A flexible scope theory of intensionality *

Patrick D. Elliott
Massachusetts Institute of Technology

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Extant attempts to incorporate *intensionality* into the grammar either systematically over-generate, or systematically under-generate. In this paper, building on Keshet 2011, we aim to reconcile a scopal account of *de re* with the possibility of *de re* readings out of scope islands. Building on compositional techniques for dealing with exceptionally scoping indefinites (Charlow 2014, 2019), we develop an intensional grammar in which exceptional *de re* is achieved via *cyclic scope*. World-sensitive expressions are converted into scope-takers via a constrained inventory of type-flexible operators. Type flexibility *explains* the possibility of apparently island-violating *de re* by predicting the possibility of cyclic scope-taking. We argue that the resulting theory — which we dub the *flexible scope theory* — is sufficiently expressive to address the under-generation issues of current accounts, while still capturing constraints on *de re* in an explanatory fashion.

1. Introduction

In an intensional context, nominal predicates may be interpreted *de re* or *de dicto*. Under the *de re* interpretation, (1) can be true even if George's beliefs don't pertain to *Red Sox players*, but rather to a group of people who, unbeknownst to him, happen to be Red Sox players. On the *de dicto* interpretation, George's desires pertain to *Red Sox players*, and (1) need not entail that any Red Sox players actually exist. Theoretically, the standard way of cashing this out is to assume that predicates in general are *world sensitive*.

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(1) George wants $\overbrace{[\boxed{\text{the Red Sox players}}\text{ to win the game}]}^{\text{intensional context}}$.

There are two broad camps for incorporating world-sensitivity into a compositional semantics — the Scope Theory of Intensionality (ScopTI) and the Binding Theory of Intensionality (BTI). The BTI is extremely expressive, but must be supplemented with a binding theory for world variables. The ScopTI is much more restrictive, but seemingly under-generates – addressing these under-generation issues will be a central focus of this paper.

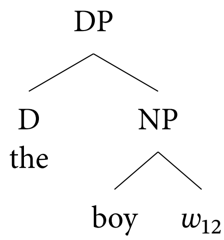
The state of the art scope theory is Keshet's (2008, 2011) *split intensionality*. Split intensionality succeeds in addressing some of the worst under-generation issues, but others remains. Concretely, Keshet's (2010) account of exceptional *de re*[1] runs into some apparently insurmountable obstacles.

In this paper, I'll aim to improve on split intensionality by presenting a new take of the ScopTI, which I'll call the *flexible scope theory*, whereby expressions can receive exceptional *de re* interpretations via cyclic scope-taking, facilitated by a minimal inventory of type-shifters. The flexible scope theory will preserve a central insight of Keshet's split intensionality theory — namely, that *de re* involves scoping at an edge position. The resulting theory will bear a non-accidental family resemblance to Charlow's (2014, 2019) theory of exceptionally scoping indefinites.

2. The scope theory and its discontents

2.1. The binding theory vs. the scope theory

According to the Binding Theory of Intensionality (BTI), there are expressions in the object language – world pronouns – denoting *variables ranging over possible worlds*; according to, e.g., von Fintel & Heim's (2011) implementation, the Logical Form (LF) for a simple Determiner Phrase (DP) such as *the lawyers* involves the predicate *lawyers* taking a covert world pronoun as its first argument, as illustrated below.



World pronouns are assumed to be bona fide pronouns, and therefore may be bound be bound or free. According to the BTI, a *de re* interpretation arises when a covert world pronoun is bound by a non-local binder. The LF for (2) according to the BTI, where *lawyers* is interpreted *de re*, is schematized in (3).

[1] The term "exceptional *de re*", following Demirok (2019), will be used to describe configurations in which an expression in a scope island is interpreted *de re* relative to an expression outside of the scope island.

(2) George wants $\boxed{\text{the lawyers}}$ to leave.

(3) 1 George [wants w_1] [2 [the [lawyers w_1]] to [leave w_2]]

The BTI completely divorces world-sensitivity from scope, and is therefore extremely expressive. Concretely, as shown by Percus (2000) and others, the BTI, if not restricted, can generate a range of unattested *de re* interpretations. We discuss the constraints on *de re* at length in §5. On such a theory, there is a need for a *binding theory for world variables*. It is far from obvious that such a theory can be made to follow from independently motivated restrictions on pronominal binding.[2]

According to the Scope Theory of Intensionality (ScopTI)[3], on the other hand — at least, on its simplest form – world sensitivity tracks *scope*. There is no need for world pronouns on such a theory. In order to account for the for the *de re* interpretation of *lawyers* in (2), the ScopTI says that the DP scopes above the intensional verb *want*, as schematized in (4):[4]

(4) $\boxed{\text{the lawyers}}$ λx [George wants [t_x to leave]].

An appealing feature of the ScopTI is that it is much more constrained than the BTI — concretely, it predicts that constraints on *de re* interpretations should track constraints on scope. Unfortunately, it immediately runs into some problems. For example, DPs embedded inside of constituents known to be *scope islands* can nevertheless receive *de re* readings. Consider for example (5) — it can be true in a context in which Roger falsely believes a group of linguists to be philosophers, and furthermore, believes that they are all drunk.

(5) Roger thinks that $\overbrace{[\boxed{\text{every linguist}}\text{ is drunk}]}^{\text{scope island}}$.

However, embedded finite clauses are generally considered to be islands for scope-taking operations (May 1977), as illustrated by the absence of a wide scope reading of the universal in (6):

(6) Exactly two philosophers think [that every linguist is drunk]. ✗ $\forall$ > exactly two

Furthermore, even if scope-taking *could* exceptionally violate a scope island in order to achieve a *de re* interpretation, as pointed out by Keshet, this makes bad predictions for the scopal interaction between the Quantificational Phrase (QP) and the embedding operator. Keshet: p. 254 illustrates this with example (7). As he observes, *everyone in this room* must be interpreted *de re*,

[2] But see Schlenker 2006 for some arguments in favor of world and time pronouns.

[3] von Fintel & Heim (2011: chapter 8) refer to the scope theory as the "standard theory". See Keshet & Schwarz 2019 for an overview.

[4] Following much of the existing literature in linguistic semantics, I'll be using Quantifier Raising (QR) (May 1977, Heim & Kratzer 1998), i.e., literal syntactic movement, as the mechanism of choice for scope-taking in this paper. I believe that nothing in the following discussion hinges seriously on quantifier raising, as opposed to an *in-situ* mechanisms for scope-taking.

otherwise the conditional antecedent would be contradictory. (7) *can't* mean however: *everyone in this room x is s.t. if x were outside, it would be empty*; the conditional antecedent is a universal statement about everyone (actually) outside. Therefore the quantificational force of *everyone* must scope below the conditional operator.

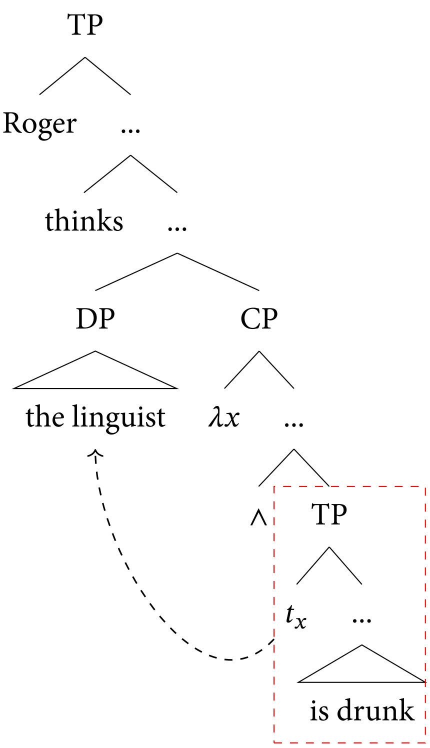
(7) If [$\boxed{\text{everyone in this room}}$ were outside], it would be empty. ✓ if-then > ∀; ✗ ∀ > if-then

In order to address this and similar issues while maintaining a *constrained* theory of *de re*, Keshet (2008, 2011) develops a more nuanced take on the ScopTI: *split intensionality*. The idea, briefly, is that there is a privileged position at the clause edge in which DPs can be interpreted *de re* relative to an embedding verb, without scoping out of a scope island. In the next section, we survey *split intensionality*, pointing out its advantages over the BTI, before discussing some apparently insurmountable problems for the theory.

2.2. Split intensionality

The state of the art in the ScopTI is Keshet's (2008, 2011) *split intensionality*. Split intensionality is designed to address under-generation issues of the ScopTI. As alluded to above, one of the primary issues for the ScopTI is the fact that *de re* readings are not constrained by scope islands. Keshet's solution involves positing a distinguished position at the clause edge, beneath the embedding predicate, but above an operator dubbed *up* (after Montague 1970), written ∧. Keshet assigns (5) the LF below. To quote Keshet 2011: p. 264: "[...] this creates an intensional twilight zone, where DPs may be evaluated de re relative to an operator, but still scope beneath this operator in terms of quantificational force." This is illustrated for the *de re* reading of *the linguist* in (1) in figure (1)

Figure (1): Roger thinks [the linguist is drunk]



The technical implementation won't be so important for our purposes, but concretely: Keshet assumes a compositional regime in which the interpretation function is parameterized to an evaluation world, which may be extensionalized in order to resolve a type mismatch (Heim & Kratzer's (1998: chapter 12) *intensional function application*, see also von Fintel & Heim 2011). The purpose of the $\wedge$ is to trigger a syncategorematic rule *intensional abstraction*, defined below:

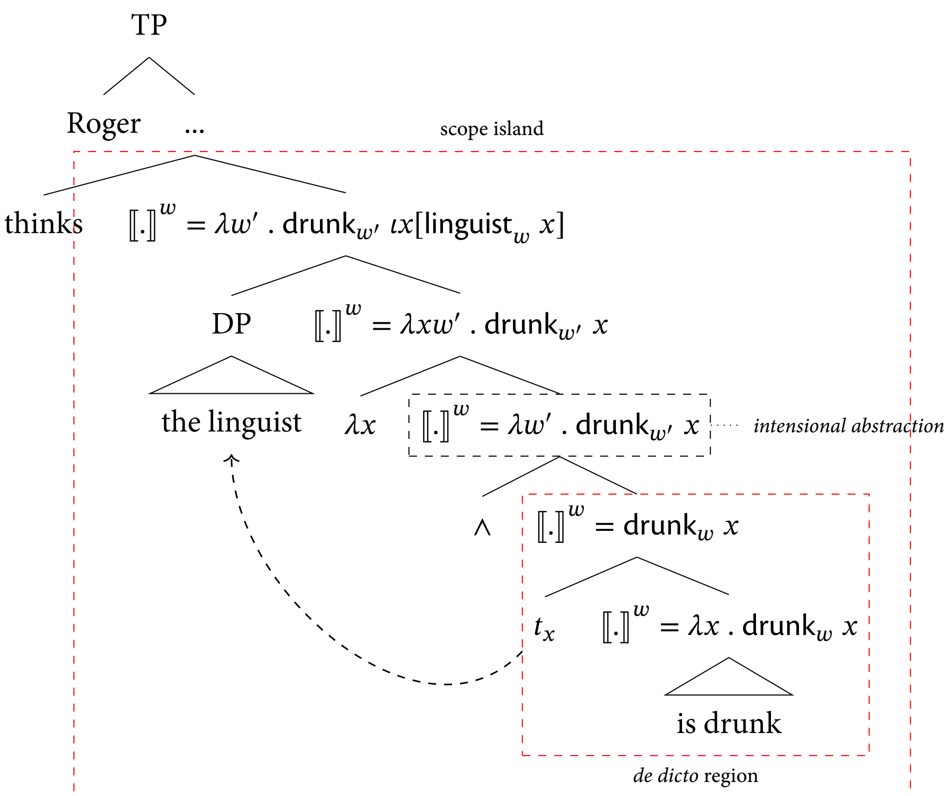
(8) *Intensional abstraction* (def.): for any world w, $\left[\!\!\left[\begin{array}{c} \alpha \\ \wedge \quad \beta \end{array} \right]\!\!\right]^{w} := \lambda w' \,.\, [\![\beta]\!]^{w'}$

The result of doing intensional abstraction *below* the landing site of the DP, is that the DP ends up evaluated relative to the global evaluation world, whereas the predicate is evaluated relative to the $\lambda w'$ introduced by $\wedge$. This is illustrated in figure (2).[5]

[5] A brief note on the notational conventions adopted in this paper:

- Expressions of the object language are set in serif, the meta-language in sans serif, and types in a `fixed width` font.
- λs are often suppressed in functions with multiple arguments.
- White-space is simply interpreted as function-argument application, which associates to the left, i.e. $f\ x\ y$ is bracketed as $(f\ x)\ y$.

Figure (2): Scoping at the intensional twilight zone



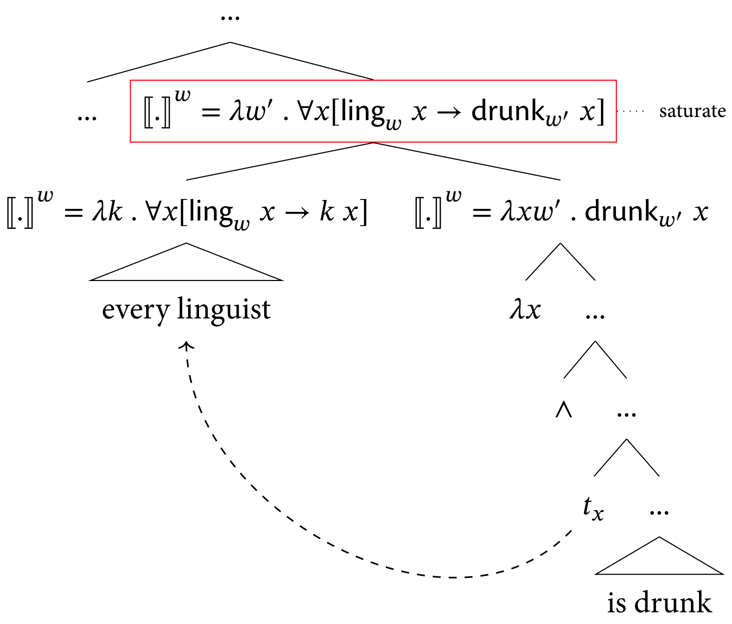
As the reader will surely have noticed, something additional needs to be said for examples involving quantificational DPs, which are of type $(e \to t) \to t$ — if a quantifier QRs above an up-operator, there will be a type mismatch, since the scope site is of type $e \to s \to t$. Keshet's solution is to posit a syncategorematic rule especially for quantificational DPs, based on Büring's (2005) *argument saturation*. We provide a simplified version of Keshet's proposal below:

(9) *Saturate* (def.): for any world w, $$[\![\,[_{\alpha}\ \beta_{(e\to t)\to t}\ \ \gamma_{e\to s\to t}]\,]\!]^{w} = \lambda w' \,.\, [\![\beta]\!]^{w}\ (\lambda x \,.\, [\![\gamma]\!]^{w}\ w')$$

Composing a QP with an intensional scope site "passes up" the world argument of the scope site, as illustrated below for the example *Roger thinks that every linguist is drunk*, with *every linguist* interpreted *de re*.

