2 toy-w_1-g_1~~]]]]

b. $[_S$ $T^{\langle 1,a\rangle}$ . . . $[_{DP}$ it [~~o_3 g_1~~]] . . .]

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

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. This assignment binder affords a resource for capturing the shifted interpretation of the choice-function pronoun representing the donkey pronoun. The semantics from §8.2.3 must be revised to allow the assignment-quantification to extend to the quantifier's scope argument, as in (134).[44]

(134) $[\![\textbf{every}]\!] = \lambda P^{+}_{\langle a,et\rangle}.\lambda Q^{+}_{\langle a,et\rangle}.\lambda g_g\,.\left[\forall x_e \exists a_a\!: P^{+}(a)(x)(g)\right] Q^{+}(a)(x)(g)$
(*to be revised*)

(135) $[\![\text{DP}^{\langle 2,a\rangle}]\!] \approx \lambda Q_{et}.\lambda g_g\,.\left[\forall x_e \exists a_a\!: x(g) = a(g)(2\text{cf})(baby_{g(1a)(1s)})\right.$
$\left.\wedge\, x(g) \text{ got } a(g)(3\text{cf})(toy_{g(1a)(1s)}) \text{ in } g(1a)(1s)\right] Q(x)(g[a(g)/2a])$
$[\![(132)]\!] \approx \lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(g),$
$\left[\forall x_e \exists a_a\!: x(g) = a(g)(2\text{cf})(baby_{g(1s)}) \wedge x(g) \text{ got } \underline{a(g)(3\text{cf})(toy_{g(1s)})} \text{ in } g(1s)\right]$
$x(g) \text{ liked } \underline{a(g)(3\text{cf})(toy_{g(1s)})} \text{ in } w(g)$

The derived semantic value in (135) says, roughly, that for every $o \in E$ s.t. [there are choice functions F, F' s.t. F ($=a(g)(2\text{cf})$) selects o from among the babies, F' ($=a(g)(3\text{cf})$) selects some o' ($=a(g)(3\text{cf})(toy_{g(1s)})$) from among the toys, and o got 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, i.e. the choice-function pronoun $[\mathbf{a}_3\text{-}\mathbf{g}_2\ \mathbf{toy}\text{-}\mathbf{w}_1\text{-}\mathbf{g}_1]$, and (ii) the assignment-quantification/binding introduced by the syntax/semantics of the determiner.

The semantics for 'every' in (134) derives a so-called "universal reading" for donkey sentences such as (130): the truth-conditions require 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 prominent theories 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; (136b) is intuitively true as long as every person who has a dime will put *some* dime that she has in the meter.

(136) 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)

[44]In the general definition of the binder-index: with **every**, $\tau = a, \sigma = \langle\langle a, et\rangle, t\rangle, \gamma = e$; with the DP: D CP_{rel}, $\tau = a, \sigma = t, \gamma = e$.

c. Every person who submitted a paper had it rejected once.

(Chierchia 1995: ex. 3)

It is contentious whether (at least some) donkey sentences conventionally have both existential and universal readings, or whether all donkey sentences conventionally have one type of reading (e.g. existential) and the other type of reading is to be explained conversationally. Yet in light of examples such as (136) it is worth investigating how we might weaken the conventional truth-conditions to capture existential readings. 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).

8.3.2 Pass 2: Existential and asymmetric readings

One way of capturing existential readings is to weaken the semantics of the determiner. Consider the following revised entry and resulting semantic value for (132):

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

(138) $[\![\mathrm{DP}^{\langle 2,a\rangle}]\!] \approx \lambda Q_{et}.\lambda g_g\,.\left[\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(\mathit{baby}_{g(1a)(1s)})\right.$
$\left.\wedge\ x(g) \text{ got } a(g)(3\mathrm{cf})(\mathit{toy}_{g(1a)(1s)}) \text{ in } g(1a)(1s)\right]$
$\exists a'_a\colon x(g) = a'(g)(2\mathrm{cf})(\mathit{baby}_{g(1a)(1s)}) \wedge x(g) \text{ got } a'(g)(3\mathrm{cf})(\mathit{toy}_{g(1a)(1s)}) \text{ in } g(1a)(1s)$
$\wedge\ Q(x)(g[a'(g)/2a])$

$[\![\mathrm{S}]\!] \approx \lambda g_g\,.\ \forall w \text{ s.t. } w(g) = @(g),$
$\left[\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(\mathit{baby}_{g(1s)}) \wedge x(g) \text{ got } a(g)(3\mathrm{cf})(\mathit{toy}_{g(1s)}) \text{ in } g(1s)\right]$
$\exists a'_a\colon x(g) = a'(g)(2\mathrm{cf})(\mathit{baby}_{g(1s)}) \wedge x(g) \text{ got } a'(g)(3\mathrm{cf})(\mathit{toy}_{g(1s)}) \text{ in } g(1s)$
$\wedge\ x(g) \text{ liked } a'(g)(3\mathrm{cf})(\mathit{toy}_{g(1s)}) \text{ in } w(g)$

The derived semantic value requires, roughly, that for every $o \in E$ s.t. [there are choice functions F, F' s.t. $o = F(\mathit{baby})$ and o got $F'(\mathit{toy}) = o'$], there is a choice function F'' s.t. o got $F''(\mathit{toy}) = o''$ and o liked o''.

The revised semantics captures the existential reading. (137) 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. 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. Although the donkey pronoun only explicitly represents the descriptive content 'toy' from its antecedent, the condition "... $P^+(a')(x)(g)$ ..." in (137) 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. (130) is correctly predicted false in a scenario where a baby b liked some toys or other but hated all the toys it received.

Although the semantics for the determiner introduces assignment-quantification in both restrictor and scope, the 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 (139)–(140), assuming a parallel LF to (132).

(139) 'Most babies which got a toy liked it'

(140) $[\![\textbf{most}]\!] = \lambda P^+_{\langle a,et\rangle}.\lambda Q^+_{\langle a,et\rangle}.\lambda g_g\,.\left[MOST\, x_e\colon \exists a_a\colon P^+(a)(x)(g)\right]$
$\exists a'_a\colon P^+(a')(x)(g) \wedge Q^+(a')(x)(g)$

$[\![(139)]\!] \approx \lambda g_g\,.\,\forall w$ s.t. $w(g) = @(g)$,
$\left[MOST\, x_e\colon \exists a_a\colon x(g) = a(g)(2\text{cf})(baby_{g(1s)}) \wedge x(g)\text{ got } a(g)(3\text{cf})(toy_{g(1s)})\text{ in } g(1s)\right]$
$\exists a'_a\colon x(g) = a'(g)(2\text{cf})(baby_{g(1s)}) \wedge x(g)\text{ got } a'(g)(3\text{cf})(toy_{g(1s)})\text{ in } g(1s)$
$\wedge\ x(g)\text{ liked } a'(g)(3\text{cf})(toy_{g(1s)})\text{ in } w(g)$

(139) 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 there is no choice function F that selects a toy that is both gotten and liked by b_2/b_3 (i.e. no a' s.t. b_2/b_3 got $a'(g)(3\text{cf})(toy)$ and b_2/b_3 liked $a'(g)(3\text{cf})(toy)$). The semantics avoids giving symmetric construals of asymmetric readings.

8.3.3 Donkey pronouns in attitude ascriptions

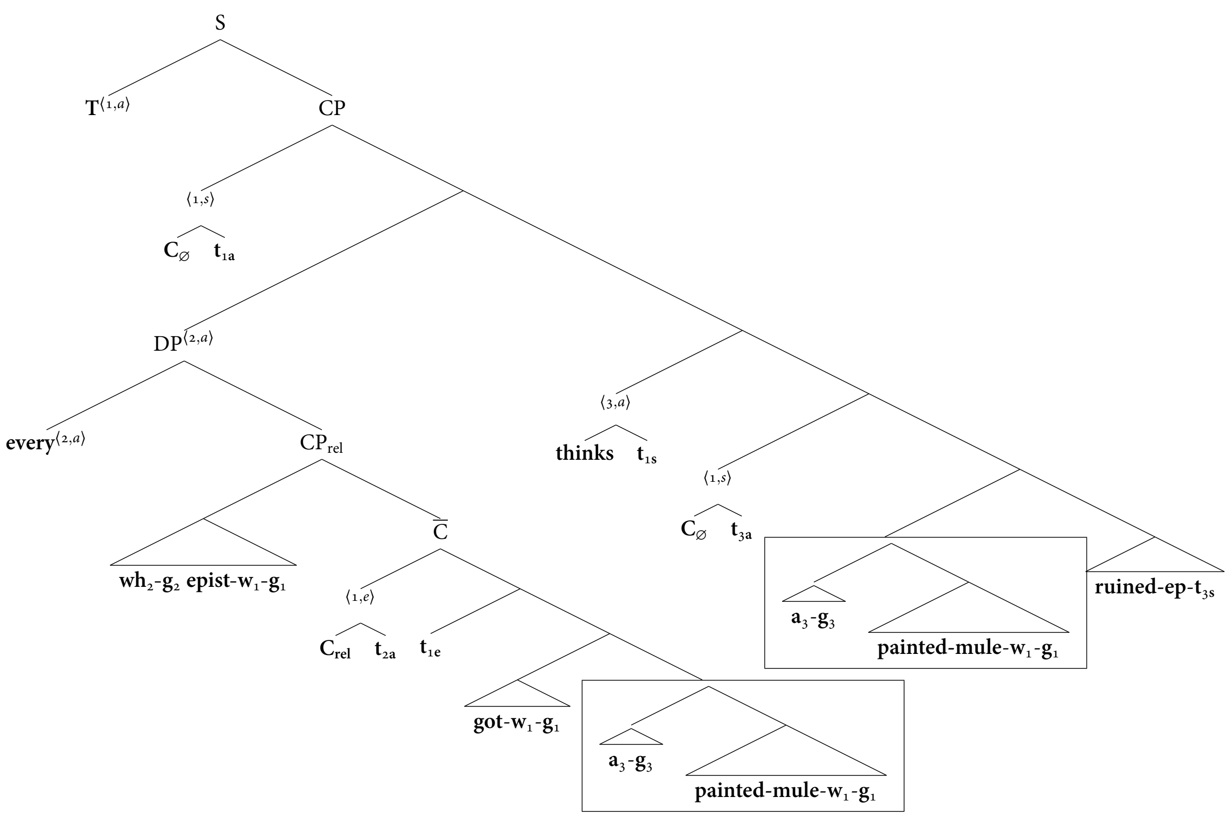
The final type of example I wish to consider is sentences where a donkey pronoun is embedded under an attitude verb, as in (141).