- Arrow notation is used for function types, which associates to the right, i.e., $a \to b \to c$ is bracketed as $a \to (b \to c)$.

Figure (3): Scoping a QP via saturate



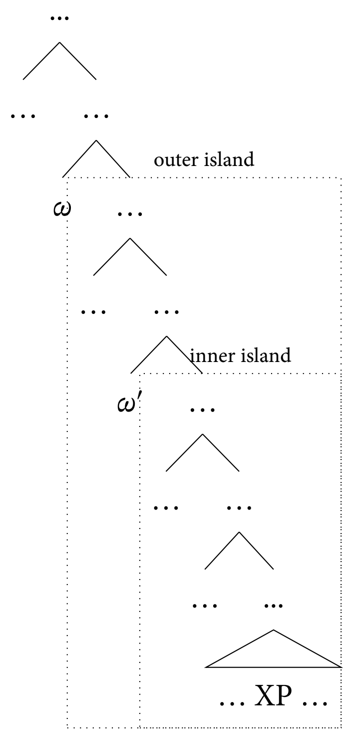
It should be clear that scoping a quantifier over an up-operator allows the restrictor to be interpreted *de re* with respect to the embedding predicate, while the quantificational part of the QP's meaning takes narrow scope with respect to the embedding predicate.

2.3. Problems for *Split Intensionality*

2.3.1. Doubly-embedded scope islands

One immediate prediction made by split intensionality is that configurations involving *doubly-embedded scope islands* only allow an XP in the inner-most scope island to be interpreted *de re* relative to the minimally c-commanding embedding predicate. This is illustrated schematically in figure (4) — if both ω and ω' embed scope islands, then split intensionality only allows XP to be interpreted *de re* relative to w'. This is because XP can only scope as high as the edge of the minimally containing scope island.

Figure (4): Doubly-embedded scope islands



Keshet suggests, counter-intuitively, that this prediction is a good one. The argument is based on judgments involving the antecedent of counterfactual conditions. As a baseline, Keshet observes that a counterfactual with a tautological antecedent sounds odd, illustrated via the contrast below.

(10) a. If three students were professors, the classes would be better taught.

b. #If three professors were professors, the classes would be better taught.

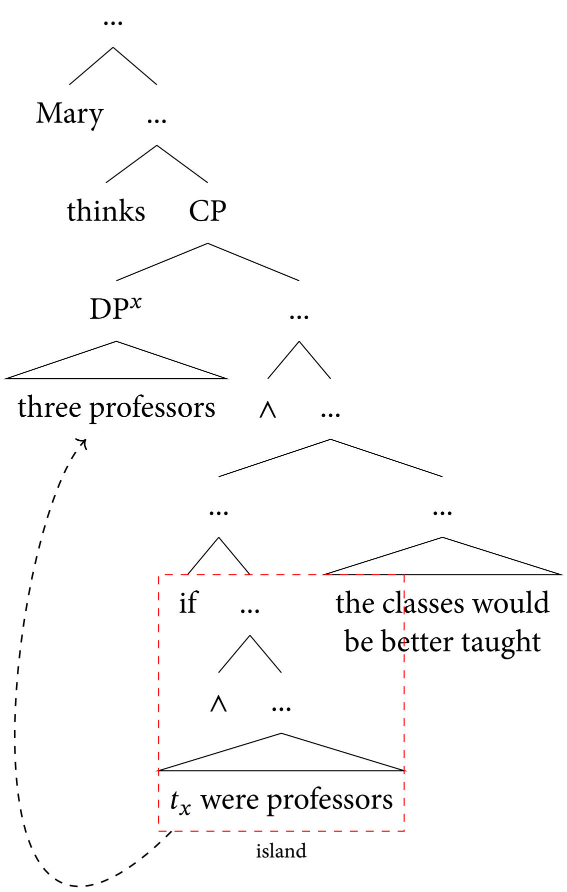
(Keshet 2011: p. 257)

The key observation here is: if the DP *three professors* were interpreted *de re* relative to some higher operator, then the antecedent has a chance of no longer being tautological. If the entire counterfactual statement in (10b) were embedded under an attitude verb, the DP *three professors* could be interpreted *de re* relative to the higher operator only by violating the islandhood of the condition antecedent. Split intensionality therefore predicts that (10b) should not be rescuable via embedding under a higher attitude verb. This indeed appears to be the case, as illustrated by Keshet: p. 258's example (11):

(11) #Mary thinks that if three professors were professors, the classes would be better taught.

A *de re* interpretation of *three professors* relative to *thinks* would require an LF such as (5), which (on a QR-based theory of scope-taking, at least), would be ruled out by syntactic locality constraints.

Figure (5): Blocking the totally *de re* reading



A problem with the reasoning here is that expressions which are independently known to take *exceptional scope* seem to give rise to parallel judgments. To elaborate, consider (12). This has a salient reading which can be paraphrased as: *There's a relative of John's x, s.t. if x were John's friend, John would be in x's will.* This reading (apparently) involves *a relative of John's* taking exceptionally wide scope out of the condition antecedent.

(12) If [a relative of John's^x were his friend], he'd be in their$_x$ will. $\exists >$ if-then

Just as before, a tautological antecedent gives rise to oddness:

(13) #If [a relative of John's^x were related to him], he'd be in their$_x$ will.

Now, observe that if we embed the entire conditional statement in (13) under an attitude verb the result is still odd, as illustrated by (14). By way of contrast, (15) has a perfectly sensible reading (that doesn't involve Mary doubting a tautology), just in case *a relative of John's* is interpreted *de re*.

(14) # Mary doubts [that [if $\boxed{\text{a relative of John's}}$ were related to him], he'd be in their will].

(15) Mary doubts [that $\boxed{\text{a relative of John's}}$ is related to him].

Since it's independently possible for *a relative of John's* to take exceptional scope out of the counterfactual antecedent, and furthermore *scope feeds de re* according to split intensionality, it's prima facie mysterious on this theory why (14) doesn't have a sensible reading – it suggests that whatever the explanation for the oddness of (14) is, it shouldn't be based on scope, and therefore weakens this particular argument in favor of split intensionality.

Moreover, it is possible to come up with sentences which are parallel to example (14) which nevertheless have a sensible reading. (16) provides a baseline — the counterfactual statement sounds odd, since the antecedent is tautological. Furthermore, (17) has a sensible reading, just in case *three syntacticians* is interpreted *de re*.

(16) # If three syntacticians were linguists, this semester would be more fun.

(17) Mary doubts that three syntacticians are linguists.

The relevant test case is (18). To my ear, this has a sensible reading just in case *three syntacticians* is interpreted *de re*. I don't have a full understanding of why Keshet's original examples sound so odd, but I would speculate that the oddness has its source in a repetition of the NP restrictor.

(18) Mary doubts [that [if $\boxed{\text{three syntacticians}}$ were linguists], this semester would be more fun].

Looking now beyond the specific cases discussed by Keshet, its clear in the general case that *de re* readings out of doubly-embedded scope islands are possible (see Grano 2019 for different arguments for the same conclusion). (19), for example, doesn't necessarily entail that Mary's beliefs involve anyone being in this room. It can be true in a scenario in which there's a group of people X who are actually in this room; Mary believes that X are actually outside.

(19) Mary [thinks that Tom hopes [that everyone in this room is outside]].

2.3.2. Bäuerle's puzzle

Another problem for *split intensionality*, and for scope theories more generally, is *Bäuerle's puzzle* (Bäuerle 1983). Bäuerle's puzzle involves a scope paradox that emerges on classical scope theories of intensionality. Keshet (2010: p. 692) illustrates the puzzle with the following example, after Bäuerle.

(20) George thinks [every Red Sox player is staying in some five star hotel downtown].

The crucial observation is that (20) has a reading with the following properties:

- *every Red Sox player* is interpreted *de re*.
- *five star hotel downtown* is interpreted *de dicto*.
- *some five star hotel downtown* takes scope over *every Red Sox player*.

(20) could be true under this reading in the following situation: *George has mistaken the Red Sox players for the Yankees, and he thinks that this group of people are all staying in the same five star hotel downtown*. To see the scope paradox, consider that on a split intensionality theory, to be interpreted *de re*, and DP must scope above an up operator at the clause edge. The LF for the target reading must therefore fulfill the following requirements, which give rise to a contradiction by transitivity:

- $\forall > \wedge$
- $\wedge > \exists$
- $\exists > \forall$

Keshet's response is tied to the observation that *some five star hotel downtown* is an expression that can take exceptional scope. Keshet adopts a theory of exceptionally scoping indefinites according to which they are interpreted as choice-functional variables, existentially bound from their scope site. Under the target reading, therefore, (20) has the LF below.[6]

(21) $\exists f$ George thinks [every $\text{RSP}^x \wedge [t_x$ is staying in $f(\text{FSHD})]$]

Because Keshet's response is wedded to a particular analysis of exceptionally scoping indefinites, it's not going to be sufficiently general. This is because Bäuerle's puzzle generalizes to non-exceptionally-scoping QPs. Consider (22) — this has a reading on which *exactly three Red Sox players* is interpreted *de re*, *every hotel room* is interpreted *de dicto*, but *every* takes scope over *exactly three*. To illustrate, (22) can be true in a scenario where: George has mistaken a group of people staying in a hotel for Yankees - they are actually Red Sox players. He believes that people from this group are staying three-to-a-room, and they trashed their hotel rooms.

[6] In fact, what we present here is Grano's adjustment of Keshet's analysis to bring it in line with split intensionality. Nothing in the argumentation crucially hinges on this.

(22) George [thinks that $\boxed{\text{exactly three Red Sox players}}$ trashed $\boxed{\text{every hotel room}}$].

Since *every hotel room* isn't an exceptional scope taker, the same strategy isn't available for having it take wide quantificational scope over *exactly three Red Sox players*, while being interpreted low for the purposes of *de re/de dicto*. It seems that, in general, a problem with Keshet's approach, and scope theories in general, is tying quantificational and intensional scope too tightly together.[7]

3. Scope theory redux

3.1. Bootstrapping an intensional fragment

In this section, we'll start from minimal means and bootstrap a different way of achieving world-sensitivity that (I'll argue) slices the pie in just the right way. Rather than assuming that the interpretation function $[\![.]\!]$ is relativized to a world parameter, I'll simply assume that we want our semantics to deliver intensions as sentential meanings. In (24) I characterize the space of intensional values by defining a type constructor S. S is a function from types to types — it takes a type a and gives back an intensional type, i.e., a functional type $\mathsf{s} \to \mathsf{a}$, where s is taken to be the type of a possible world.

(24) $\mathsf{S\ a} \coloneqq \mathsf{s} \to \mathsf{a}$

One straightforward way of achieving an intensional fragment is to assume that predicates return *propositions* rather than truth-values. The denotation I assume for simple predicates is illustrated in (25) with *swim*. If we assume that proper names are rigid, then we can treat them as type e, and composition of a simple sentence such as *Jo swims* should proceed straightforwardly.

(25) $[\![\text{swim}]\!] \coloneqq \lambda x w\,.\,\mathsf{swim}_w\ x$ $\qquad \mathsf{e} \to \mathsf{S\ t}$

Since definite descriptions give rise to *de re/de dicto* ambiguities, they must exhibit world-sensitivity, and therefore be parameterized to a world argument. If we assume a Fregean analysis of definite descriptions, then there is only one way of implementing this – we must treat definite descriptions as *individual concepts* (i.e., world-sensitive individuals).[8]. I'll therefore assume that definite descriptions are of type $\mathsf{S\ e}$, as illustrated below:

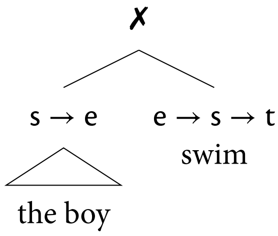
[7]See also Grano (2019) for arguments that Keshet's solution is unsuccessful even for exceptional scope-takers — in a nutshell, it predicts that exceptional scope-takers can only be interpreted *de re* relative to the minimal scope island containing the NP restrictor. This is clearly a bad prediction — exceptional scope takers can be interpreted *de re* even out of doubly-embedded scope islands. The following can be true if Roger has mistaken a linguist for a philosoper, and hopes that they are drunk; he reports this hope to Josie, who has made the same mistake, and she believes him.

(23) Josie thinks [that Roger hopes [that a certain linguist is drunk]].

[8]For now, we'll defer the discussion of DP-internal compositionality, although this will become important later when we return to Bäuerle's puzzle.

(26) $[\![\text{the boy}]\!] = \lambda w \,.\, \iota x[\mathsf{boy}_w\ x]$ $\quad$ $\mathsf{S\ e}$

It will turn out, perhaps surprisingly, that thinking through the simple mechanical puzzle of how to compose the meanings in (25) and (26) will give us *almost* everything we need in order to achieve *exceptional de re*. First of all, observe that attempting to compose the predicate with the DP results in a type mismatch, assuming that meanings compose via function application.