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

King 2004 appeals to such examples as raising challenges 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, as King notes, 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 (142) 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. Let **epist** abbreviate 'epistemologist', and **ruined-ep** abbreviate the unanalyzed predicate 'ruined-epistemology'.)

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



$$[\![\text{S}]\!] \approx \lambda g_g\,.\,\forall w{:}\,w(g) = @(g),$$
$$\left[\forall x_e \exists a_a{:}\, x(g) = a(g)(2\text{cf})(\mathit{epist}_{g(1s)}) \wedge x(g) \text{ got } a(g)(3\text{cf})(\mathit{painted\text{-}mule}_{g(1s)}) \text{ in } g(1s)\right]$$

$$\exists a'\colon \big(x(g) = a'(g)(2\text{cf})(epist_{g(1s)}) \wedge x(g) \text{ got } a'(g)(3\text{cf})(painted\text{-}mule_{g(1s)}) \text{ in } g(1s)\big)$$
$$\wedge \big(\forall a''_a\colon a''(g) \text{ is compatible with } \text{SOM}_{x(g),w(g)}, \forall w''(g)\colon w''(g) = @(a''(g)),$$
$$a''(g)(3\text{cf})(painted\text{-}mule_{g(1s)}) \text{ ruined-epistemology in } w''(g)\big)$$

Roughly, 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 $F'(painted\text{-}mule)$. (142), on its nonspecific reading, says that for every such o, for every possibility g'' compatible with o's state of mind, $g''(3\text{cf})(painted\text{-}mule)$ ruined epistemology.

I said above that I would treat instances of donkey anaphora as copies of their linguistic antecedent. Yet coindexing the donkey pronoun's assignment-variable with the DP's binder-index would represent a specific reading: the scope condition would require that there be some choice function F'' such that for every possibility compatible with the subject's state of mind, a particular individual $F''(painted\text{-}mule)$ ruined epistemology. Nonspecific readings such as (142) may thus motivate relaxing the copy-requirement on syntactic representations of donkey pronouns to allow for possible differences in the choice-function pronoun's assignment-variable. Locally binding the donkey pronoun's assignment-variable captures the nonspecific reading: which choice function is assigned to 3cf, and hence which individual is selected, may vary across the subject's doxastic alternatives.

In contrast, the world-pronoun in the representation of the donkey pronoun is *not* locally bound. King (2004) characterizes the intended nonspecific reading of sentences such as (141) 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 mine)

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 — i.e. the beliefs aren't about some 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 the LF in (142) 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 (144) reinforce the de re reading of the donkey pronoun.

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

(144) [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 $\text{nickel}_{@}$"

(143) *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 (144) 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 world-pronoun in the representation of the donkey pronoun has the same index as the linguistic antecedent and is bound long-distance. The stronger claim that the pronouns *must* have de re readings seems to hold as well. Contrast the infelicitous use of the pronoun 'it' with the felicitous use of 'a dime' in (145), reflected in the informal world-indexing in (146).

(145) [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

(146) a. #Every boy who has a $\text{dime}_{@}$ in his pocket thinks^{i} it_{i} should go in the meter.

b. Every boy who has a $\text{dime}_{@}$ in his pocket thinks^{i} a dime_{i} should go in the meter.

'It' is anomalous in (145) where the boys don't think, of the *actual* dimes in their pocket, that some or other of *them* should go in the meter. Donkey pronouns contrast with explicit spelled-out DPs in this respect (cf. Büring 2004).

These examples suggest that nonspecific readings of donkey pronouns in attitude ascriptions 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). Treating instances of donkey anaphora as copies of their linguistic antecedent (modulo possible differences in the choice-function pronoun's assignment-variable) captures this (cf. (133)).

8.3.4 *Choice-function pronouns and "context-dependent quantifiers"*

It is worth briefly comparing the approach to donkey anaphora in this section with the "Context-Dependent Quantifier" (CDQ) account from King 2004. On King's view, donkey pronouns are quantifiers which inherit their force and restriction from their linguistic antecedent and other features of the sentence. Like the account in this section, King's CDQ account treats donkey pronouns as representing material from the linguistic context. Yet the accounts differ in crucial respects. These differences highlight several features of an assignment-variable-based implementation.

First, 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 (147).

(147) 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 — and indefinites for that matter — in terms of coindexing on the choice-function pronoun's assignment-variable (see (142), also §8.2.2).

Second, I argued above that donkey pronouns under attitude verbs obligatorily receive de re readings — readings where the pronoun's intuitive descriptive content is anchored to the world of the antecedent. Simply saying that the donkey pronoun "has the same quantificational force as its antecedent" (2004: 105) fails to capture this, absent additional mechanisms for capturing de re readings with narrow scope quantifiers. Whatever mechanisms are provided, a pressing challenge is to explain the contrasts in available readings between donkey pronouns and explicit quantifier phrases, as in (145)–(146) (see Büring 2004, Elbourne 2005 for additional contrasts).

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 (124) must be recovered from 'donkey' and some combination with 'farmer' and 'owns', so that 'it' quantifies over donkeys owned by the quantificational subject; (124) isn't equivalent to (148).

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

(148) 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. (124) 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:

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

The syntax/semantics in this section avoids such complications. Instances of donkey anaphora are represented syntactically as copies of their linguistic antecedents (modulo possible differences in the choice-function pronoun's assignment-variable; cf. (133)). The relevant semantic restriction in interpreting the donkey pronoun is captured by the assignment-quantification/binding introduced by the matrix determiner, which requires that the witness assignment verifying the determiner's scope argument verifies the restrictor argument.

8.4 Extensions: DPs and pronoun binding

8.4.1 Determiners and assignment-quantification?

The semantics in (134)/(137) treats '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 allowed 'every' to combine with its type $\langle e, t\rangle$ arguments. This assignment binding 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 the syntax/semantics for determiner quantifiers in relative constructions relates to their familiar $\langle et, \langle et, t\rangle\rangle$ type when combining with a noun phrase, as in (150a).

One revisionary option is to analyze determiner quantifiers as in general taking CP complements, and say that apparent NP complements, as in (150a), have covert structure corresponding to that in a headed relative clause, as in (150b).

(150) a. $[_{DP}$ $[_{D}$ Every $[_{NP}$ baby]]] laughed
b. $[_{DP}$ $[_{D}$ Every $[_{CP}$ … $[_{NP}$ baby] …]]] 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 overt CP complements cross-linguistically (see Caponigro 2002, de Vries 2002). Unifying the structure of DPs affords 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 D+CP/type-$\langle aet, \langle aet, t\rangle\rangle$ implementation is an instance of the more general approach to the syntax/semantics interface throughout the paper.

The extra structure afforded by a D+CP analysis may provide a locus for implicit domain restriction, at least in simple examples such as (151) (von Fintel 1994, Stanley & Szabó 2000, Stanley 2002). The domain variable in (151b) providing the contextually relevant restriction is represented analogously to the restriction explicitly provided in a restrictive relative.

(151) a. Every baby laughed.
b. $[_{S} \ldots [[_{DP}\ \mathbf{every}^{\langle 2,a\rangle}\ [_{CP}\ \mathbf{F_{2cf}\text{-}g_2}\ \mathbf{baby}\ [_{\overline{C}}\ [\mathrm{C}\ \mathbf{t_{2a}}]^{\langle 1,e\rangle}\ [\mathbf{t_{1e}}\ \underline{[\mathbf{P_{1et}}\ \mathbf{g_1}}]]]]]^{\langle 2,a\rangle}\ \mathbf{laughed}]]$
c. $[\![S]\!] \approx \lambda g_g\,.\,\big[\forall x_e \exists a_a\colon x(g) = a(g)(2\mathrm{cf})(baby) \wedge g(1et)(x(g))\big]$
$\exists a'\colon \ldots \wedge x(g)$ 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 (and assumed in §4.3).

The pronoun 'itself' in (152) is represented, like donkey pronouns, as a copy of its linguistic antecedent, $[_{\text{DP}}\,\mathbf{F_{cf}\text{-}g\ cat}]$. (For simplicity use the "universal donkey reading" entry for 'every' in (137). Further applications with pronominal anaphora shortly. Cf. (133).)

(152) a. Every cat petted itself.

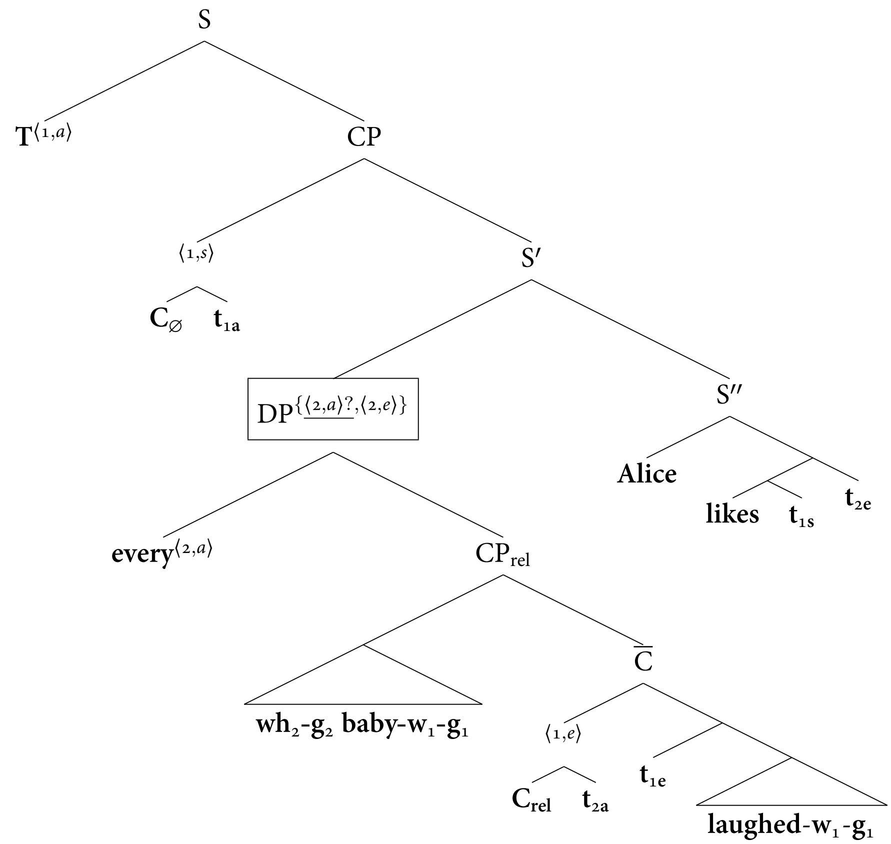
b. $[_{\text{S}} \ldots [[_{\text{DP}}\ \mathbf{every}^{\langle 2,a\rangle}\ [_{\text{CP}}\ \underline{\mathbf{F_{2cf}\text{-}g_2\ cat}}\ [_{\overline{\text{C}}}\ [\text{C}\ \mathbf{t_{2a}}]^{\langle 1,e\rangle}\ [\mathbf{t_{1e}}\ [\mathbf{P_{1et}}\ \mathbf{g_1}]]]]]^{\langle 2,a\rangle}\ [\mathbf{petted}$ $\underline{\mathbf{F_{2cf}\text{-}g_2\ cat}}]]]$

c. $[\![\text{S}]\!] \approx \lambda g_g\,.\left[\forall x_e \exists a_a\colon x(g) = a(g)(2\text{cf})(cat) \ldots\right] x(g)$ petted $a(g)(2\text{cf})(cat)$

An alternative more conservative response is to treat (at least some) determiner quantifiers as systematically ambiguous between items taking arguments of type $\langle e,t\rangle$ vs. type $\langle a,et\rangle$, or to introduce a general lexical rule which converts a determiner quantifier's basic familiar lexical entry into an "assignment-lifted" entry such as (134). Such moves are familiar from type-shifting and flexible-type approaches to quantifiers, connectives, etc. (e.g. Hendriks 1993, Partee & Rooth 1983 Jacobson 1999; cf. Heim & Kratzer 1998). LFs with the "wrong" homonym or (possibly derived) entry could be semantically excluded due to incurring a type-mismatch, as when the determiner is base-generated internal to a relative clause.

One issue for such a response concerns object-position quantifier phrases with relative clauses:

(153) Alice likes every baby which laughed.



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 from the internal argument of 'likes', binding an individual-trace. A question is whether the relative-clause-generated 'every' in (153) should be treated as type $\langle aet, \langle et, t\rangle\rangle$ (as in (127)) or type $\langle aet, \langle aet, t\rangle\rangle$ — i.e., whether the lexical entry should treat the scope argument fundamentally as type $\langle e,t\rangle$ or type $\langle a, et\rangle$. The former option evidently 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 $\langle aet, \langle aet, t\rangle\rangle$ for examples such as (153) with object-position D+CP_{rel} quantifier phrases. 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 (153). However, a prima facie worry may come from crossover…

8.4.2 *Donkey crossings: Donkey crossover, inverse linking, genitive binding*

Following Reinhart 1983 a prominent generalization of **weak crossover** is that an expression β can bind a pronoun only if β 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 the intuitive binding possibilities in (154).

(154) a. Who_i (t_i) likes her_i child?
b. Who_i does $\text{her}_{j/*i}$ child like t_i?

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

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

(156) a. *$\textit{Its}_i$ lawyer sued every farmer who beat *a* $\textit{donkey}_i$. (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 (156) can bind its trace but, unlike the subject DP in (155), it cannot provide a linguistic antecedent for the donkey pronoun 'it'.

Absent additional constraints, nothing would seem to exclude the following rough LF and semantic value for (156) (ignoring intensionality):

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

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 (157) would be excluded because they violate Reinhart's generalization: the assignment-variable in the choice-function pronoun $[\mathbf{a}_{3cf}\ \mathbf{g}_2]$ (underlined in (157)) 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.[45]

(158) *Variable Binding Constraint:* An occurrence of an expression in a tree γ may s-bind occurrences of at most one variable.

a. An occurrence of an expression, β, *s-binds* an occurrence of a variable, $\mathbf{v}_{i\sigma}$, in γ iff the sister of β is the largest subtree of γ in which $\mathbf{v}_{i\sigma}$ is s-free.

b. $\mathbf{v}_{i\sigma}$ is *s-free* in γ iff there is no occurrence in γ 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 (157) 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 $[\mathbf{a}_{3cf}\text{-}\mathbf{g}_2\ \textbf{donkey}]$ representing 'its', in addition to the individual binder-index binding the trace $\mathbf{t}_{3e}$. This violates the constraint in (158). 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 (157) can have an acceptable reading, but only with an intuitively free reading of 'its'. There is no analogous constraint excluding an intuitively bound reading of 'its' in (155) where the DP is in an A-position: since the in situ subject DP doesn't bind a trace, it is free to bind the donkey pronoun.

Adopting the revisionary syntax/semantics of determiner quantifiers from §8.4.1 may provide a means of generalizing the above approach to weak crossover to examples without relative clause restrictor arguments, as in (159)–(160).

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

a. $[_{\text{S}} \ldots [_{\text{S}'}[_{\text{DP}}\ \textbf{every}^{\langle 2,a\rangle}\ [_{\text{CP}}\ \mathbf{F}_{2cf}\text{-}\mathbf{g}_2\text{-}\textbf{dog}\ [_{\overline{\text{C}}}\ [\text{C}\ \mathbf{t}_{2a}]^{\langle 1,e\rangle}\ [\mathbf{t}_{1e}\ \mathbf{P}_{1et}\text{-}\mathbf{g}_1]]]]]^{\underline{\langle 2,a\rangle}}$ $[_{\text{VP}}\ \textbf{likes the-owner-of-}\underline{\mathbf{F}_{2cf}\text{-}\mathbf{g}_2\text{-}\textbf{dog}}]]]$

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

a. $[_{\text{S}} \ldots [_{\text{S}'}[_{\text{DP}}\ \textbf{every}^{\langle 2,a\rangle}\ [_{\text{CP}}\ \mathbf{F}_{2cf}\text{-}\mathbf{g}_2\text{-}\textbf{dog}\ [_{\overline{\text{C}}}\ [\text{C}\ \mathbf{t}_{2a}]^{\langle 1,e\rangle}\ [\mathbf{t}_{1e}\ \mathbf{P}_{1et}\text{-}\mathbf{g}_1]]]]]^{\underline{\{\langle 2,a\rangle,\langle 3,e\rangle\}}}$ $[_{\text{S}''}\ \textbf{the-owner-of-}\underline{\mathbf{F}_{2cf}\text{-}\mathbf{g}_2\text{-}\textbf{dog}}\ \textbf{likes}\ \underline{\mathbf{t}_{3e}}]]]$

[45] I will often be sloppy about distinguishing expressions/variables (qua types) from occurrences.

The pronominal anaphors are represented as copies of their linguistic antecedents (§8.4.1; cf. (133)). In (160) 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. There is no analogous obstacle to binding the pronoun in (159) when the DP is in subject position.

The foregoing approach carries over to other recalcitrant cases of apparent binding out of DPs (see e.g. Büring 2004). In the remainder of the section I would like to consider two such cases: *inverse linking* and *genitive binding*.

First consider an **inverse linking** example such as (161).

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

Inverse linking raises well-known challenges for compositional semantics. The embedded 'every parent' 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 DP 'some child of t' to form the constituent 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 structures are subject to weak crossover effects:[46]

(162) a. **She* is loved by some child of *every parent*.
b. ≉ "for every parent *o*, there is some child *o′* of *o* such that *o* is loved by *o′*"

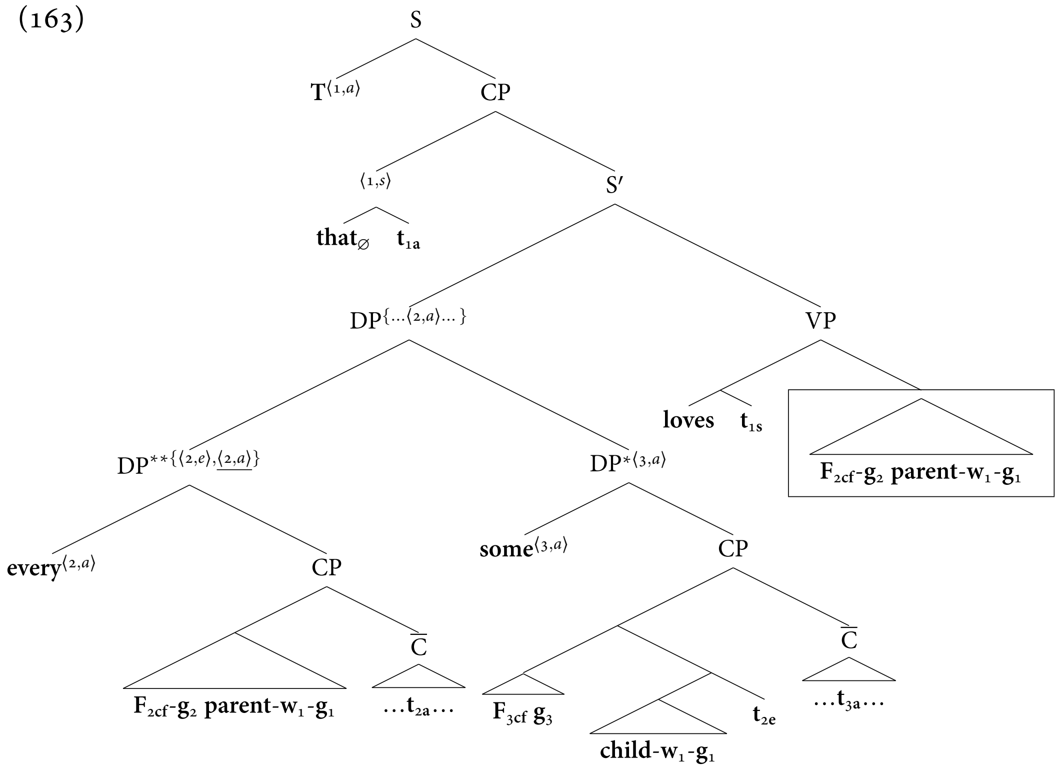
The raised 'every parent' can bind its trace in (161)–(162); but it can provide a linguistic antecedent for the pronoun only in (161) when embedded in the subject DP, and not in (162) when embedded in the QR'd object DP.

The predicted LF for (161) is roughly as in (163), with 'her' represented as a copy of its linguistic antecedent $[\mathbf{F}_{cf}\text{-}\mathbf{g}\ \mathbf{parent}]$ ('of' treated as semantically vacuous).

[46] It may be more appropriate to use an example where the pronoun, like the quantifier, is in (roughly) an object position, as in (i); to abstract away from additional complications from possessives/genitives, I proceed with simpler examples such as (162). (More on genitives shortly.)