What exactly is the problem here? One way of thinking about it is as follows: we need to somehow extract just the type e part of the definite description, and feed it into the predicate, while ensuring that the world argument of the DP is interpreted relative to the same world as that of the predicate. Below, I define a composition rule ☆ (pronounced: *bind*) in order to accomplish just this.[9]

(27) Bind (def.)
$m^{☆} := \lambda k \,.\, \lambda w \,.\, k\ (m\ w)\ w$ $\quad$ $☆ : \mathsf{S\ a} \rightarrow (\mathsf{a} \rightarrow \mathsf{S\ b}) \rightarrow \mathsf{S\ b}$

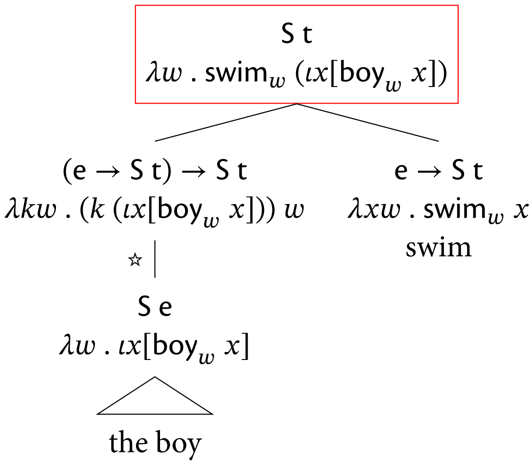
Bind takes an argument m and a function k; it returns a new function from a world w, where: (i) w is first fed into m, and (ii) the result is fed into k, and the resulting open world argument is re-saturated by w. Note that I've defined *bind* in a maximally polymorphic way — what is necessary for *bind* to work is that its first argument have an outer world argument, and its second argument be a function with an inner world argument. Pervasive polymorphism will ultimately be essential to our explanation for exceptional *de re*, which we'll discuss in §3.2.

Now that we have bind, I'll assume that definite descriptions are *bind-shifted* in order to allow them to compose with predicates.[10]

[9] We'll often indicate application of a unary type-shifter as a superscript, i.e., $m^{☆} := ☆\ m$

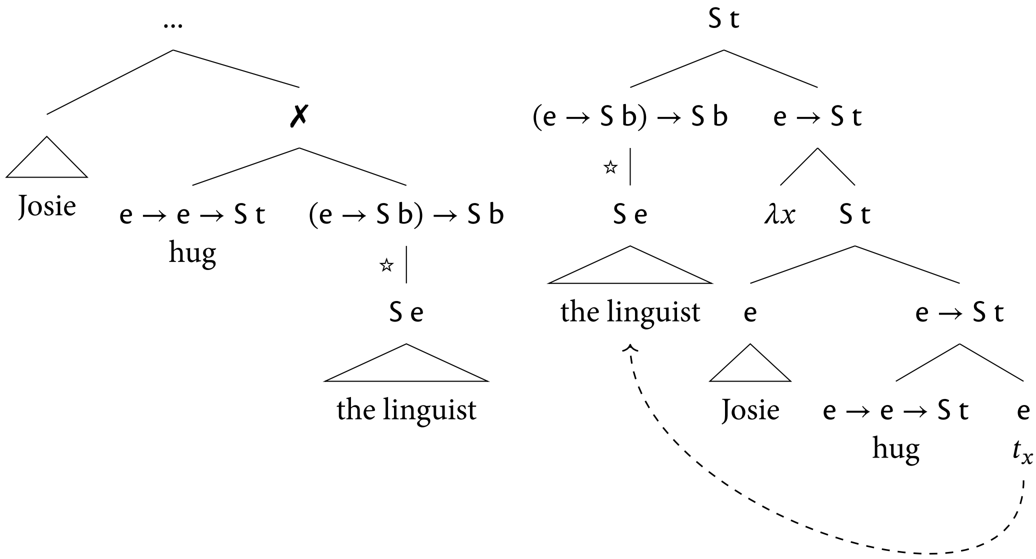
[10] There are questions surrounding the ontological status of, e.g., bind. Is it an interpreted, phonologically null piece of the syntax, or rather a freely available *composition rule*, applying purely at LF? We remain neutral on this issue, and, as far as we can see, the analysis is compatible with either view. In order to distinguish between operations like bind, and bona fide linguistic expressions, we'll often represent their application via a unary branching node.

Figure (6): The boy swims



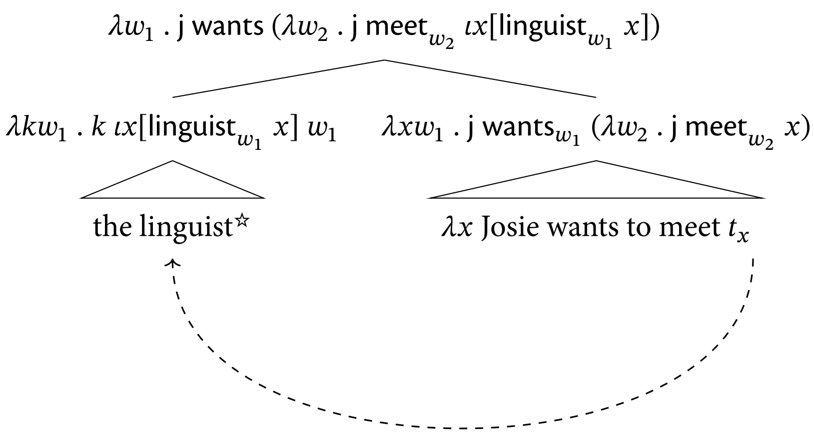
Tellingly, when we have a definite description in *object position*, it must be bind-shifted and undergo QR in order for composition to proceed:

Figure (7): Bind-shifting feeds scope-taking



At this point, we have a simple scope theory of intensionality. *De re* interpretations out of non-scope-islands can be achieved straightforwardly by bind-shifting a DP and scoping it out of the intensional environment. Let's illustrate this for *want*. Positing QR out of the complement of *want* is unproblematic, since it is not a scope island, as illustrated in (8).

Figure (8): Josie wants to meet the linguist



Just like the classical ScopTI, the theory as laid out so far falls short of accounting for *exceptional de re*, on the assumption that the operation via which world-sensitive values take scope is subject to the same locality constraints as scope-taking operations in general. It will turn out, however, that an account of exceptional *de re* is almost within our grasp — all we need is one additional operation.

3.2. Achieving *exceptional de re*

Now that we have motivated bind, we have *almost* everything we need in order to achieve exceptional *de re*. All we need is an additional type-shifter, which happens to be much simpler than bind. This type-shifter will play a similar role to Keshet's $\wedge$, therefore, we'll also call it $\wedge$ (pronounced *up*). Our up-shifter simply takes some value a and turns it into a *trivially* intensional value by adding a vacuous λw.

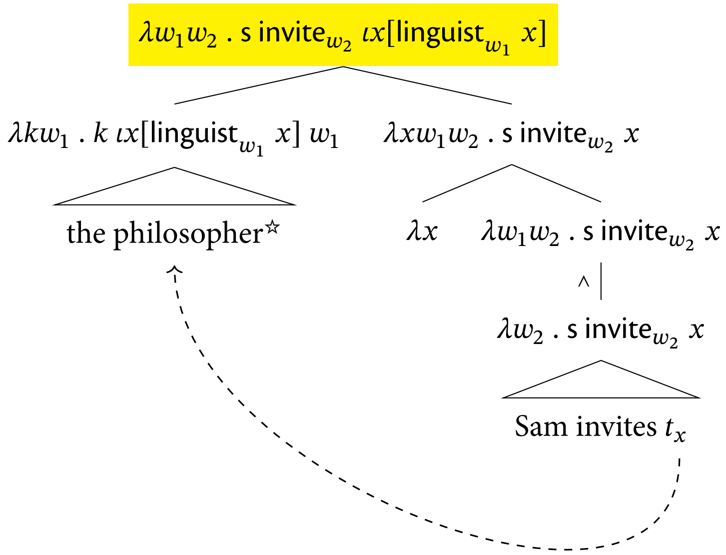
(28) Up (def.)
$a^{\wedge} \coloneqq \lambda w \,.\, a$ $\qquad\qquad \wedge : \mathsf{a} \rightarrow \mathsf{S\ a}$

Now we have everything we need to derive exceptional *de re* in the following example (29) without violating a scope island! The general logic is going to be as follows: the DP moves to the edge of the scope island over an up-shifter, deriving a *world-sensitive proposition* as the meaning of the embedded clause. The embedded clause is subsequently bind-shifted in order to resolve a type mismatch with the embedding verb, and scoped out. The DP in the edge position is thereby interpreted relative to the same world as the embedding predicate, achieving *de e*.

(29) Tom hopes [Sam invites $\boxed{\text{the philosopher}}$].

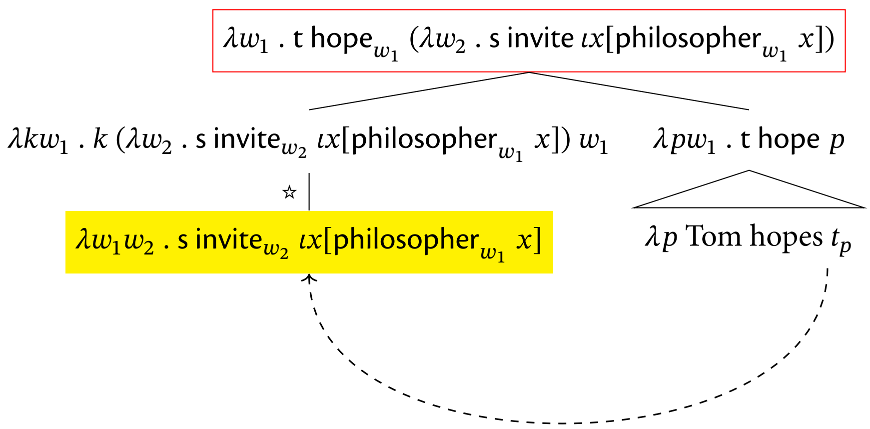
Let's go through the computation where *the philosopher* is interpreted *de re* step-by-step. First, we bind-shift the DP, and scope it above an up-shifter inserted at the edge of the embedded clause.

Figure (9): locally scope DP over up-shifter



The scope-island itself now denotes a *world-sensitive proposition*, whereas the embedding predicate *hope* is looking for a proposition. Since *bind* is polymorphic, it may address exactly this kind of type-mismatch; we bind-shift the scope island, and QR it to the edge of the matrix clause. Note that *philosopher* is interpreted relative to the global world of evaluation, whereas the rest of the embedded clause semantically reconstructs. We've achieved exceptional *de re*.

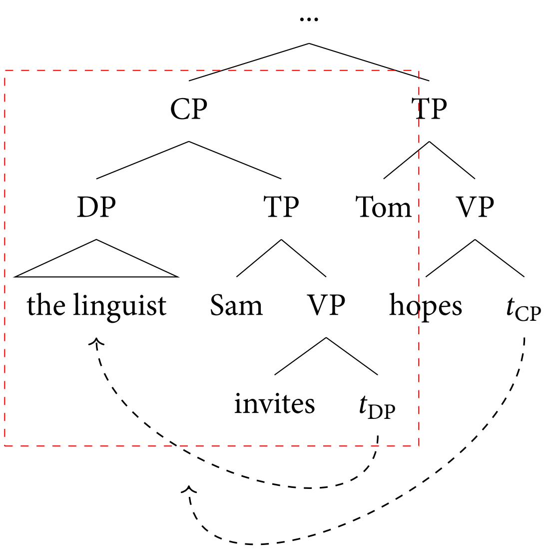
Figure (10): locally scope embedded clause



Zooming out, the resulting LF involves *cyclic scope*. This is reminiscent of the account of exceptionally scoping indefinites proposed by Charlow (2019), which is itself a distant cousin of

Dayal's account of Baker's ambiguity. Syntactically, as noted by Charlow (2019), there are some precedents for movement operations of this kind in the overt syntax, such as snow-balling pied-piping in Finnish (see Huhmarniemi 2012).[11]

(30)



3.3. Multiple embeddings and intermediate readings

It's possible to construct examples in which a DP is interpreted *de re* relative to some lower operator, but *de dicto* relative to some higher operator (see Keshet & Schwarz 2019 and Grano 2019 for additional discussion). For example, (31) can be true in a scenario in which there's a linguist who both Sam and Tom falsely believe to be a biologist. Mary falsely believes them to be a philosopher, and furthermore, Mary thinks that Tom hopes Sam invites this person. We can account for this reading if *the philosopher* can be interpreted *de re* relative to *hope*, but *de dicto*, relative to *think*.

(31) Mary thinks that [Tom hopes that [Sam invites $\boxed{\text{the philosopher}}$]].

On the flexible scope theory, we can account for this reading straightforwardly by scoping *the philosopher* to the edge of the most deeply embedded clause, over an up-shifter, followed by local scope of the most deeply embedded clause to the edge of the next most deeply embedded clause. This is illustrated schematically below. A more detailed derivation is suppressed, but should be straightforward to reconstruct.

[11] We don't attempt to explicitly argue for the syntactic reality of these movement operations in this paper. In fact, the basic features of the analysis carry over to continuation semantics (Barker 2002, Barker & Shan 2014), an in-situ theory of scope-taking, as shown in appendix A.

(32) Mary thinks [$\boxed{\boxed{\text{the philosopher}}^{\star}\ \lambda x \wedge \text{Sam invites } t_x}^{\star}\ \lambda p$ Tom hopes t_p].

Similarly, it's easy to construct a scenario in which Mary, Tom, and Sam all have false beliefs about the profession of the referent of the DP, but the speaker knows that the referent is a philosopher. On this reading, the DP receives a *total de re* interpretation. Since the process of local scope over an up-shifter, followed by scope of the containing constituent is recursive, this is easy to achieve on the flexible scope theory. Again, the derivation is schematized below:

(33) $\boxed{\boxed{\boxed{\text{the philosopher}}^{\star}\ \lambda x \wedge \text{Sam invites } t_x}^{\star}\ \lambda p\ \text{Tom hopes } t_p}^{\star}\ \lambda q$ Mary thinks t_q.

3.4. Exceptional scope and the monad laws

Readers familiar with functional programming and/or category theory may recognize the type constructor S, alongside the operations $\star$ and $\wedge$, as a *monad*, a mathematical construct commonly used for modeling "effectful" computation. Concretely, the tuple $(\mathtt{S}, \wedge, \star)$ is an instantiation of the `Reader` monad.[12] To qualify as monad, the operations $\wedge$ and $\star$ must obey three laws: *Left Identity*, *Right Identity*, and *Associativity*.