(i) a. **Her* book is loved by some child of *every parent*.
b. ≉ "for every parent *o*, there is some child *o′* of *o* s.t. the book of *o* is loved by *o′*"

(163)



Suppose, adapting Kobele 2010, that the semantic value of the subject DP is derived by allowing a limited role for **function composition** in complex DPs formed from DP-internal QR/movement: DP* is type $\langle et, t\rangle$; the raised DP**, after combining with the binder-index, is type $\langle t, t\rangle$; the functions combine by function composition to yield the DP of generalized quantifier type $\langle et, t\rangle$, as reflected in (164)–(165). (For simplicity assume the entry for 'every' from (137).)

(164) $[\![\text{DP}]\!] = [\![\text{DP}^{**}]\!] \circ [\![\text{DP}^{*}]\!]$
$= \lambda P_{et}.[\![\text{DP}^{**}]\!]([\![\text{DP}^{*}]\!](P))$
$\approx \lambda P_{et}.[\lambda T_t.[\lambda g_g.\forall x_e \exists a_a{:}\, x(g) = a(g)(2\text{cf})(\mathit{parent}_{g(1a)(1s)}), T(g[x(g)/2e][a(g)/2a])]]$
$\big(\lambda g_g.\exists y_e \exists a'_a{:}\, y(g) = a'(g)(3\text{cf})(\mathit{child\text{-}of\text{-}g(2e)}_{g(1a)(1s)}), P(y)(g[a'(g)/3a])\big)$
$\approx \lambda P_{et}.\lambda g_g\,.\, \forall x_e \exists a_a{:}\, x(g) = a(g)(2\text{cf})(\mathit{parent}_{g(1a)(1s)}),$
$\exists y_e \exists a'_a{:}\, y(g) = a'(g)(3\text{cf})(\mathit{child\text{-}of\text{-}x(g)}_{g(1a)(1s)}),$
$P(y)(g[x(g)/2e][a(g)/2a][a'(g)/3a])$

(165) $[\![(163)]\!] \approx \lambda g_g\,.\, \forall w{:}\, w(g) = @(g),$
$\forall x_e \exists a_a{:}\, x(g) = a(g)(2\text{cf})(\mathit{parent}_{g(1s)}),$

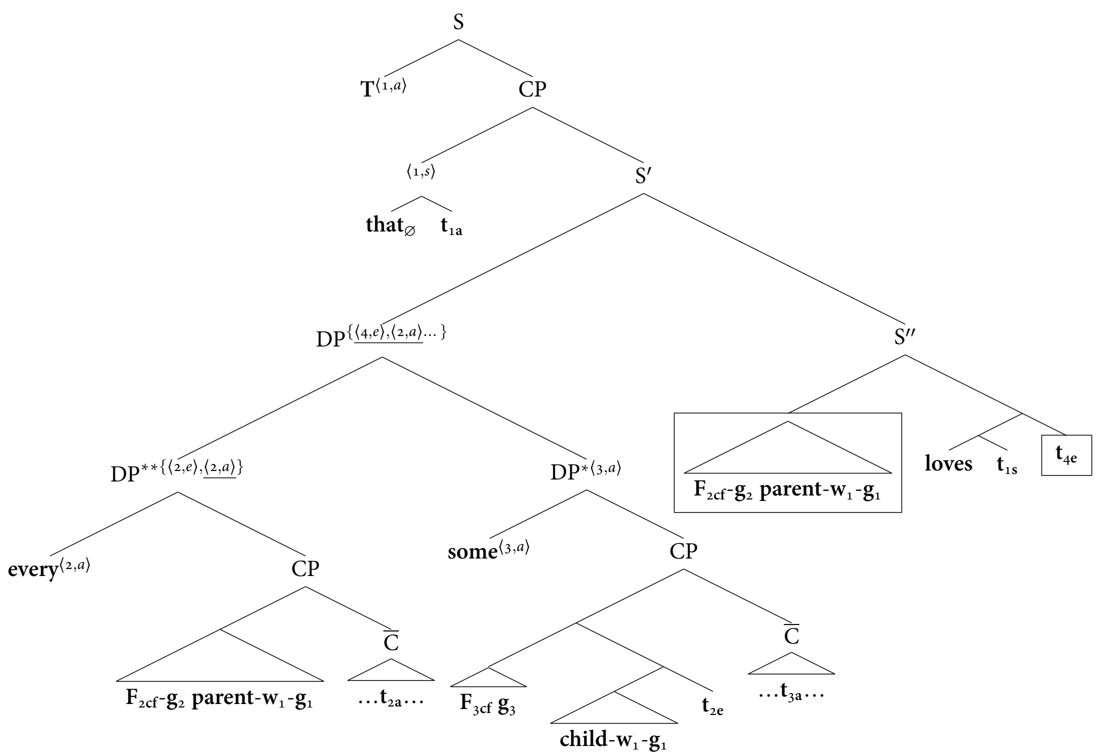
$$\exists y_e \exists a'_a\!: y(g) = a'(g)(3\text{cf})(\mathit{child\text{-}of\text{-}x}(g)_{g(1s)}),$$
$$y(g) \text{ loves } a(g)(2\text{cf})(\mathit{parent}_{g(1s)}) \text{ in } w(g)$$

The derived semantic value captures the inverse linking reading: (165) 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.

Now consider the "inverse crossover" violation in (162), modified in (166):

(166) **She*$_i$ loves some child of *every parent*$_i$.

a. $\not\approx$ "every parent loves a child of hers"



The account of weak crossover/"donkey crossover" carries over directly: The object DP has a set of binder-index features including an individual binder-index resulting from QR, and an assignment binder-index projecting from the embedded DP** (projected from **every**). The individual binder-index binds the DP's coindexed trace $\mathbf{t_{4e}}$. In order for the interpretation of the pronoun 'she' to covary with the DP, the assignment binder-index must bind the assignment-variable in $[\mathbf{F_{2cf}\ g_2}]$ in the representation of 'she'. This violates the binding constraint in (158) which excludes a single expression from binding distinct variables.

Finally, consider donkey-style pronoun binding and crossover with **genitives** (n. 46).

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

(168) 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*"

(169) a. **He*$_i$ is liked by *every boy*$_i$'s cat. (≠ (167))
b. ≉ "for every boy *b*, the cat *c* owned by *b* is s.t. *b* is liked by *c*"

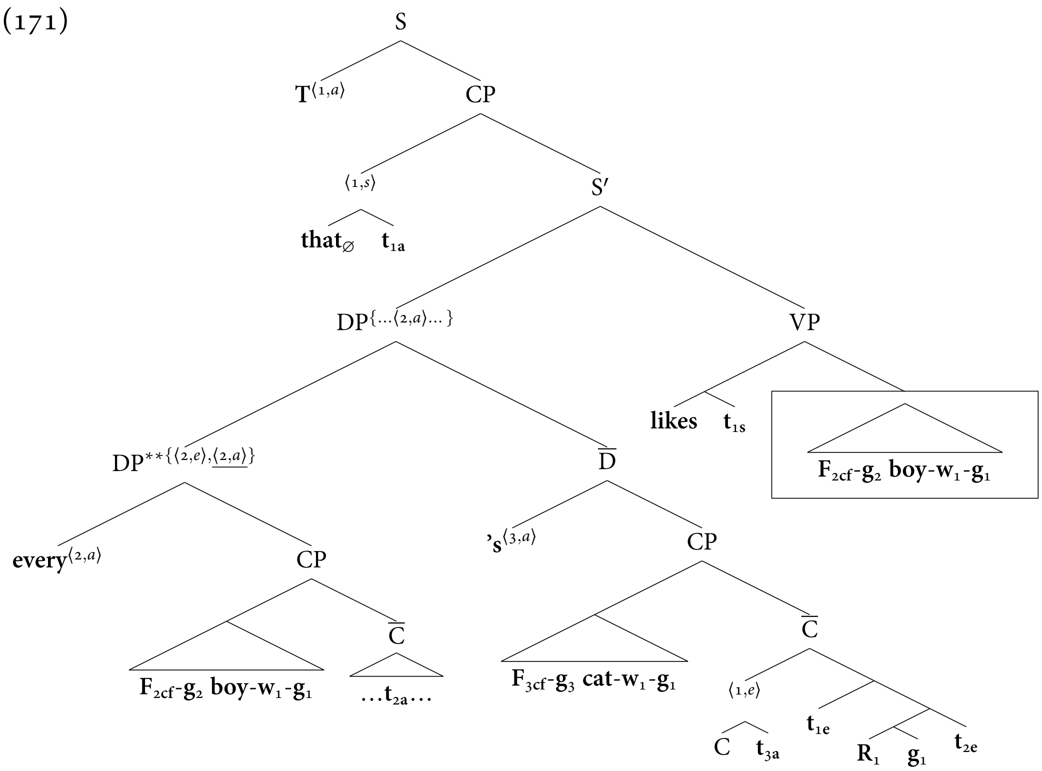
In (167) the embedded DP *every boy* can provide a linguistic antecedent for 'him' even though it doesn't c-command it at LF, being in a specifier position of the main DP. In (168), the pronoun can be linked either to the embedded DP *every boy's sister* or to the DP *every boy* embedded in it, though neither c-command the pronoun. Yet the interpretation of the pronoun can vary with the main genitive DP only when the DP in subject position, as in (167)–(168), but not when the DP QR's in (169).

While we're already waxing speculative, consider the rough D+CP-style analysis of genitive DPs "*X*'s *N*" in (170): As usual, **'s** is the head determiner, and, following Partee 1984, the interpretation is determined relative to a contextually supplied relation-pronoun **R**; however, adapting the D+CP analyses above, **'s** originates in the CP complement, the nominal *N* is sister to the choice-function pronoun in SpecCP, and the possessor *X* originates in $\overline{\mathrm{C}}$ sister to **R**. The genitive **'s** may be given the same semantics as a definite determiner.