(34) Monad laws

a. *Left Identity*
$(\wedge\ a)^{\star}\ f = f\ a$

b. *Right Identity*
$m^{\star}\ (\lambda x\ .\ x^{\wedge}) = m$

c. *Associativity*
$(m^{\star}\ f)^{\star}\ g = m^{\star}\ (\lambda x\ .\ (f\ x)^{\star}\ g)$

Since the S is just an instantiation of an existing, well understood monad — the `Reader` monad, a proof of the monad laws for S is suppressed here. A consideration of the laws can help us understand *why* exactly a monad is necessary for accounting for exceptional scope. Consider again a schematic LF for the exceptional *de re* reading of *the philosopher* in the following example:

(35) Tom hopes [Sam invites $\boxed{\text{the philosopher}}$]

(36) $\boxed{\boxed{\text{the philosopher}}^{\star}\ \lambda x \wedge \text{Sam invites } t_x}^{\star}\ \lambda p$ Tom hopes t_p.

By *associativity*, this is guaranteed to be equivalent to the following:

[12]This is not the first work to suggest that intensionality can be modeled as a kind of environment sensitivity via `Reader`. See, e.g., Shan 2002b, Shan 2005, Cohn-Gordon 2016 and Asudeh & Giorgolo 2016.

(37) $\boxed{\text{the philosopher}}^{\star}\ \lambda x\ [{}^{\wedge}\ \text{Sam invites}\ t_x]^{\star}\ \lambda p\ \text{Tom hopes}\ t_p$.

By *left identity*, this is guaranteed to be equivalent to the following, i.e., an LF involving *island-violating* QR:

(38) $\boxed{\text{the philosopher}}^{\star}\lambda x\ [\text{Tom hopes Sam invites}\ t_x]$.

In general, given a type constructor m, if there are operations $\eta_{\mathsf{a}\to\mathsf{m\,a}}$ and $\gg\!=_{\mathsf{m\,a}\to(\mathsf{a}\to\mathsf{m\,b})\to\mathsf{m\,b}}$, which obey the monad laws, the natural language correlate is that expressions of type $\mathsf{m\,a}$ should exhibit exceptional scope behavior. In the current setting, $\mathsf{m} = \mathsf{S}$, $\eta = {}^{\wedge}$, and $\gg\!= = \star$. *Intensionality*, as modelled by S, therefore slots neatly into a broader category of phenomenon which exhibit exceptional scope.

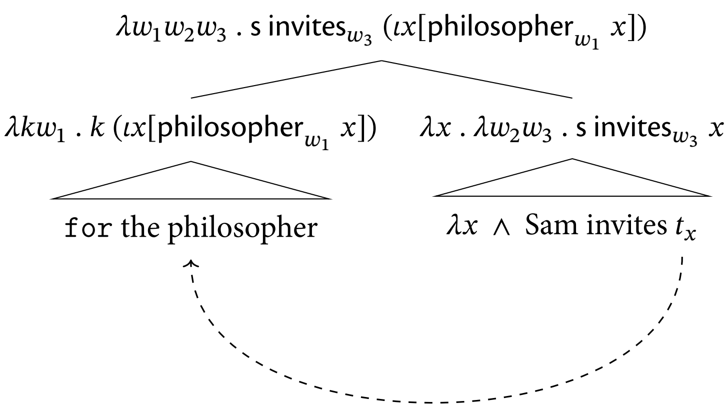
An exemplar is Charlow's (2014, 2019) account of the exceptional scope of indefinites, and indeed this work very much inspired the strategy for accounting for exceptional *de re* pursued here. Charlow models the indeterminacy associated with indefinites. Exceptional scope is accounted for via the logic of cyclic-scope taking, which by the monad laws, as we've just seen, is equivalent to *bona fide* scoping out.

One way of seeing why a monad is *necessary* for accounting for exceptional scope is to consider other ways in which we might lift expressions of type $\mathsf{S\,a}$ into scope-takers. Consider, e.g., the following operation, `for`. This operation takes an intensional value, and returns a scope taker that *expects* a b and *returns* an $\mathsf{S\,b}$.

(39) $\texttt{for}\ m \coloneqq \lambda k\,.\,\lambda w\,.\,k\,(m\,w)$ $\qquad\qquad \texttt{for} : \mathsf{S\,a} \to (\mathsf{a} \to \mathsf{b}) \to \mathsf{S\,b}$

If we apply `for` to a DP, and scope it to the edge of an up-shifted proposition (type $\mathsf{S\,t}$), there is no way of getting back something of type $\mathsf{S\,(S\,t)}$; rather, what we get is a *doubly* world-sensitive proposition of type $\mathsf{S\,(S\,(S\,t))}$. Intuitively, this is because, `for` doesn't provide a way of unifying the λw associated with the DP, with the λw introduced by the up-shifter. Scoping out the embedded clause via `for` would simply result in something of too high a type — we assume here that declarative sentences must ultimately denote a value of type $\mathsf{S\,t}$.

Figure (11): Scope via `for`



The operation `for` is `map` with the arguments flipped — `map` is an operation that maps a function of type ($\mathtt{a} \to \mathtt{b}$) into something of type $\mathsf{S}\,\mathtt{a}$. From a categorical perspective, the type constructor S and `map` constitute a *functor*, a strictly weaker notion than a monad – in fact, a monad *entails* a functor.[13] What makes the difference here is that monadic bind, i.e., $\star$, builds in a way of collapsing two layers of intensionality into one. It is this property that allows for an account of exceptional scope in terms of cyclic scope over an up-shifter.

3.5. Evidence for scope: the nested DP constraint

So far, to get to the core of the account of exceptional *de re* proposed here, we've focused exclusively on *de re* interpretations of definite descriptions, putting quantificational DPs to one side. Based on what we've seen so far, it may seem as if DPs may be receive *de re* interpretations arbitrarily, relative to any structurally higher intensional operator. Is there really *any* independent reason to believe that the *de re* interpretation of a definite DP is tied to its scope-taking ability, given the lack of any obvious restrictions on *de re* readings? In this section, we'll see initial evidence that *de re* readings *are* in fact subject to a systematic structural restriction — one that patterns with independently motivated restrictions on scope-taking.

Romoli & Sudo (2009) discuss possible readings of examples involving a DP nested inside of another DP, such as (41). Given that the nested DP is embedded in complement of an attitude verb, by the logic of the *de re*/*de dicto* ambiguity, there are 2^2 possible readings of the sentence. The first two readings are the most salient — the entire nested DP can be interpreted (i) *totally de re* or (ii) *totally de dicto*. Of particular interest is the availability of *mixed readings*: (iii) *president* is interpreted *de re*, and *wife de dicto*, and (iv) *president* is interpreted *de dicto*, and *wife de re*. Romoli & Sudo argue that only (iii) is available; (iv) is systematically unavailable. As we'll see, this falls out automatically if *de re* is fed by scope-taking, even given the expressive power of the system outlined here.

(41) Mary thinks that $\boxed{\text{the wife of } \boxed{\text{the president}}}$ is nice.

Romoli & Sudo: p. 430 ask us to consider the following context: "Mary is watching television and sees Barack Obama, the actual president, and his sister besides him. Also, she doesn't know who he is and she thinks that the woman besides him must be is his wife." As they (in my view, correctly) observe, (41) is judged to be true in this scenario. On the flexible scope theory, we can easily generate this by scoping *the president* out of its container (cf. Heim & Kratzer 1998), to the edge of the embedded clause, over an up-shifter, followed by scoping the embedded clause.

It is, however, often assumed that DP is a scope island, primarily in order to account for *Larson's generalization*.[14] There's no need to weigh in on this debate here, but it's worth showing that the

[13] We can define `for`/`map` in terms of our existing monadic operations, in the following way:

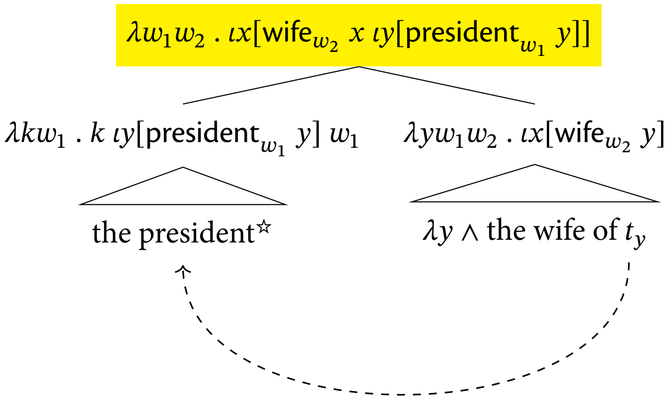
(40) $\texttt{for}\; m \;= \lambda k\,.\, m^{\star}\,(\lambda x\,.\,(k\,x)^{\wedge})$

[14] This has however been the subject of significant debate. See, e.g., Sauerland 2005 for arguments that DP isn't a scope island, and Charlow 2010 for a response.

flexible scope theory is sufficiently expressive to account for the attested mixed reading *without* scoping the contained DP out of its container. Briefly, the logic is as follows: we scope *the president* to the edge of the containing DP, over an up-shifter, and then cyclic scope proceeds as usual.

First, the contained DP scopes to the edge of the container, over an up-shifter, deriving a *doubly world-sensitive individual* as the value of the nested DP.

Figure (12): DP-internal scope



Next, the nested DP is bind-shifted, and scopes out to the edge of the embedded clause — note that the DP must undergo *two* steps of movement for composition to proceed. The first leaves behind an extension trace (type e), the second leaves behind an intensional trace (type S e), which itself takes scope via bind. The result, as usual, is a *world-sensitive proposition*, of type S (S e). This is illustrated in figure (13). Finally, the embedded scope island is bind-shifted and scoped out. The result is that the contained DP is interpreted relative to the global evaluation world, and everything else semantically reconstructs. This is illustrated in figure (14). This corresponds to Romoli & Sudo's attested mixed reading.

Figure (13): Scope to the edge of the embedded clause

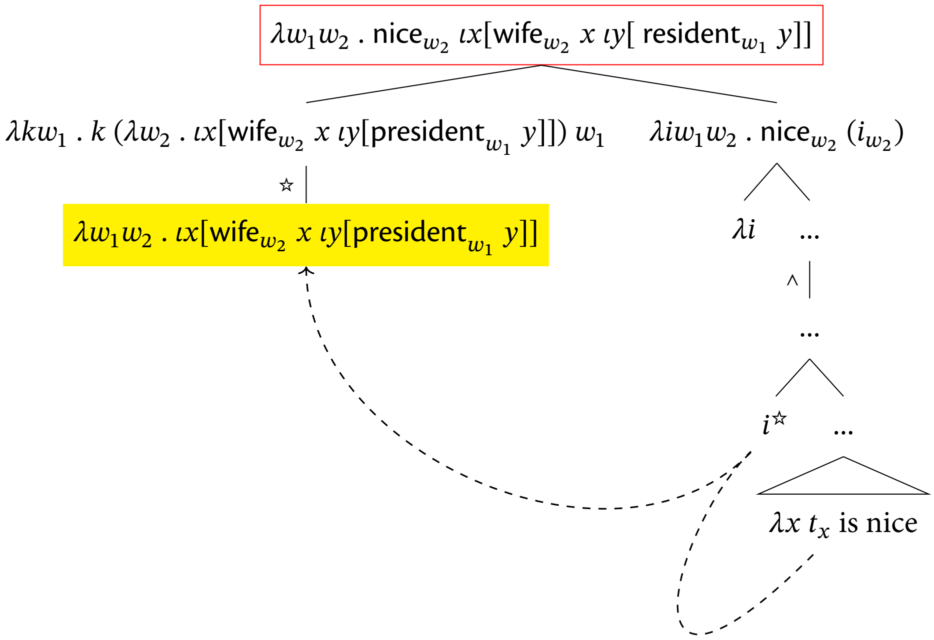
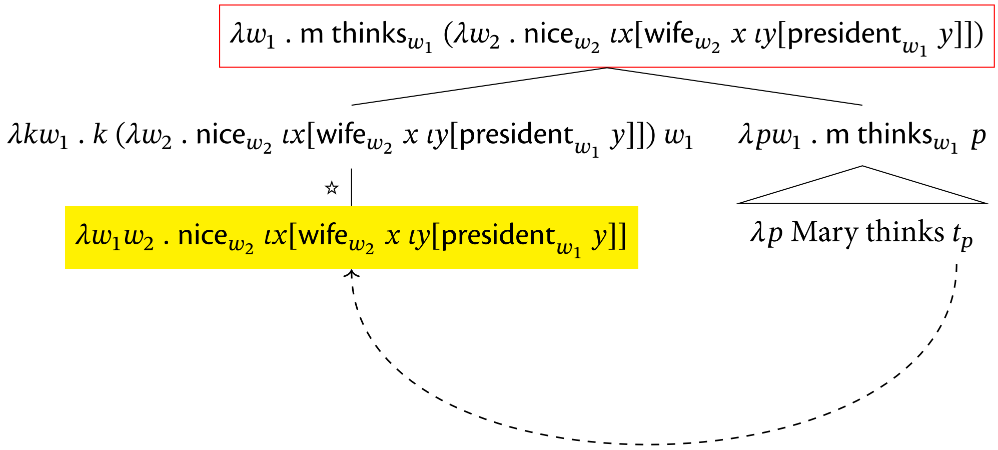


Figure (14): Scope out the embedded clause



Moving on, now let's consider the mixed reading that is argued by Romoli & Sudo to be unattested. Romoli & Sudo: p. 430 ask us to consider the following context: "Mary sees Bono Vox on TV with his wife Alison Hewson. Mary wrongly believes that he is the president, and furthermore, that the nice woman next to him is his sister. Thus, the wife-relation is actually true, but the characterization of Bono Vox as the president is not." As Romoli & Sudo (again, in my view correctly observe) our sentence (repeated in (42)) is intuitively *false* in such a context.

(42) Mary thinks that the wife of the president is nice.

As Romoli & Sudo point out, this is a rather mysterious restriction on a theory such as the BTI. On *any* scope-driven theory however, including the flexible scope theory outlined here, this restriction naturally falls out. This is because, for *president* to be interpreted *de dicto* and *wife de re*, *the president* should scope within the embedded clause, below the up-shifter at the clause edge, whereas the containing DP should scope above the up-shifter, as schematized in the following (illicit) LF:

(43) $\boxed{\text{the wife of } t_x}^{\star}\ \lambda y \wedge [\boxed{\text{the president}}^{\star}\ \lambda x\ t_y \text{ is nice}]$.

This LF must be disallowed, on independent grounds, since it involves an unbound trace, and traces must be bound.[15]. Scope theories therefore make a good prediction for restrictions on *de re* readings — here we've shown that it's possible for a scope theory to avoid the over-generation worries associated with the classical ScopTI and its successors, while still retaining an explanation for the nested DP constraint. Scope theories have other explanatory virtues too, which we'll come back to once we completed our exposition of the flexible scope theory in the next section.

4. Intensional scope and quantificational scope

So far, our fragment has one glaring omission — we've said nothing yet about quantificational DPs such as *every boy*. Relatedly, we've said nothing regarding how definite descriptions come to denote individual concepts in the first place. This section will address both of these issues, and it will turn out that the question of how DP-internal composition proceeds is closely connected to the compositional mechanisms we need to incorporate quantificational DPs into our fragment. In the next subsection, we'll begin with a discussion of the (seemingly) purely mechanical question of how definite descriptions come to denote individual concepts.

[15]On a QR-based theory of scope-taking, this must be blocked in the syntax. In some alternative theories of scope-taking, such as Barker & Shan's (2014) continuation semantics, this question doesn't even arise, and the unattested reading simply can't be derived. See appendix A for details.

There is of course substantial evidence that the syntax should be able to generate configurations such as (43) — typically, this configuration is described as involving remnant movement (thanks to Stanislao Zompi for bringing this matter to my attention). Arguably, predicate fronting in English involves remnant movement:

(44) $[t_x$ leave the house$]^y$, Kez^x never would t_y.

Regardless, traces cannot be interpreted as free variables. The status of remnant movement at LF is a broader question than can be addressed here, but in order to avoid an unbound trace, the *remnant* (i.e., the containing DP) would have to fully semantically reconstruct. See, e.g., Sternefeld 2001 for discussion.

4.1. DP-internal composition

On the flexible scope theory, it's essential that definite DPs are interpreted as individual concepts. But, how do we account of this compositionally? We can begin by assuming that definite determiners receive a classical Fregean interpretation.[16] There is, of course, no semantic reason to make determiners themselves world-sensitive.

(45) $[\![\text{the}]\!] \coloneqq \lambda P \,.\, \iota x[P\ x]$ $\qquad (\mathsf{e} \to \mathsf{t}) \to \mathsf{e}$

It should be obvious that if we try to compose a definite determiner with our proposed predicate denotations (type $\mathsf{e} \to \mathsf{S}\ \mathsf{t}$), the result is a type mismatch — our existing inventory of type-shifters won't help at all. In the general case, what we need is a way of taking something of type $(\mathsf{a} \to \mathsf{b}) \to \mathsf{c}$ and shifting it into something of type $(\mathsf{a} \to \mathsf{S}\ \mathsf{b}) \to \mathsf{S}\ \mathsf{c}$. It turns out that there is in fact straightforward way to define this operation in terms of our existing operations *bind* and *up*. First, we'll need to define a helper function *flip* (46) (which we'll write as **C**, inspired by combinatory logic) — the function name is mnemonic: all it does is take a curried function, and flips the order of the arguments.[17]

(46) $m^{\mathbf{C}} \coloneqq \lambda w x \,.\, m\ x\ w$ $\qquad \mathbf{C} : (\mathsf{a} \to \mathsf{b} \to \mathsf{c}) \to \mathsf{b} \to \mathsf{a} \to \mathsf{c}$

We now define a new type-shifter *cotraverse*[18] (which we'll write as $\mathcal{F}$) in (47), in terms of *bind*, *up*, and *flip*. The intuition here is as follows: a determiner f is a purely extensional function from a predicate to a truth value, which we need to somehow compose with a function m from an individual to an *intensional* truth-value. First, we push the intensionality in m outwards via *flip*, then we map f into the contained predicate.[19]

(47) $f^{\mathcal{F}} \coloneqq \lambda f \,.\, \lambda k \,.\, k^{\star \circ \mathbf{C}}\, (\lambda P \,.\, (f\ P)^{\wedge})$ $\qquad \mathcal{F} : ((\mathsf{a} \to \mathsf{b}) \to \mathsf{c}) \to (\mathsf{a} \to \mathsf{S}\ \mathsf{b}) \to \mathsf{S}\ \mathsf{c}$

Once we apply cotraverse to the definite determiner, the result is a function that takes a function from individuals to propositions (the restrictor), and returns an individual concept, just as desired:

(48) $[\![\text{the}]\!]^{\mathcal{F}} = \lambda k \,.\, k^{\star \circ \mathbf{C}}\, (\lambda P \,.\, (\iota x[P\ x])^{\wedge})$ $\qquad (\mathsf{e} \to \mathsf{S}\ \mathsf{t}) \to \mathsf{S}\ \mathsf{e}$

The lifted determiner may now compose with its restrictor, returning an individual concept, which composes with the main predicate via bind. This is illustrated in the derivation below for "the boy swims". Since $\mathcal{F}$ is defined in terms of *bind* and *up*, we can engage in some routine simplifications, taking advantage of the monad laws.

[16] The same questions will of course arise if we instead assumed a Russellian (i.e., a quantificational) denotation for the definite determiner. As we will defer discussion of quantificational scope until later, it is presentationally convenient to take the Fregean denotation.

[17] Importantly, we don't take flip to be a bona fide type-shifter, it simply exists to make the definition of the operation in (47) more terse.

[18] At this point, the chosen nomenclature may seem rather arcane. This will be illuminated in §4.7, where we discuss the logical foundations of cotraverse.

[19] I'm extremely grateful to an anonymous reviewer for suggesting this strategy, which considerably simplifies a related proposal put forward in a previous version of this paper.

(49) a. $([\![\text{the}]\!]^{\mathcal{F}}\ [\![\text{boy}]\!])^{\star}\ [\![\text{swim}]\!]$

b. $= ((\lambda wx \,.\, \mathsf{boy}_w\ x)^{\star}\ (\lambda P \,.\, (\iota x[P\ x])^{\wedge}))^{\star}\ (\lambda xw \,.\, \mathsf{swim}_w\ x)$

c. $= (\lambda wx \,.\, \mathsf{boy}_w\ x)^{\star}\ ((\lambda P \,.\, (\iota x[P\ x])^{\wedge})^{\star}\ (\lambda xw \,.\, \mathsf{swim}_w\ x))$ by *associativity*

d. $= (\lambda wx \,.\, \mathsf{boy}_w\ x)^{\star}\ (\lambda P \,.\, \lambda w \,.\, \mathsf{swim}_w\ (\iota x[P\ x]))$ by *left identity*

e. $= \lambda w \,.\, \mathsf{swim}_w\ (\iota x[\mathsf{boy}_w\ x])$ $\mathsf{S\ t}$

Since cotraverse is of a sufficiently general type, we can also apply it to quantificational determiners, of type $(\mathsf{e} \to \mathsf{t}) \to (\mathsf{e} \to \mathsf{t}) \to \mathsf{t}$. A quantificational determiner shifted via cotraverse takes a function from individuals to propositions (the restrictor), and returns a *world sensitive quantifier* of type $\mathsf{S}\ ((\mathsf{e} \to \mathsf{t}) \to \mathsf{t})$.

(50) $[\![\text{every}]\!]^{\mathcal{F}} = \lambda r \,.\, r^{\star \circ \mathsf{C}}\ (\lambda P \,.\, ([\![\text{every}]\!]\ P)^{\wedge})$ $(\mathsf{e} \to \mathsf{S\ t}) \to \mathsf{S}\ ((\mathsf{e} \to \mathsf{t}) \to \mathsf{t})$

Composition of a lifted determiner with a restrictor is illustrated below:

(51) a. $[\![\text{every}]\!]^{\mathcal{F}}\ [\![\text{boy}]\!]$

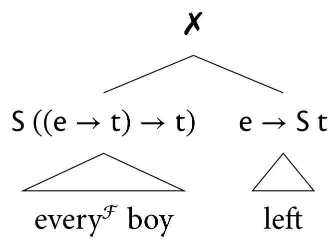
b. $= (\lambda wx \,.\, \mathsf{boy}_w\ x)^{\star}\ (\lambda P \,.\, ([\![\text{every}]\!]\ P)^{\wedge})$

c. $= \lambda w \,.\, \lambda k \,.\, \forall x[\mathsf{boy}_w\ x \to k\ x]$ $\mathsf{S}\ ((\mathsf{e} \to \mathsf{t}) \to \mathsf{t})$

In the next section, we'll tackle the problem of how world-sensitive quantifiers enter into composition. The solution we'll invoke — higher-order traces — will have sweeping consequences for our intensional grammar, and ultimately will be crucial in accounting for Bäuerle's puzzle.

4.2. Higher-order traces

We've achieved a fragment in which definite determiners can return individual concepts, and quantificational determiners can return world-sensitive quantifiers, via cotraverse. We know how to compose an individual concept with a verbal predicate — we simply bind-shift it, and scope it out, but how do we compose a world-sensitive quantifier with a verbal predicate? The DP seems to have the right sort of meaning, but just going by the operations available to us, the result is a type mismatch, as illustrated below:



We do however have an operation for composing a purely *extensional* quantifier of type $(\mathsf{e} \to \mathsf{t}) \to \mathsf{t}$ with a verbal predicate of type $\mathsf{e} \to \mathsf{S\ t}$, namely cotraverse; if we apply cotraverse to a purely extensional quantifier, we get a function of type $(\mathsf{e} \to \mathsf{S\ t}) \to \mathsf{S\ t}$, which we can apply to the scope via function application. In order to marshal our existing machinery to compose a world-sensitive quantifier with a verbal predicate, we must therefore bind-shift the quantifier, and scope it out, leaving behind an (extensional) *higher-order trace* of type $(\mathsf{e} \to \mathsf{t}) \to \mathsf{t}$, which composes with the scope via $\mathcal{F}$ — strikingly, the same type-shifter which we motivated via DP-internal composition is crucially implicated in the composition of QPs. The intuition here is that the final landing site of QP marks its *intensional* scope, whereas the higher-order trace marks its quantificational scope. In other words, the extensional part of the meaning semantically reconstructs to t_Q. This is illustrated in figure (15). In (52), we evaluate the result.

Figure (15): "Every boy swims"

$$(\lambda w\,.\,\lambda k\,.\,\forall x[\mathsf{boy}_w\ x \to k\ x])^{\star}\ (\lambda Q\,.\,(\lambda w x\,.\,\mathsf{swim}_w\ x)^{\star}\ (\lambda P\,.\,(Q\ P)^{\wedge}))$$

- $\lambda l\,.\,(\lambda w\,.\,\lambda k\,.\,\forall x[\mathsf{boy}_w\ x \to k\ x])^{\star}\ l$
  - $\star$
    - $\lambda w\,.\,\lambda k\,.\,\forall x[\mathsf{boy}_w\ x \to k\ x]$
      - every$^{\mathcal{F}}$ boy
- $\lambda Q\,.\,(\lambda w x\,.\,\mathsf{swim}_w\ x)^{\star}\ (\lambda P\,.\,(Q\ P)^{\wedge})$
  - λQ
  - $(\lambda w x\,.\,\mathsf{swim}_w\ x)^{\star}\ (\lambda P\,.\,(Q\ P)^{\wedge})$
    - $\lambda k\,.\,m^{\star\,\circ\,\mathsf{C}}\ (\lambda P\,.\,(Q\ P)^{\wedge})$
      - $t_Q^{\mathcal{F}}$
    - swims

(52) a. $(\lambda w\,.\,\lambda k\,.\,\forall x[\mathsf{boy}_w\ x \to k\ x])^{\star}\ (\lambda Q\,.\,(\lambda w x\,.\,\mathsf{swim}_w\ x)^{\star}\ (\lambda P\,.\,(Q\ P)^{\wedge}))$

b. $= (\lambda w\,.\,\lambda k\,.\,\forall x[\mathsf{boy}_w\ x \to k\ x])^{\star}\ (\lambda Q\,.\,(\lambda w\,.\,Q\ (\lambda x\,.\,\mathsf{swim}_w\ x)))$

c. $= \lambda w\,.\,\forall x[\mathsf{boy}_w\ x \to \mathsf{swim}_w\ x]$

The use of higher-order traces here bears a resemblance to semantic theories of scope reconstruction (see, e.g., Cresti 1995 and von Fintel & Heim 2011). It's worth mentioning that the extent to which *overt* movement allows for semantic reconstruction is a somewhat vexed issue (see, e.g., Fox 1995, Romero 1998, and Poole 2017 for critical discussion), but nothing in the flexible scope theory crucially hinges on the QR-based approach to scope; indeed there are many theories of scope-taking which don't require explicit reference to variables and assignments (see appendix A). In the more general case, it would require further stipulation to *rule out* LFs involving higher-order abstraction.[20]

4.3. Fodor's third reading

Fodor (1970) famously discussed sentences such as (53) (this particular example is taken from von Fintel & Heim 2011: p. 100). She observes that it has three readings, which she labels *specific de re*, *non-specific de dicto*, and *non-specific de re*.

[20] I'm grateful to an anonymous reviewer for pressing me on this point.

(53) Mary wanted to buy $\boxed{\text{a hat just like mine}}$.

On the *specific de re* reading, (53) says that there's a hat that is actually just like mine, and Mary happens to want to buy it. In our terms, this reading involves both wide intensional and quantificational scope. We can derive it by bind-shifting *a hat just like mine* and scoping it out, leaving a higher order-trace above *want*.