(170) *D+CP-style genitive:*
a. 'Alice's cat'
b. $[_{\mathrm{DP}}\ [_{\mathrm{D}^\circ}\ \mathbf{'s}^{\langle 2,a\rangle}\ [_{\mathrm{CP}}\ \mathbf{F_{2cf}\text{-}g_2\text{-}cat}\ [_{\overline{\mathrm{C}}}\ [\mathrm{C}\ \mathbf{t_{2a}}]^{\langle 2,e\rangle}\ [_{\mathrm{IP}}\ \mathbf{t_{2e}}\ \mathbf{R_{1eet}\text{-}g_1}\ \mathbf{Alice}]]]]]^{\langle 2,a\rangle}$
c. $[\![\mathbf{'s}]\!] = [\![\mathbf{the}]\!]$
$[\![\mathrm{DP}^{\langle 2,a\rangle}]\!] = \lambda P_{et}.\lambda g_g\,.\left[\iota x_e(g)\exists a_a{:}\, x(g) = a(g)(2\mathrm{cf})(cat) \wedge g(1a)(1eet)(Alice)(x(g))\right]$
$P(x)(g[a(g)/2a])$
d. ≈ "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"

The compositional semantics of complex genitive DPs proceeds analogously to the cases of inverse linking, as reflected in (171) for (167). The embedded DP** 'every boy' raises to a specifier position of the subject DP, and, after combining with the individual binder-index, binds its trace in $\overline{\mathrm{D}}$. DP** and $\overline{\mathrm{D}}$ of types $\langle t,t\rangle$ and $\langle et,t\rangle$, respectively, combine again 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 pronoun. (Again assume the "universal donkey" entry from (137).)

(171)



$$\begin{aligned}
&[\![\text{DP}]\!] = [\![\text{DP}^{**}]\!] \circ [\![\overline{\text{D}}]\!] \\
&\approx \lambda P_{et}.\lambda g_g\,.\ \forall x_e \exists a_a{:}\, x(g) = a(g)(2\text{cf})(boy_{g(1a)(1s)}), \\
&\quad \iota y_e(g)\exists a'_a{:}\, y(g) = a'(g)(3\text{cf})(cat_{g(1a)(1s)}) \wedge g(1a)(1\text{eet})(g(2e))(y(g)), \\
&\quad\quad P(y)(g[x(g)/2e][a(g)/2a][a'(g)/3a])
\end{aligned}$$

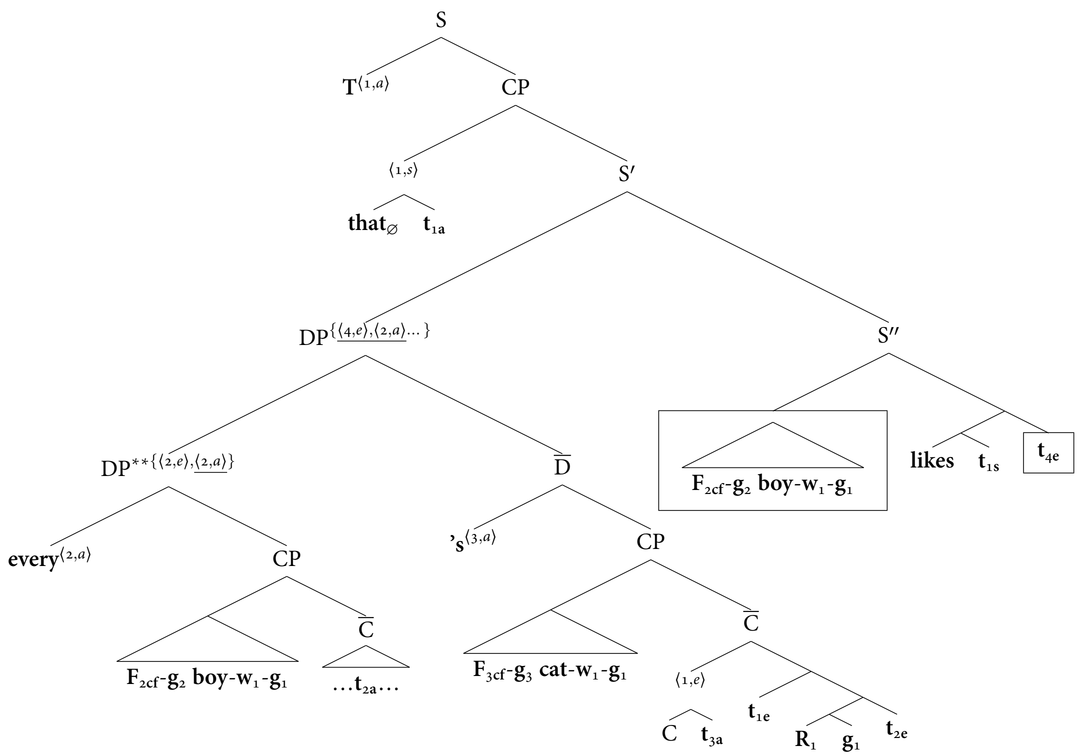
$$\begin{aligned}
&[\![\text{S}]\!] \approx \lambda g_g\,.\ \forall w{:}\, w(g) = @(g), \\
&\quad \forall x_e \exists a_a{:}\, x(g) = a(g)(2\text{cf})(boy_{g(1s)}), \\
&\quad\quad \iota y_e(g)\exists a'_a{:}\, y(g) = a'(g)(3\text{cf})(cat_{g(1s)}) \wedge g(1\text{eet})(x(g))(y(g)), \\
&\quad\quad\quad y(g) \text{ likes } a(g)(2\text{cf})(boy_{g(1s)}) \text{ in } w(g)
\end{aligned}$$

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 (e.g. "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 that bears *R* to *o* likes *o*. As with (163), the intuitively bound reading of 'him' follows from the representation of pronominal anaphors as copies of their linguistic antecedents, the D+CP implementation of the syntax of genitive DPs, and the use of function composition for deriving the semantic value of the complex subject DP.

The above account of weak crossover carries over to "genitive crossover" violations such as (169), modified LF in (172):

(172) **He$_i$* likes *every boy$_i$*'s cat.

a. ≠ 'Every boy likes his cat'



The main DP has a set of binder-index features including an individual binder-index resulting from QR, and an assignment binder-index projected from DP** (projected from **every**). The QR'd object DP binds its coindexed trace $\mathbf{t}_{4e}$. Given the constraint that an expression cannot semantically bind distinct variables, a bound reading of the pronoun is excluded, and the assignment-variable $\mathbf{g}_2$ in the copy representing 'he' cannot be bound by the DP.

To sum up: This section has speculated about how the assignment-quantificational approach to donkey anaphora from §8.3 might be extended to other theoretically recalcitrant phenomena with pronominal anaphora — e.g., apparent binding out of

DPs with **inverse linking** and **genitive binding**, and related binding puzzles regarding **weak crossover**. 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 scope of these DPs follow from (i) the treatment from §§8.3–8.4.1 of pronominal anaphors as copies of their linguistic antecedents (cf. (133)), and (ii) the generalized D+CP hypothesis from §8.4.1, along with (iii) a limited role for function composition in the compositional semantics of complex DPs formed from DP-internal movement. I suggested possibly explaining weak crossover data such as **Reinhart's generalization** via a general semantic principle that no expression can bind distinct variables: Since a moved expression must bind its trace, a QR'd object DP cannot also bind an assignment-variable in the representation of (say) a subject-position pronoun. The pronoun cannot be bound by the object DP — in examples with simple DPs ((160)), donkey sentences ((156)–(157)), inverse linking ((162)/(166)), and genitive binding ((169)/(172)) alike — because the DP's binding potential is exhausted from binding the trace left from QR. There is no analogous obstacle to binding a pronoun when the DP is in subject position — hence Reinhart's generalization that bound pronouns, unlike traces, must be bound from A-positions.

Actually this last inference was too quick. The above discussion applied to DPs with assignment binder-indices. At least on the account from §8.1, *wh*-phrases aren't themselves treated as having assignment binder-indices. More needs to be said to generalize the explanations to weak crossover effects with *wh* interrogatives, as in (154). This limitation is perhaps as it should be at this stage: §8.1 was deliberately neutral on issues regarding *wh* movement. There are also well-known exceptions where weak crossover configurations are acceptable, both in English and cross-linguistically; examples with *wh* interrogatives are especially contentious. How to develop the approach to weak crossover in this section will depend on one's views on the syntactic vs. semantic status of *wh* movement, reconstruction, pied piping, etc.[47] A more general binding theory and investigation of crossover data are needed.

[47] For instance, suppose one assumed the *in situ*-friendly approach in §8.1 which doesn't semantically require movement of *wh*-phrases at LF. The relevant notion of binding in (158), call it "c-binding," might be revised as in (i). Examples such as (ii) would be excluded, assuming the *wh*-phrase is first type-lifted to $\langle et, t \rangle$ in the usual way: the *wh*-phrase c-binds both its trace (by condition (*a*) and 'her' (by condition (*b*)).

(i) a. An occurrence of an expression in a tree may c-bind occurrences of at most one expression.
b. An occurrence of an expression, β, *c-binds* an occurrence of an expression, α, iff (*a*) α is s-bound by β (as per (158)) or (*b*) α is a copy of β.

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

On that irenic note, let's recap: The semantics from §8.3 treats (at least some) relative-clause-originating determiner quantifiers as taking restrictor and scope arguments of type $\langle a, et \rangle$. This semantics raises the question of how to handle object-position D+CP_{rel} phrases undergoing QR. I suggested that weak crossover data may provide a fruitful test case for addressing this question and interactions among QR, assignment-binding, and pronominal anaphora. A worry with many existing accounts of (donkey) crossover is that they end up formalizing precisely what needs to be explained — the distinction between trace-binding and pronoun-binding. Contrasts such as in (155)–(156) are often captured via stipulations on admissible indexings (e.g. REINHART 1987) or ad hoc syntactic/semantic distinctions 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 pronouns (including, crucially, individual-variables in E-type representations) and traces, distinct binding operators and domains for assignments corresponding to the two categories, and distinct principles regarding admissible LFs for pronouns/traces and their respective binding operators. At minimum the present assignment-variable-based framework offers independent grounds for formally distinguishing pronouns and traces (cf. §§2, 4.3). Pronouns $[\mathbf{v}_{i\tau}\ \mathbf{g}_j]$, unlike traces $\mathbf{t}_{i\tau}$, include an assignment-variable from which the element receives its interpretation; no assignment-variable is included in the representation of a trace 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 pronominal anaphora and crossover. The prospects for the proposed assignment-variable-based approaches to determiner quantification, relativization, and trace-/pronoun-binding remain to be seen. Phenomena regarding ellipsis, "sloppy identity" readings, and discourse anaphora may offer fruitful additional applications to explore.

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b. $[_S \ldots [\ [\mathbf{wh_2\text{-}g_2\ parent}]^{\langle 2,e\rangle}\ [\mathbf{the\text{-}child\text{-}of\text{-}wh_2\text{-}g_2\ parent\ likes\ t_{2e}}]]]$

Of course more would need to be said about the acceptability of examples such as in (iii), or the fact that the German sentence corresponding to (ii) is grammatical.

(iii) 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*?

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 proposed 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). Semantic composition proceeds via function application. A speculative role for function composition was briefly considered in the compositional semantics of certain complex DPs, such as in inverse linking and genitive binding.

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 treatment of the syntax/semantics interface with complementizers, determiner quantifiers, modal quantifiers, and sentence-type operators; 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, Percus's point); the compositional derivation of a partition semantics for questions; the approach to various types of conditionals (bare and modalized, declarative and interrogative) as plural definite descriptions; a unified analysis of *wh*-words, relative determiners, and indefinites; a speculative general treatment of apparent binding out of DPs and weak crossover effects, such as with donkey pronouns, inverse linking, and genitive binding; and a fully compositional semantics for quantifier raising, relative clauses, and *wh* interrogatives.

The paper focused primarily on applying the assignment-variable-based framework to local/global readings with quantifiers, attitude verbs, and modal verbs; extensions to interrogative sentences, certain types of conditionals, and relative clauses were also considered. 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 discussion of assignment-quantification with determiner quantifiers raises difficult questions about type-flexibility, traces vs. pronouns, crossover, and discourse anaphora. 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 in this paper 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

(13) $[\![\mathbf{v}_{\mathrm{i}\sigma}]\!] = \lambda a_a.\lambda\sigma_n \ldots \sigma_1.\lambda g_g \,.\, a(g)(\mathrm{i}\sigma)({}^{\downarrow}\sigma_n)\ldots({}^{\downarrow}\sigma_1)$

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

(14) $[\![\mathbf{t}_{\mathrm{i}\sigma}]\!] = \lambda\sigma_n \ldots \sigma_1.\lambda g_g \,.\, g(\mathrm{i}\sigma)({}^{\downarrow}\sigma_n)\ldots({}^{\downarrow}\sigma_1)$

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

(24) *Generalized binder-index*

$$[\![{}^{\langle i,\tau\rangle}]\!] = \lambda\alpha_{\langle\langle\tau,\langle_1\gamma_1\cdots\gamma_n,t\rangle_1\cdots\rangle_n\rangle,\sigma\rangle} \,.\, \lambda\beta_{\langle_1\gamma_1\cdots\gamma_n,t\rangle_1\cdots\rangle_n} \,.\, \alpha\Big(\lambda\tau.\lambda\gamma_1\cdots\lambda\gamma_n.\lambda g \,.\, \beta(\gamma_1)\cdots(\gamma_n)(g[{}^{\downarrow}\tau/\mathrm{i}\tau])\Big)$$

A.1 Preliminary account, §§2–6

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

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

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

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

(47) $[\![\textbf{C}?]\!] = \lambda a_a.\lambda q_{st}.\lambda T_t.\lambda g_g\,.\,T = [\lambda g'\colon a(g') = a(g)\,.\,\forall w' \text{ s.t. } w'(g') = @(g'), q(w')(g')]$

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

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

(66) $[\![\textbf{may}]\!] = \lambda r_{at}.\lambda A_{at}.\lambda g_g\,.\,\exists a_a \text{ s.t. } r(a)(g)\colon A(a)(g)$

(*alternative argument structure in (67)*)

(64) $[\![\textbf{CD}]\!] = \lambda r_{at}.\lambda A_{at}.\lambda A'_{at}.\lambda g_g\,.\,\big[\iota a_a(g)^*\colon r(a)(g) \wedge A(a)(g)\big]\,A'(a)(g)$

(21) $[\![\textbf{T}]\!] = \lambda A_{\langle a,t\rangle}.\lambda g_g$. for $a = \lambda g.g$, $A(a)(g)$

(48) $[\![\textbf{Q}]\!] = \lambda \mathcal{Q}_{\langle a,tt\rangle}.\lambda g_g.\lambda T_t.\lambda g'_g$. for $a = \lambda g_g.g$,
$\forall T' \text{ s.t. } \mathcal{Q}(a)(T')(g)\colon\ T = [\lambda g''_g\colon g'' \approx_a g'\,.\,T'(g'') = T'(g')]$

A.2 *Revised accounts, §§6–8*

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

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

(126) $[\![\textbf{C}_{\textbf{rel}}]\!] = \lambda a_a.\lambda P_{et}.\lambda y_e.\lambda x_e.\lambda g_g\,.\,x(g) = y(g) \wedge P(x)(g)$

(78) $[\![\textbf{think}]\!] = \lambda w_s.\lambda \mathcal{A}_{\langle a,at\rangle}.\lambda x_e.\lambda g_g$.
$\forall a_a$ s.t. $a(g)$ is compatible with $\text{SOM}_{x(g),w(g)}$: $\mathcal{A}(a)(a)(g)$

(77) $[\![\textbf{may}]\!] = \lambda r_{at}.\lambda \mathcal{A}_{\langle a,at\rangle}.\lambda g_g\,.\,\exists a_a \text{ s.t. } r(a)(g)\colon \mathcal{A}(a)(a)(g)$

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

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

(79) $[\![\textbf{CD}]\!] = \lambda r_{at}.\lambda \mathcal{A}_{\langle a,at\rangle}.\lambda \mathcal{A}'_{\langle a,at\rangle}.\lambda a'_a.\lambda g_g\,.\,\forall w \text{ s.t. } w(g) = @(a'(g)),$
$\big[\iota a_a(g)^*\colon r(a)(g) \wedge \mathcal{A}(a)(a)(g)\big]\,\mathcal{A}'(a)(a')(g)$

(80) $[\![\textbf{Com}]\!] = \lambda a'_a.\lambda A_{at}.\lambda a_a.\lambda g_g\,.\,A(a')(g)$

(76) $[\![\textbf{T}]\!] = \lambda \mathcal{A}_{\langle a,at\rangle}.\lambda g_g$.
for $a = \lambda g''_g\,.\,g''\colon \mathcal{A}(a)(a)(g)$

(96) $[\![\textbf{Q}]\!] = \lambda \mathcal{A}_{\langle a,at\rangle}.\lambda g_g.\lambda T_t.\lambda g'_g$.
$\exists a_a \text{ s.t. } \forall h_g : a(h) \approx_{\neg a} g,$
$\forall A'_{at} \text{ s.t. } A' = \mathcal{A}(a),$
$T = [\lambda g''\colon g'' \approx_a g'\,.\,A'(a)(g'') = A'(a)(g')]$

wh-words, relative determiner, indefinite article (§8)

$[\![\mathbf{F}_{\mathbf{i},\mathbf{cf}}]\!] = \lambda a_a.\lambda P_{et}.\lambda g_g\,.\,a(g)(i\mathrm{cf})({}^{\downarrow}P)$

a. $i$cf: an index for a function of type $\langle et, e\rangle$ that is a choice function

b. (103): A function $F \in D_{\langle \tau t, \tau\rangle}$ is a **choice function** iff $\forall P_{\tau t} \neq \varnothing\colon P(F(P))$.

Assignment-quantifying determiner quantifiers (§8.3)

(134) $[\![\mathbf{every}]\!] = \lambda P^{+}_{\langle a,et\rangle}.\lambda Q^{+}_{\langle a,et\rangle}.\lambda g_g\,.\left[\forall x_e \exists a_a\colon P^{+}(a)(x)(g)\right] Q^{+}(a)(x)(g)$ (*universal donkey reading*)

(137) $[\![\mathbf{every}]\!] = \lambda P^{+}_{\langle a,et\rangle}.\lambda Q^{+}_{\langle a,et\rangle}.\lambda g_g\,.\left[\forall x_e \exists a_a\colon P^{+}(a)(x)(g)\right]$
$\exists a'_a\colon P^{+}(a')(x)(g) \wedge Q^{+}(a')(x)(g)$ (*existential donkey reading*)

B Metasemantics / Metalanguage

(10) **Models $\mathcal{M}$:**

- E: set of entities
- T: set of truth-values, $\{0, 1\}$
- W: set of worlds
- G: set of assignments

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

- $D_e = E^G$
- $D_t = \{0,1\}^G$
- $D_s = W^G$
- $D_a = G^G$
- $D_g = G$
- $D_{\tau\sigma} = D_\sigma^{D_\tau}$

(12) a. For β of basic type $\beta \in \{e, s, t, a\}$, ${}^{\downarrow}\beta_\beta = \lambda g_g.(\beta(g))(g)$.

b. For σ type $\sigma = \langle \sigma_n, \langle \ldots, \sigma_0\rangle \cdots\rangle$, ${}^{\downarrow}\sigma_\sigma$ is defined by the condition ${}^{\downarrow}\sigma({}^{\downarrow}\sigma_n)\ldots({}^{\downarrow}\sigma_1) = \sigma(\sigma_n)\ldots(\sigma_1)(g)$.

(38) *Assignment modification*

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

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

c. $h_g[\cdots]_1 \ldots [\cdots]_n := [\cdots]_1 \circ \ldots \circ [\cdots]_n(h)$

(105) "Weak τ-equivalence"

a. $h \approx_\tau h' := \forall \mathrm{i}\colon \mathrm{i}\tau \neq 1s \rightarrow h(\mathrm{i}\tau) = h'(\mathrm{i}\tau)$

b. $h \approx_{\neg\tau} h' := \forall \mathrm{i}\forall \sigma \neq \tau\colon \mathrm{i}\sigma \neq 1s \rightarrow h(\mathrm{i}\sigma) = h'(\mathrm{i}\sigma)$

(106) “Strong τ-equivalence”

a. $h \approx^{@}_{\tau} h' := \forall \mathrm{i}{:}\, h(\mathrm{i}\tau) = h'(\mathrm{i}\tau) \wedge h(1s) = h'(1s)$

b. $h \approx^{@}_{\neg\tau} h' := \forall \mathrm{i} \forall \sigma \neq \tau{:}\, h(\mathrm{i}\sigma) = h'(\mathrm{i}\sigma) \wedge h(1s) = h'(1s)$

Interpretation of quantification in the metalanguage: §§2.2, 3.3, 4.1, 7.3, 7.8

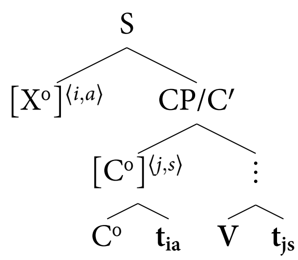
Truth-in-a-context: §§2.2, 8.2.2

Constraints on readings / Interpretation of assignments: §§1, 2.1, 3.1, 3.3, 3.4, 4.1, 4.3.3, 8.1, 8.4.1