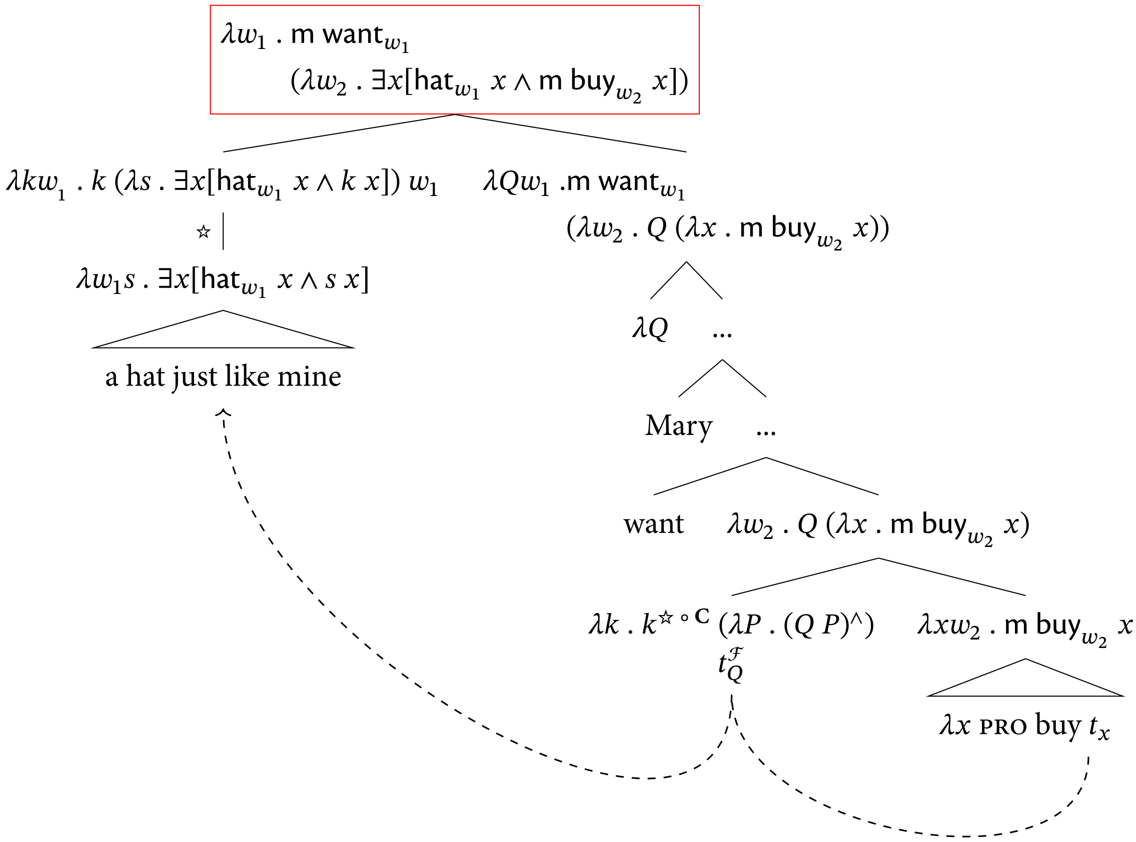
(54) $\boxed{\text{a hat just like mine}}^{\star}$ $\lambda Q\ t_Q^{\mathcal{F}}$ (λx Mary wanted PRO buy t_x).

On the *non-specific de dicto* reading, (53) says that Mary's desire consists of the following: *buying a hat that is just like mine; any such hat will do*. In our terms, this reading involves both narrow intensional and quantificational scope. Just as before, the intensional and quantificational meaning components scope together. We derive it by bind-shifting *a hat just like mine*, and scoping it below *want*.

(55) Mary want [$\boxed{\text{a hat just like mine}}^{\star}$ $\lambda Q\ t_Q^{\mathcal{F}}$ (λx PRO buy t_x)].

The *non-specific de re* reading is of particular interest, as it is here that quantificational scope and intensional scope diverge. Concretely, on this reading (53) says something like the following: *Mary has a desire to buy any hat that satisfies a particular condition, e.g., one that suits her. Unbeknownst to Mary, my hat happens to suit her. She may not be aware of it, but her desires encompass my hat.* In our terms, this reading involves narrow quantificational scope but wide intensional scope. How do we achieve this in our system? Since we've already motivated higher-order traces, in order to compose QPs, we simply take advantage of this possibility to reconstruct the quantificational part of *a hat just like mine* below *want* (see von Fintel & Heim 2011: chapter 8 for discussion of this strategy); intensional effects can thereby outscope quantificational effects. The derivation of the third reading is illustrated in the LF in figure (16).

Figure (16): Fodor's third reading



There is, of course, logically a fourth potential reading we may consider — a *specific de dicto* reading. If we consider our original example, repeated below as (57), this would amount to a context in which there is a particular hat that Mary wants to buy, and she wants to buy it under the description "a hat just like mine". There is a broad consensus in the literature that Fodor's *fourth reading* is in fact unavailable (see von Fintel & Heim 2011: chapter 8, Keshet & Schwarz 2019 a.o. for discussion).[21]

(57) Mary wants to buy a hat just like mine.

Even with the expressive power of the flexible scope theory, it's not possible for quantificational

[21] Szabó (2010) argues that the specific *de dicto*, although not possible in examples such as (57), is necessary to account for cases such as (56).

(56) Mary thinks she bought an expensive coat. It is actually quite expensive.

See Keshet & Schwarz (2019) for a response pointing out potential confounding factors in Szabó's data.

effects to outscope intensional effects.[22] Why is this? A fundamental design feature of the flexible scope theory is that logical operators, such as determiners, receive their classical (extensional) meanings, and only manage to interact with world sensitive things via type-lifting. In order to achieve quantificational effects out-scoping intensional ones, we'd need to posit a determiner that quantifies over *individual concepts*. In order to account for the absence of Fodor's fourth reading, we speculate that there simply aren't any natural language determiners that do this as part of their inherent meaning – natural language determiners are Generalized Quantifiers (GQs), and must be lifted via cotraverse in order to interface with an intensional grammar.

4.4. An account of Bäuerle's puzzle

Now that we've upgraded our fragment into one that can handle quantificational DPs via cotraverse, we're finally at a point where we can present the resolution to Bäuerle's puzzle. Since quantificational and intensional scope are divorced in a systematic way, the resolution turns out to be surprisingly straightforward. Consider again the problematic sentence, repeated in (58):

(58) George thinks every Red Sox player is staying in some five star hotel downtown.

Recall, the reading we're interested in is the one on which: (i) *every Red Sox player* is interpreted *de re*, and takes narrow quantificational scope below *some*; (ii) *some five star hotel downtown* is interpreted *de dicto*, and takes wide quantificational scope within the embedded clause, over *every*. Consequently, we want the intensional effects of *every Red Sox player* to outscope its quantificational effects, and we want the quantificational effects of *some five star hotel downtown* to outscope the quantificational effects of *every Red Sox player*. We can achieve this by scoping just *every Red Sox player* over an up-shifter, and semantically reconstructing its quantificational meaning component.

The derivation is broken down here into two steps, shown in figures (17) and (18): figure (17) illustrates the composition of the embedded clause; *some five star hotel* scopes to a position below the *up* operator, leaving behind a higher-type trace $t_{Q'}$, whereas *every Red Sox player* scopes to a position *above* the up-shifter, leaving behind a higher-type t_Q below $t_{Q'}$. (18) illustrates the composition of the matrix clause: the embedded clause is bind-shifted and scoped out.

[22] In the literature on functional programming, it's common to distinguish between the bread and butter of pure computation via function-argument application, and accompanying "effects" (see, e.g., Mcbride & Paterson 2008). In a formal semantic setting, *effects* are "extra" meaning components modeled by a type constructor such as S, that require additional machinery, such as bind, in order to thread through the computation. We don't model quantifier scope as an effect explicitly here, but see appendix A.

Figure (17): Bäuerle's puzzle step 1

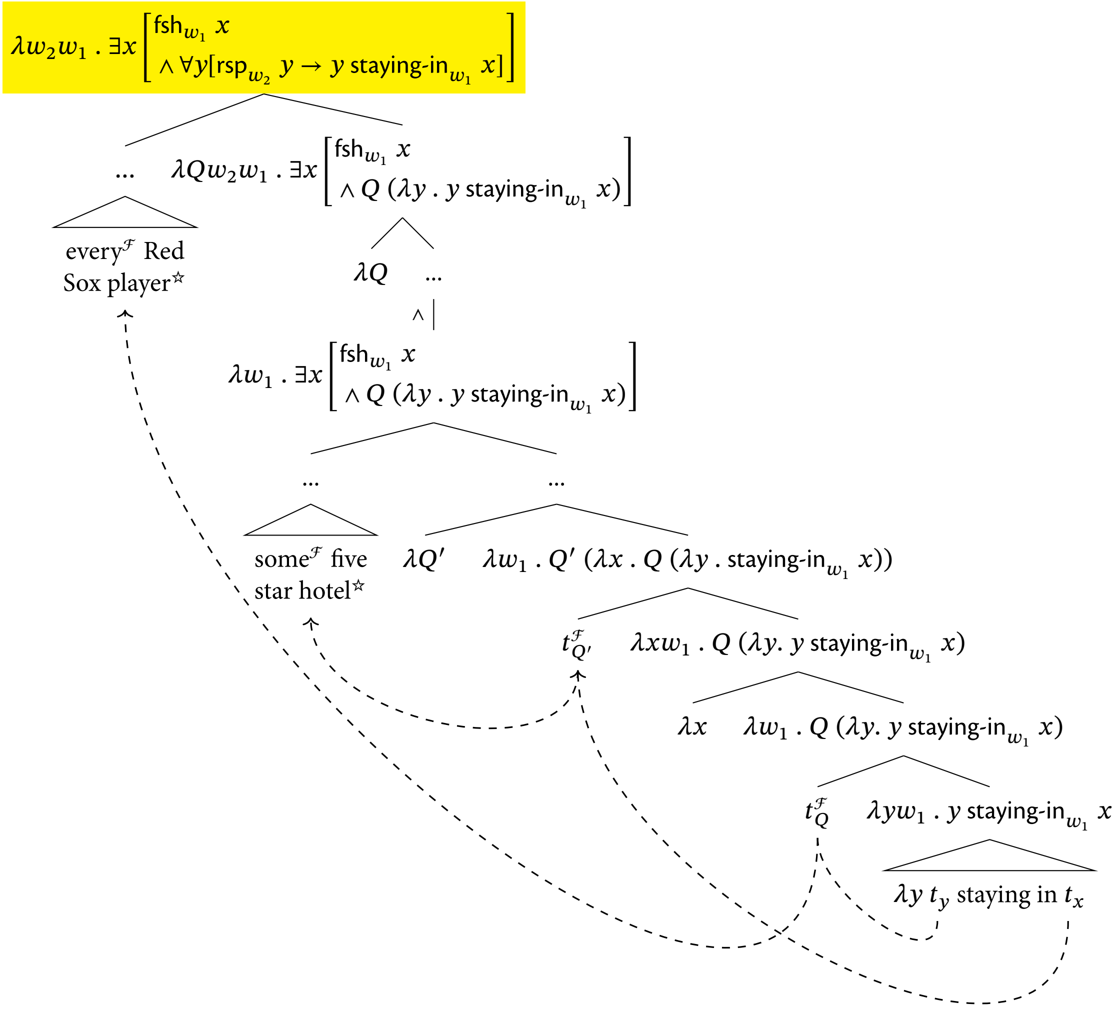
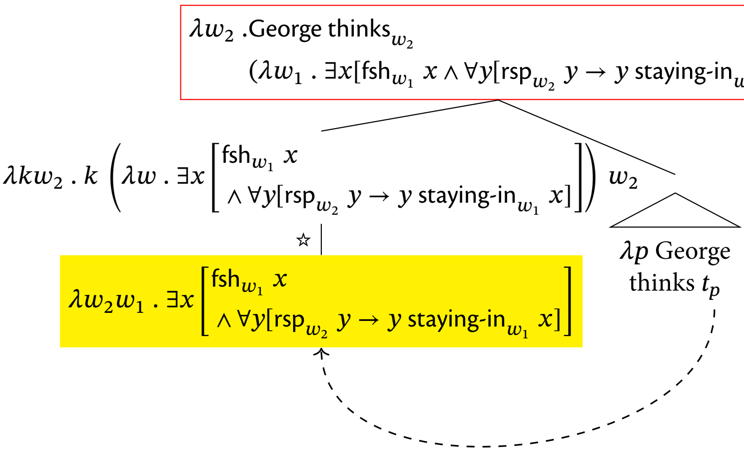


Figure (18): Bäuerle's puzzle step 2



4.5. Negative Polarity Items

Additional evidence for a theory which allows intensional effects and quantificational effects to scope together, or for intensional effects to outscope quantificational effects, but *not* vice versa, comes from the interaction between Negative Polarity Items (NPIs) and *de re* readings. In a sentence such as (61), *no unicorn* (the NPI licensor) can be interpreted *de dicto*, while the NPI *any Soviet republic* is interpreted *de re*, i.e., (61) is true in a scenario in which John thinks the following: *No unicorn lives in Russia, Poland, Slovenia, etc.*, but doesn't know anything about the history of these countries.[23]

(61) John thinks [that **no unicorn** lives in $\boxed{\text{any former Soviet republic}}$].

[23] I'm grateful to Yasu Sudo (p.c.) for bringing these facts to my attention. The judgment reported here (checked with ~10 native English speakers) is completely at odds with the discussion of NPI licensing and *de re* in Keshet 2011: p. 261. Keshet reports the following constrast:

(59) a. My mother **doesn't** think [that I managed to pass $\boxed{\text{any class that I failed}}$].

b. # My mother thinks [that I managed **not** to fail $\boxed{\text{any class that I failed}}$].