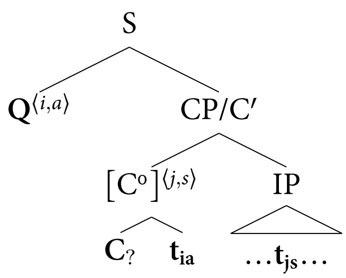
C Syntax

C.1 Sentences

(18)

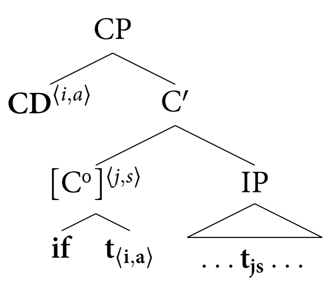


(46)

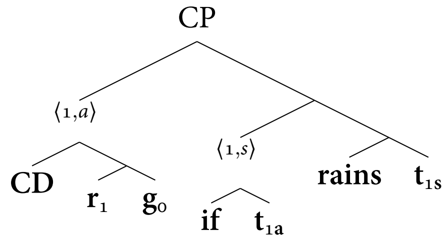


C.2 ‘If’-clauses / Conditionals

(59)



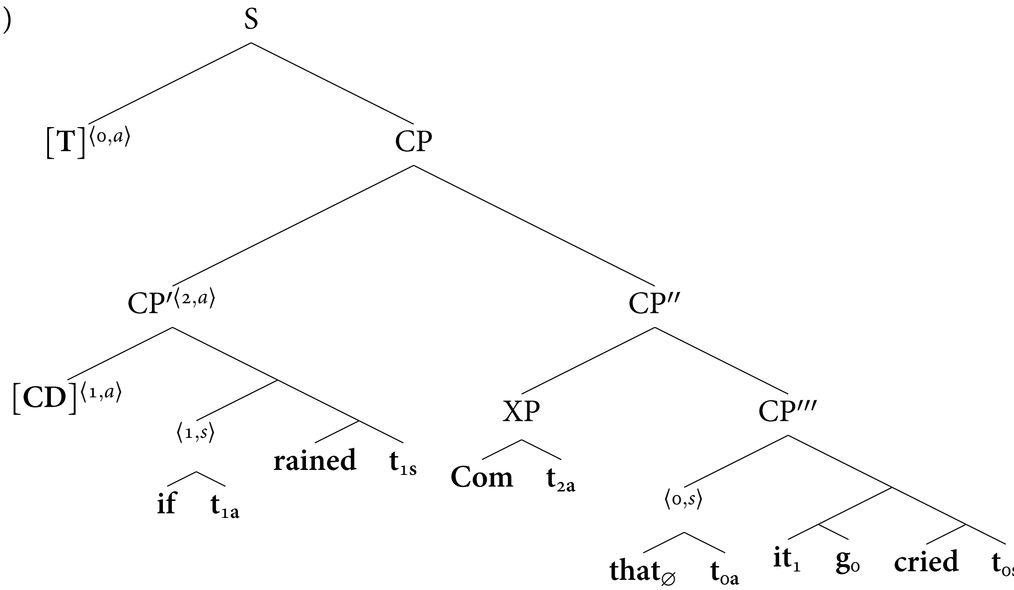
(65)



(70) *Correlatives: Proform coindexation*

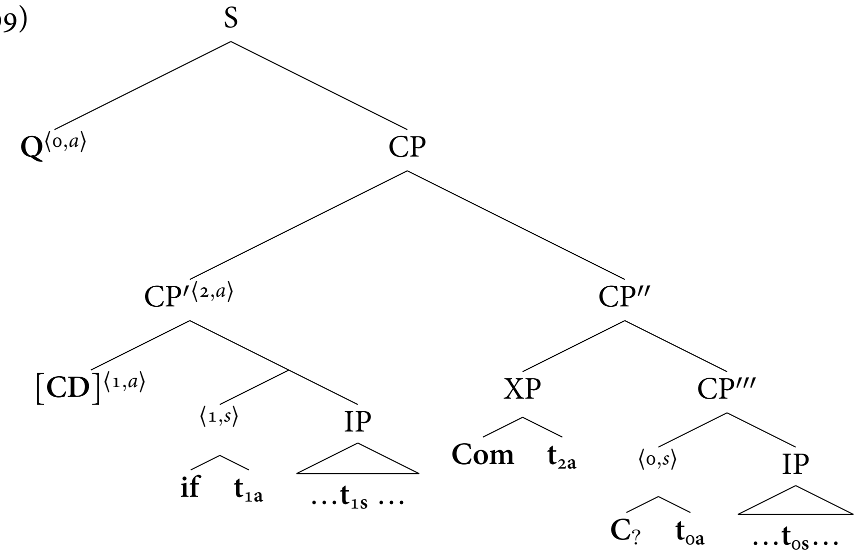
$[_{\text{CP}}$ [FREE RELATIVE CLAUSE $]_i$ $[_{\text{CP}}$ … PROFORM$_i$ …]]

(71)



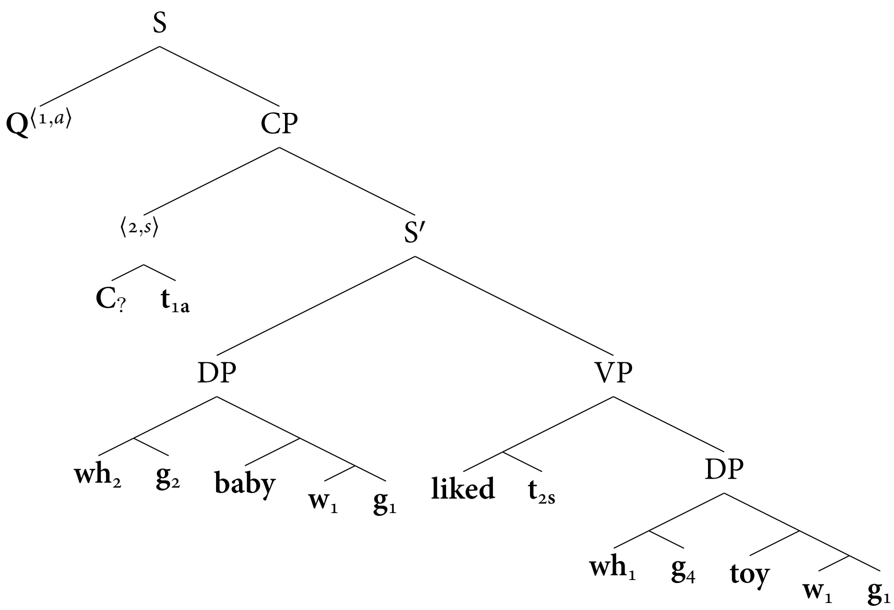
(*contrast (68) for "biscuit" LF*)

(99)



C.3 wh-interrogatives, relative clauses, pronominal anaphora

(108)



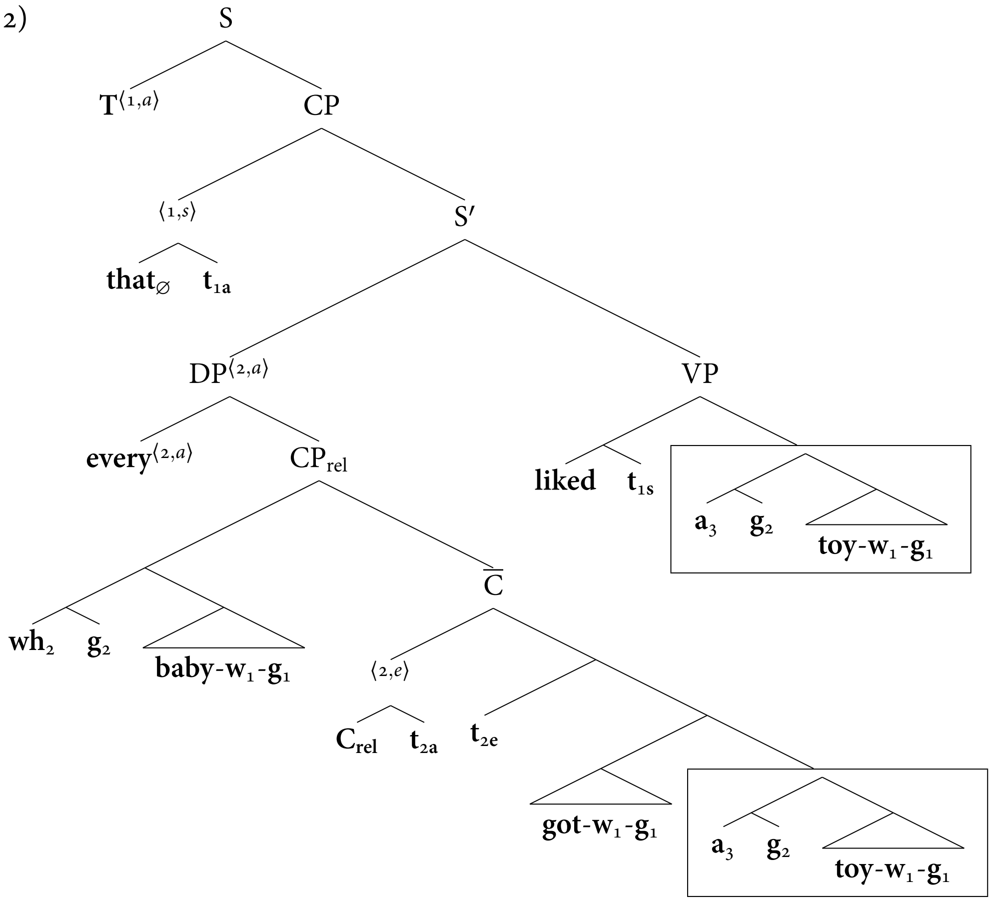
(112) Head-raising + D-complement

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

- NP is reconstructed into the relative clause
- relative clause CP is complement of D

(NB: contrast (114)–(115) for free relative)

(132)



(133) "DP/$\overline{\text{D}}$-deletion" variant

a. $[_{S'}\ [_{DP} \ldots [_{DP}\ a_3\text{-}g_2\ toy\text{-}w_1\text{-}g_1] \ldots]^{\langle 2,a\rangle}\ [_{VP} \ldots [_{DP}\ it\ [$~~$a_3\text{-}g_2\ toy\text{-}w_1\text{-}g_1$~~$]]]]$

b. $[_{S}\ T^{\langle 1,a\rangle} \ldots [_{DP}\ it\ [$~~$o_3\ g_1$~~$]] \ldots]$