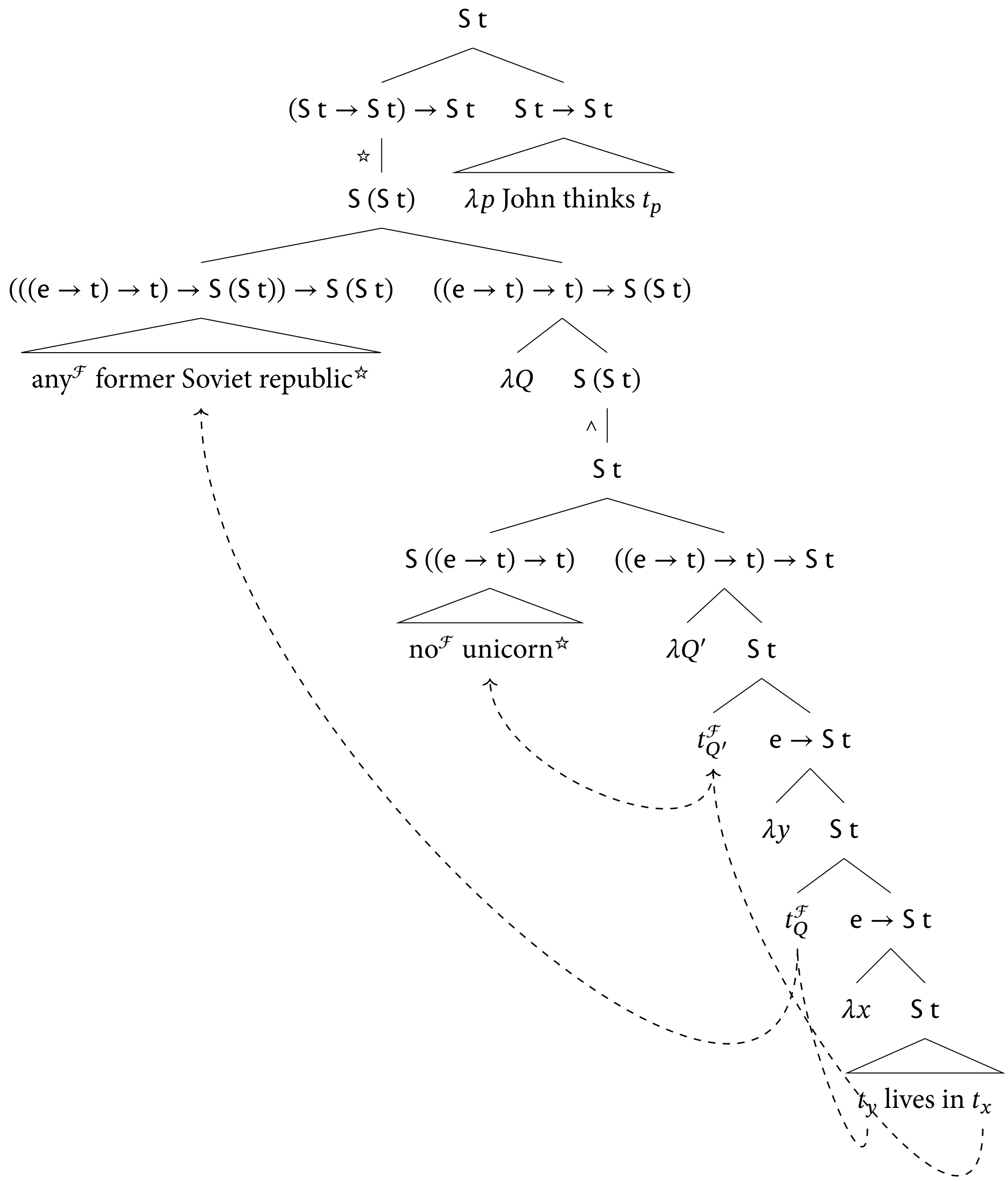
For (59b) to receive a sensible reading, *any class that I failed* must be interpreted *de re*. Since (59b) sounds odd, Keshet concludes that *de re* is blocked, since it would involve scoping over the licensor. I'm not sure why (59b) sounds as odd as it does, but simplifying the example results in a significant improvement:

(60) My mother thinks [that I **didn't** fail $\boxed{\text{any class that I failed}}$].

The structure of this example is reminiscent of Bäuerle's puzzle: in a classical scope theory, the fact that the NPI is licensed suggests that the licensor scopes over the NPI, but the fact that the NPI is interpreted *de re* and the licensor is interpreted *de dicto* suggests the opposite. This tension can be easily resolved within the flexible scope theory by allowing the intensional effects of *any former Soviet republic* to outscope its quantificational effects. The idea would be that *any former Soviet republic* scopes above an up-shifter, above the licensor, but the quantificational part semantically reconstructs.[24] This is illustrated in the LF below:

[24] And furthermore, that as long as the quantificational part of the NPI is interpreted within the scope of the licensor at LF, then the NPI is licensed.

Figure (19): Divorcing *de re* and NPI licensing



One potential issue raised by this analysis is that it suggests that semantic reconstruction feeds NPI licensing. This is not straightforward, since A-movement *bleeds* NPI licensing, despite the fact that A-moved QPs can semantically reconstruct. This is illustrated by the examples below –

(62c) acts as a control, and shows that an NPI is licensed by high negation in the complement of *seem*; (62a) shows that an A-moved QP can indeed semantically reconstruct; finally the target (62b) shows that A-movement bleeds NPI licensing.

(62) a. A philosopher seems [__ to be drunk]. seem > ∃

b. * $\boxed{\text{Any philosopher}}$ **doesn't** seem [__ to be drunk].

c. It **doesn't** seem [that $\boxed{\text{any philosopher}}$ is drunk].

This paradigm is however a problem for *any* theory of NPI licensing, especially given that scope can clearly feed NPI licensing, even when the licensor doesn't surface c-command the NPI, as in (63). As others have concluded (see Ladusaw 1979, and Barker & Shan 2014: ch. 8 for recent discussion), it seems that there must be a component in the theory of NPI licensing which makes reference to linear order.

(63) [Books by **none of these authors**] sold $\boxed{\text{any copies}}$.

4.6. Scope freezing

A well known constraint on quantificational scope in English is *scope freezing* in a family of configurations including the Double Object Construction (DOC) (Larson 1990).

(64) a. Roger gave a different beer to every linguist. ✓∀ > ∃

b. #Roger gave a different linguist every beer. ✗∃ > ∀

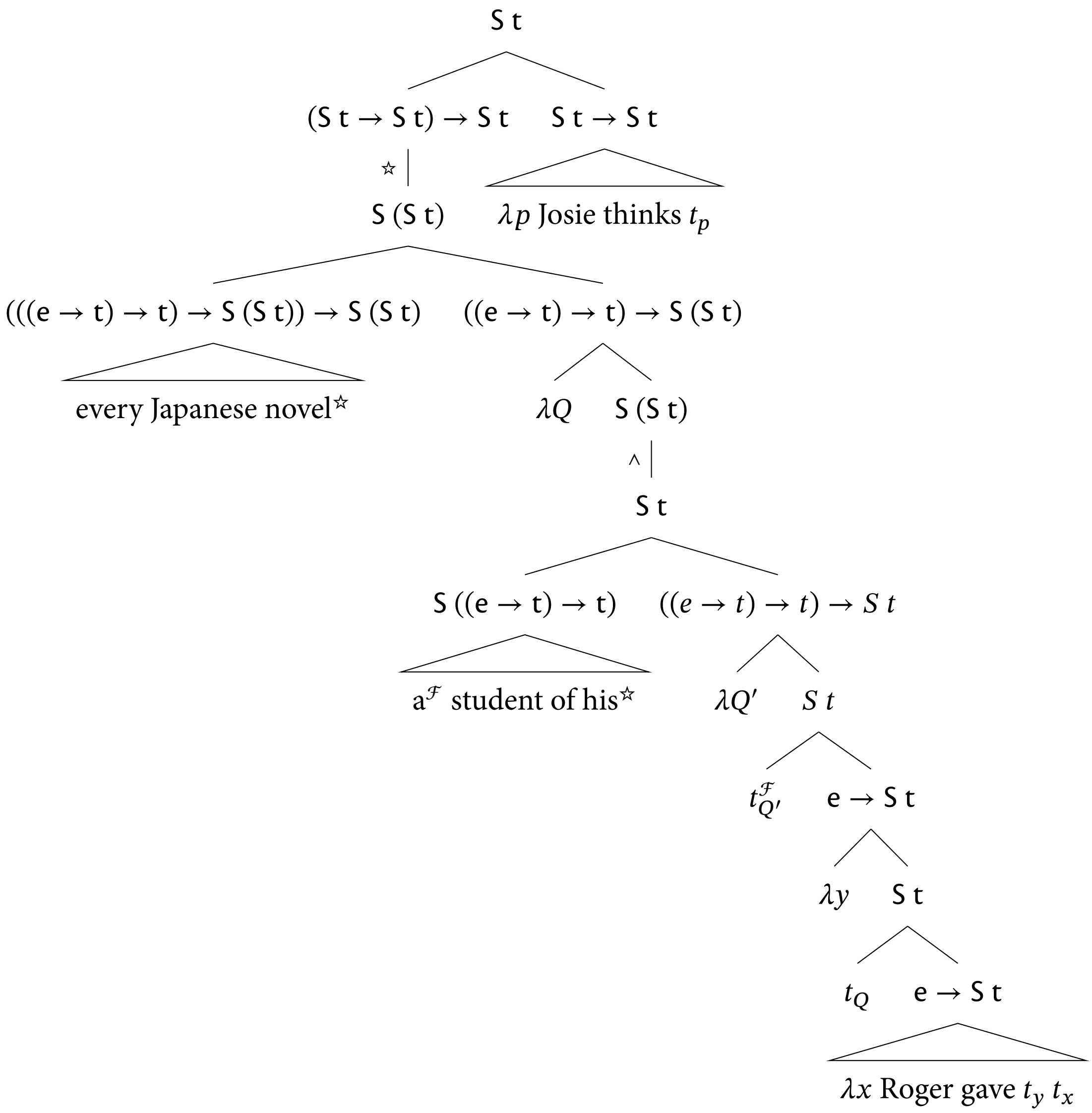
In light of the classical scope theory, and our discussion of scope islands, the obvious question to ask here is the following — do restrictions on scope track restrictions on *de re*? If they do, we expect the absence of a mixed reading where the indirect object is interpreted *de dicto* and the direct object is interpreted *de re*. As demonstrated by the acceptability of the example in (65), the direct object in fact *can* be interpreted *de re*, even if the indirect object is interpreted *de dicto*.

(65) Context: *Roger has a section on his bookshelf dedicated to Japanese novels, but Josie mistakenly thinks that they're Chinese novels. She notices that this section is empty, and assumes that Roger gave these books to one of his students.*
Josie thinks [that Roger gave a student of his $\boxed{\text{every Japanese novel}}$].

This is unexpected on a classical scope theory, but provides additional support for the flexible scope theory, in which quantificational and intensional scope are systematically divorced. In order to achieve the mixed reading of (65), we can scope *every japanese novel* over an up-shifter, allowing the quantificational part to semantically reconstruct. *A student of his*, on the other hand, scopes below the up-shifter. This is demonstrated by the LF below:[25]

[25] If the conclusions here are correct, they have an interesting consequence for the analysis of scope freezing. QR-ing the indirect object over the direct object can't be ruled out per se (cf. Bruening 2001), but rather whatever constraint gives rise to scope freezing must be stated specifically in relation to *quantificational* scope.

Figure (20): Divorcing *de re* and scope freezing effects



4.7. On the foundations of cotraverse

It should be clear at this point that *cotraverse* plays a hugely important role in our grammar — it is necessary for DP-internal composition to proceed, and in tandem with higher-order traces, manages the interaction between intensional effects and quantificational effects. In order to fully understand the role of cotraverse, it is useful to entertain a potential alternative for predicate denotations in an intensional grammar, as in (66): boy' is just our ordinary denotation for *boy*, but with the arguments flipped; the result is a world-sensitive predicate.

(66) $\mathsf{boy}' \coloneqq \lambda wx\,.\,\mathsf{boy}_w\,x$ $\qquad\qquad$ $\mathsf{S}\,(\mathsf{e} \to \mathsf{t})$

Let's say that we want to compose the definite determiner — an extensional function from predicates to individuals — with (66) in order to derive an individual concept meaning. Intuitively, we'd like to pass through the outer layer of intensionality, and apply the determiner directly to the contained predicate. There's a standard way of mapping an ordinary function into a function from monadic values to monadic values — namely, *map*, which is defined in terms of *bind* and *up*. This is because S is a functor as well as a monad — in fact, every monad implies a functor.

(67) $\mathsf{map}\ f \coloneqq \lambda m\,.\,m^{\star}\,(\lambda x\,.\,(f\ x)^{\wedge})$ $\qquad (\mathsf{a} \to \mathsf{b}) \to \mathsf{S\ a} \to \mathsf{S\ b}$

In effect, cotraverse takes a function f, and a scope k and does two things (i) it flips k, giving back an intensional value m, and (ii) it *maps* f into m. One obvious question is why we don't simply take nominal and verbal predicates to denote world-sensitive predicates, and compose DPs via *map*.[26] One problematic consequence of this move, is that there would be nothing to stop us (in the semantics at least), deriving unattested *de re* readings of predicates, by bind-shifting and scoping them out. This would fail to account for constraints on *de re* under the rubric of the *semantic predicate generalization*, discussed in the next section (§5).

(68) $\mathsf{swim}'^{\star}$ λP Roger wants (PRO P)

We therefore leave it to our type-shifter $\mathcal{F}$ to flip the arguments of the scope. Despite requiring an extra ingredient relative to *map* this is still, arguably, a natural operation. This is because S is a *distributive* functor — a distributive functor is simply any functor isomorphic to $(\to)\ \mathsf{r}$, for some type r. This means that there is a canonical way, for any functor F, or mapping a value of type $\mathsf{F\ (S\ a)}$, to a value of type $\mathsf{S\ (F\ a)}$. *Flip* is a special case of this operation (since, for any type a, $(\to)\ \mathsf{a}$ is a functor). $\mathcal{F}$ is simply *map* specialized to distributive functors. In fact, $\mathcal{F}$ can be defined simply in terms of *map* and *flip*.[27]

(69) $f^{\mathcal{F}} \coloneqq (\mathsf{map}\ f) \circ \mathbf{C}$

5. More constraints on *de re*

5.1. The semantic predicate constraint

We've already discussed the *nested* DP constraint (Romoli & Sudo 2009), and explained how scope theories in general provide an explanation for this observation. There are a number of other important constraints which have been proposed in the literature. In this section, we give a cursory overview of the constraints on *de re* which have been proposed, and show how the flexible scope theory is well-situated to account for them.

[26] I'm grateful to an anonymous reviewer for suggesting this strategy.

[27] For those readers familiar with the functional programming literature, the *distributive* class of functors is the categorical dual of the *traversible* class; $\mathcal{F}$ is the dual of `traverse` from the traversible class; in fact, it is an instantiation of `cotraverse` from Edward Khmett's haskell library `distributive` (https://hackage.haskell.org/package/distributive), whence the function name.

Percus (2000) points out that main predicates and adverbs cannot receive *de re* interpretations.[28]

(70) a. *Main predicate constraint*
Main predicates cannot be interpreted *de re*.

b. *Adverb constraint*
Adverbs cannot be interpreted *de re*.

To briefly illustrate, the *main predicate constraint* rules out a putative reading of (71) where *is Canadian* is interpreted *de re*. If *is Canadian* could be interpreted *de re*, then (71) would be true in a context, e.g., in which there are a group of individuals who, unbeknownst to Mary, are actually Canadians; Mary thinks that John is a member of this group.