(152) a. Every cat petted itself.

b. $[_S \ldots [[_{DP}$ **every**$^{\langle 2,a\rangle}$ $[_{CP}$ <u>**F**$_{2cf}$**-g**$_2$ **cat**</u> $[_{\overline{C}}\ [\text{C}\ \textbf{t}_{2a}]^{\langle 1,e\rangle}\ [\textbf{t}_{1e}\ [\textbf{P}_{1et}\ \textbf{g}_1]]]]]]^{\langle 2,a\rangle}$ [**petted** <u>**F**$_{2cf}$**-g**$_2$ **cat**</u>]]]

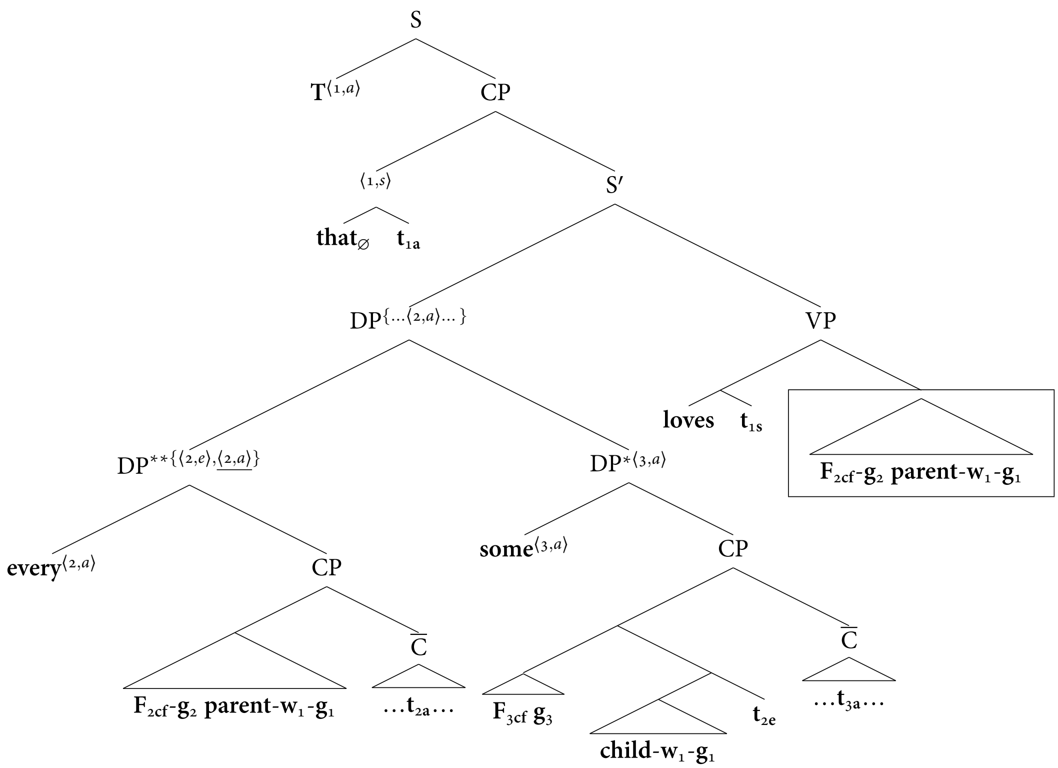
(157) a. **Its*$_i$ lawyer sued every farmer who beat *a donkey*$_i$.

b. $[_S \ldots [_{S'}[_{DP}$ **every**$^{\langle 2,a\rangle}$ $[_{CP}$ **wh**$_{2cf}$**-g**$_2$**-farmer** $[_{\overline{C}}\ [\text{C}\ \textbf{t}_{2a}]^{\langle 1,e\rangle}$ [**t**$_{1e}$ **beat a**$_3$**-g**$_2$**-donkey**]]]]]$^{\underline{\{\langle 2,a\rangle,\langle 3,e\rangle\}}}$ $[_{S''}$ **the-lawyer-of-**<u>**a**$_{3cf}$**-g**$_2$**-donkey**</u> **sued t**$_{3e}$]]]

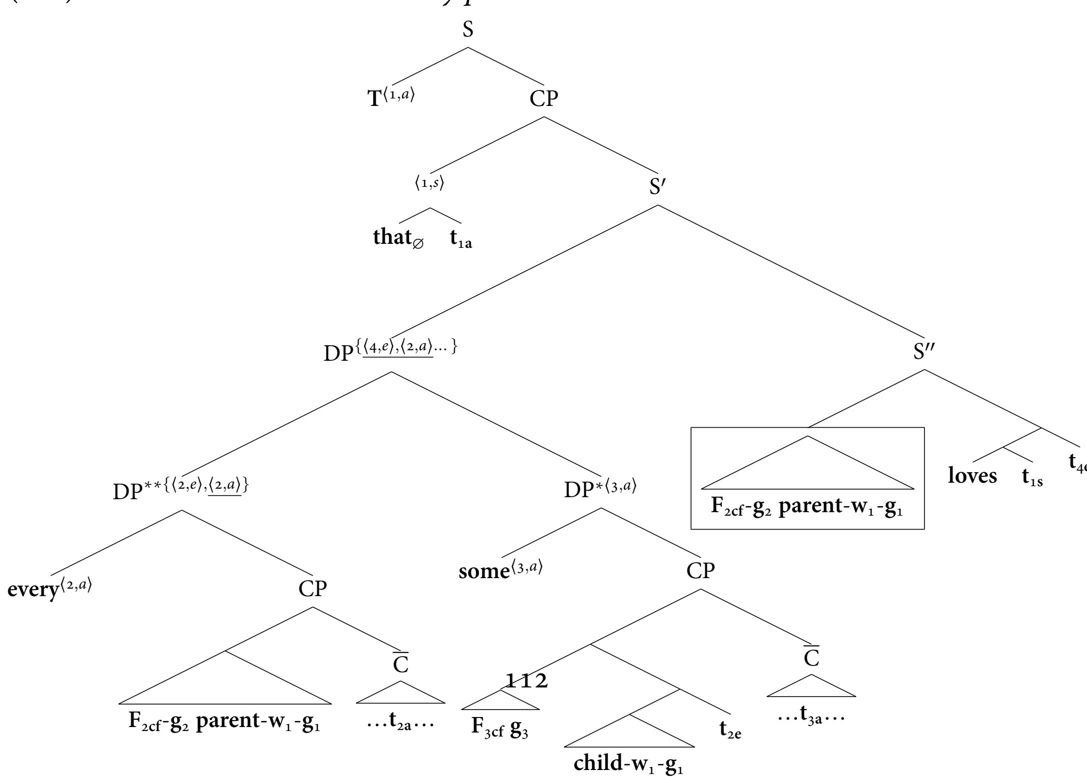
(160) a. **Its*$_i$ owner likes *every dog*$_i$

b. $[_S \ldots [_{S'}[_{DP}$ **every**$^{\langle 2,a\rangle}$ $[_{CP}$ **F**$_{2cf}$**-g**$_2$**-dog** $[_{\overline{C}}\ [\text{C}\ \textbf{t}_{2a}]^{\langle 1,e\rangle}$ [**t**$_{1e}$ **P**$_{1et}$**-g**$_1$]]]]]$^{\underline{\{\langle 2,a\rangle,\langle 3,e\rangle\}}}$ $[_{S''}$ **the-owner-of-**<u>**F**$_{2cf}$**-g**$_2$**-dog**</u> **likes** <u>**t**$_{3e}$</u>]]]

(163) ‘Some child of *every parent* loves *her*’



(166) *‘*She* loves some child of *every parent*’



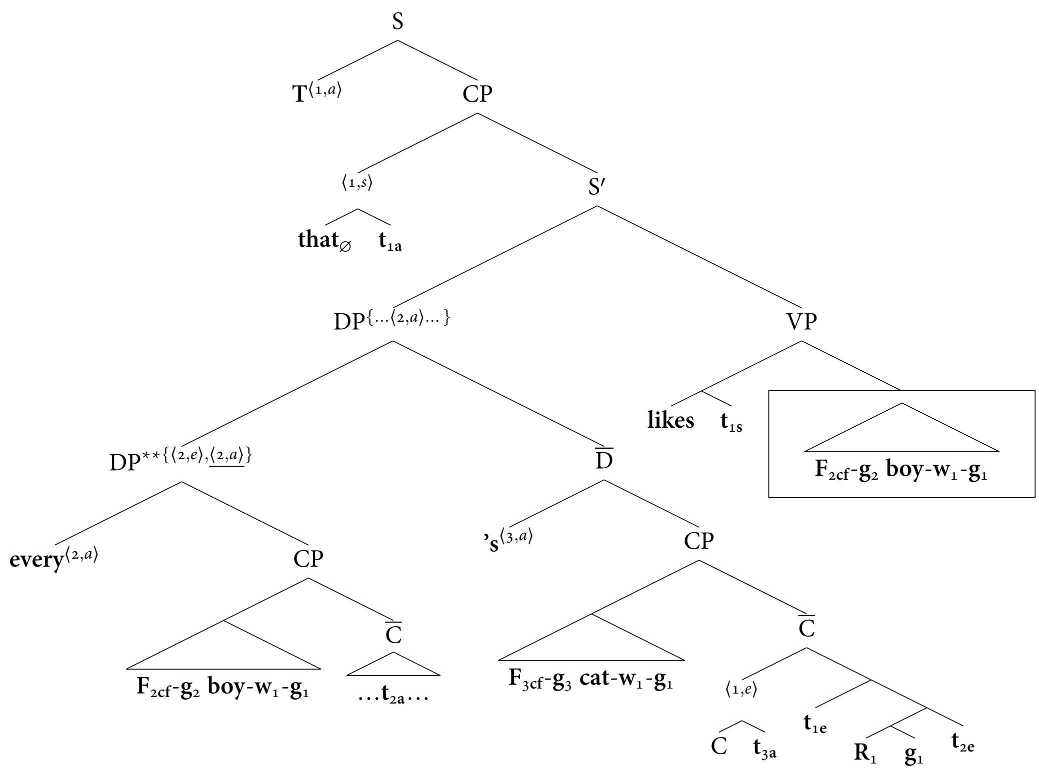
(170) *D+CP-style genitive LF:*

a. 'Alice's cat'

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

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"

(171) '*Every boy*'s cat likes *him*'



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