(71) Mary thinks [that John is Canadian].

The *adverb constraint* rules out a putative reading of (72) where *healthily* is interpreted *de re*. If this were possible, then the sentence would be true in a context, e.g., in which Mary has the wrong idea about healthy eating habits — e.g., she thinks that broccoli is unhealthy. She furthermore thinks that John eats broccoli.[29]

(72) Mary thinks [that John eats healthily].

As shown extensively by Percus, the BTI over-generates here; scope theories fare better. On the flexible scope theory, the explanation for both constraints follows from the combinatorics — main predicates have an *inner* world argument, i.e., therefore, they cannot be scoped via *bind* for type reasons; bind is only type-compatible with an expression with an outer world argument. *Cotraverse* is used to lift purely extensional operators into an extensional setting, so it doesn't help either.[30]

Regardless of whether we adopt a classical Montagovian treatment of adverb denotations as functions from predicates to predicates (i.e., type $(e \to S\ t) \to e \to S\ t$), or incorporate events into our fragment and treat adverbs as predicates ranging over events,[31] neither class of meanings will be of the right type to be scoped via *bind*.

Keshet (2008) further observes that within a DP, intersective modifiers must be interpreted relative to the same evaluation world as the head noun, as illustrated by the infelicity of (74); if

[28] Sudo (2014) discusses a systematic class of apparent exceptions to Percus's main predicate generalization. Sudo argues that these apparent exceptions have a different source, and that Percus's generalization remains in place.

[29] Percus (2000) focuses on quantificational adverbs, which introduce additional compositional complications.

[30] One thing you may try in order to scope out a predicate is to add a vacuous outer world argument by up-shifting it, like so:

(73) $[\![\mathrm{swim}]\!]^{\wedge} = \lambda w' x w\ .\ \mathsf{swim}_w\ x$ $\qquad S\ (e \to S\ t)$

This can now scope via bind, but the entire predicate, including its inner world argument, will be interpreted in its base position, via semantic reconstruction.

[31] On the assumption that event-predicates, much like individual predicates, have an inner world argument.

married could be interpreted *de re* while *bachelor* is interpreted *de dicto* (or vice versa), then the sentence should have a sensible reading, contrary to fact.

(74) # Mary thinks that the married bachelor is confused. (Keshet 2008: 53)

Keshet posits a constraint to block this:

(75) *Intersective modifier constraint*
All intersective modifiers of a DP must agree in transparency with the NP.

Again, in this fragment, the explanation is fundamentally syntactic. Since predicates (including intersective modifiers) have *inner* world arguments, they cannot themselves be scoped via bind. Intersective modifiers compose with the head noun via *generalized conjunction* (Partee & Rooth 1983), and therefore the world argument of an intersective modifier is invariably interpreted relative to the same evaluation world as the head noun.

Definite descriptions seem, in certain environments, to function semantically as predicates. Rieppel (2013) argues explicitly that descriptions such as *the greatest French soldier* can receive predicate denotations, based on data such as the following. Note that the definite description can be conjoined with intersective modifiers *clever* and *audacious*.

(76) He is clever, audacious, and $\boxed{\text{the greatest French soldier}}$. (Rieppel 2013: p. 419)

Here we make the (to our knowledge) novel observation that predicative descriptions can't be interpreted *de re*.

(77) Context: *Mary isn't smart, but has a twin sister, Sally, who is. John has no idea that Sally is smart, but rather thinks that both sisters are dumb. He confuses Mary for Sally.*
John thinks that Mary is beautiful, talented, and the smartest person in this class.

This is reminiscent of Keshet's (2008) observation that DPs in a *there*-existential cannot be interpreted *de re* (see also Musan 1995 and Romoli & Sudo 2009).

(78) Context: *There is a fox in the garden, but Nathan thinks it's dog.*
Nathan thinks there's $\boxed{\text{a fox}}$ in the garden.

According to Partee's (1986) analysis of *there*-existentials, the DP must be shifted into a semantic predicate via the BE-shifter. It seems that, in general DPs which function semantically as predicates cannot be interpreted *de re*. All the above point towards a generalization in terms of semantic type, rather than syntactic category. On the flexible scope theory, the main predicate, adverb, intersective modifier constraints, as well as the facts concerning predicative DPs and *there*-existential can be subsumed under a single generalization, which follows from the combinatoric apparatus made available by the flexible scope theory.

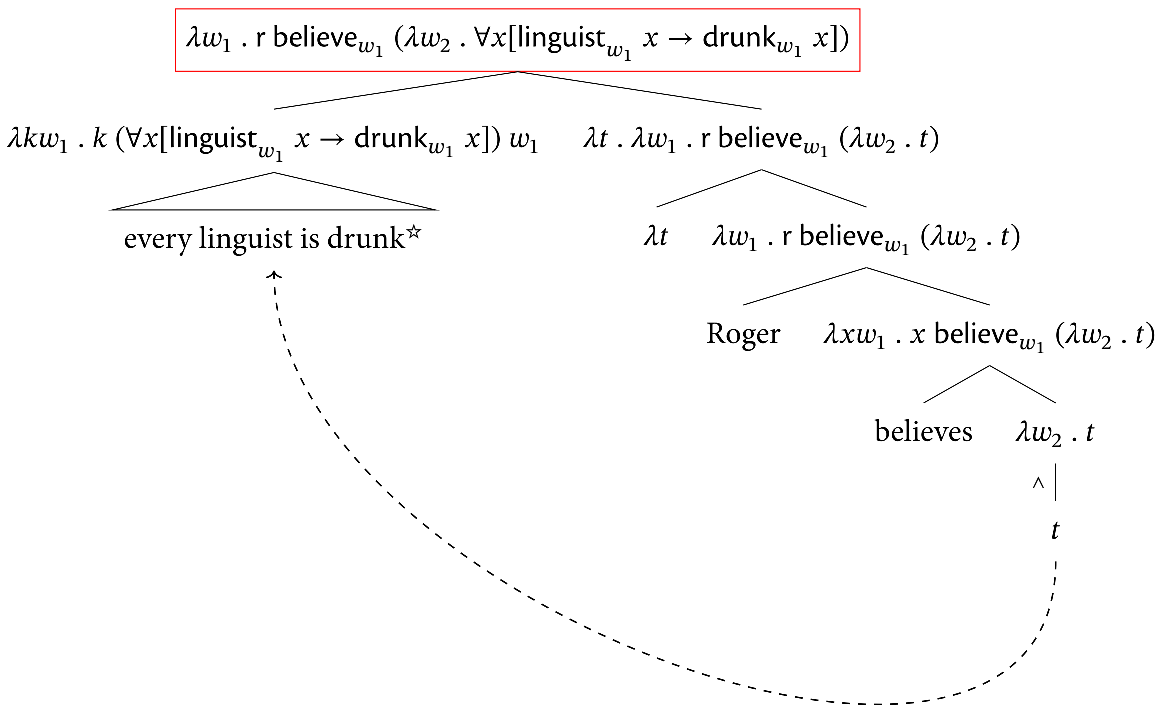
(79) *Semantic predicate constraint*
Expressions of type $\mathsf{a} \to \ldots \to \mathsf{S}\ \mathsf{b}$ cannot be interpreted *de re*.

5.2. Blocking total *de re*

If embedded clauses may scope out, leaving behind type t traces, then an unattested *total de re* reading may be derived for an example such as (80).[32] The problematic LF is shown in figure (21) — the sentence is predicted to be true in case either (a) every linguist is actually drunk, and Roger believes a tautology, or (2) it's not the case that every linguist is actually drunk, and Roger believes a contradiction.

(80) Roger believes [that every linguist is drunk].

Figure (21): Problematic "total *de re*" LF



Perhaps this reading is so pragmatically odd that we don't need to worry about blocking it in the compositional semantics, but let's say that we *do* want to block it. The problem arises because we haven't been distinguishing between intensional values, and the kind of value that $\wedge$ gives back. As far as the attitude verb is concerned, its selectional requirements can be satisfied simply by vacuously lifting a truth-value. It's possible however to distinguish these things type-wise. The

[32] I'm grateful to Julian Grove (p.c.) for pointing this out.

trick is to distinguish between an *effectful* intensional type, as in (81), and an ordinary intensional type; $\mathsf{S}\,\mathsf{t} \neq \mathsf{s} \to \mathsf{t}$.

(81) $\mathsf{S}\,\mathsf{a} := \mathsf{S}\,(\mathsf{s} \to \mathsf{a})$

Attitude verbs like *believe* look for a complement of type $\mathsf{s} \to \mathsf{t}$, rather than $\mathsf{S}\,\mathsf{t}$, as in (82). With our newly defined type constructor S, this is the only major change we need to make in our grammar.

(82) believe : $(\mathsf{s} \to \mathsf{t}) \to \mathsf{e} \to \mathsf{S}\,\mathsf{t}$

The problematic LF is blocked, since there's no way to lift the type t trace into an intensional value that doesn't result in a type mismatch — of course, crucially the grammar can't make available a way of lowering something of type $\mathsf{S}\,\mathsf{a}$ into something of type $\mathsf{s} \to \mathsf{a}$.

✗

$(\mathsf{s} \to \mathsf{t}) \to \mathsf{e} \to \mathsf{S}\,\mathsf{t}$ believe | $\mathsf{S}\,\mathsf{t}$ $\xleftarrow{\wedge}$ t *t*

Finally, in order to retain our account of exceptional *de re*, we need a way of getting a world sensitive proposition to leave behind a trace of type $\mathsf{s} \to \mathsf{t}$, rather than $\mathsf{S}\,\mathsf{t}$. This is accomplished via the following helper function:

(83) $m^{\downarrow_s} := m$ $\qquad\qquad \downarrow_S : \mathsf{S}\,(\mathsf{S}\,\mathsf{a}) \to \mathsf{S}\,(\mathsf{s} \to \mathsf{a})$

We can now derive the attested exceptional *de re* reading of (80) as follows:

(84) $\boxed{\text{every linguist is drunk}}^{\star \circ \downarrow_s}\ \lambda p$ Roger believes p

This solution is clearly syntactic in nature, and therefore it might seem unsatisfactory that we are forced into this corner, but (a) it's not clear why a speaker/hearer would ever retrieve a *totally de re* reading even if it were a possibility, given that it's independently odd to claim that an individual believes a tautology/contradiction, and furthermore (b) it's interesting to note that it is at least *possible* to block the illicit LF by making use of the expressive power of the type system.

6. Comparison to related work

Demirok (2019) develops a theory of *exceptional de re* closely related to the one outlined in this paper, according to which *de re* readings are achieved by moving DPs over an operator ID, and shifting the island into an existential quantifier, via a covert type-shifter ∃. The key-ingredients of the account are spelled-out below. Crucially, ID is rigidly typed, whereas ∃ is just a polymorphic existential determiner. Furthermore, Demirok assumes a compositional regime in which the interpretation function is parameterized to an evaluation world, which may be extensionalized in order to resolve a type mismatch (von Fintel & Heim's 2011 *intensional function application*).

(85) a. $[\![\textsc{id}]\!]^{w} = \lambda pq \,.\, p = q$ $\quad\quad$ $\mathsf{S\,t \to S\,t \to t}$

b. $[\![\exists]\!]^{w} = \lambda rk \,.\, \exists x[r\ x \wedge k\ x]$ $\quad\quad$ $\mathsf{(a \to t) \to (a \to t) \to t}$

To illustrate how Demirok's theory derives *de re* out of scope islands, let's consider a concrete example:

(86) Mary thinks everyone in this room is outside.

Focusing on the embedded clause, Demirok assumes the LF in figure (22) — ID composes with a null operator, which moves to the clause edge to create a abstraction over propositions. The universal quantifier moves to a position above ID, leaving behind a higher-type (extensional) trace. The ∃-theory therefore generates a (singleton) set of propositions as the meaning of the embedded clause. Subsequently, the covert existential ∃ takes this set as its restrictor, giving rise to an existential quantifier over propositions. The resulting existential quantifier scopes out, leaving behind a propositional trace, as illustrated in figure (23); consequently, the world argument of *everyone in this room* is interpreted relative to the global evaluation world and the rest of the material in the scope island semantically reconstructs.

Figure (22): Scoping to the edge on the ∃-theory

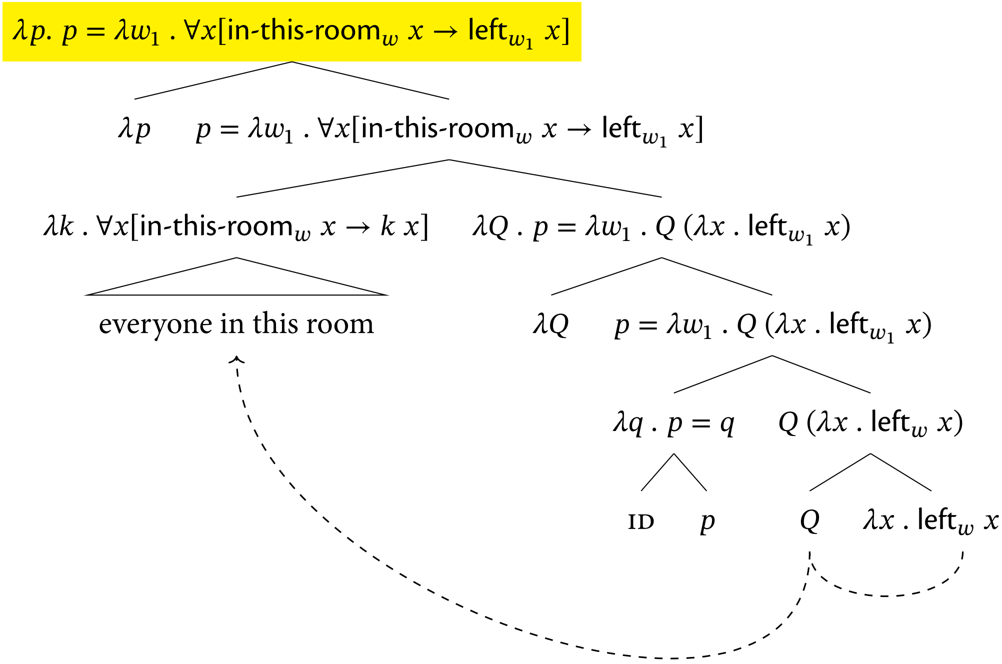
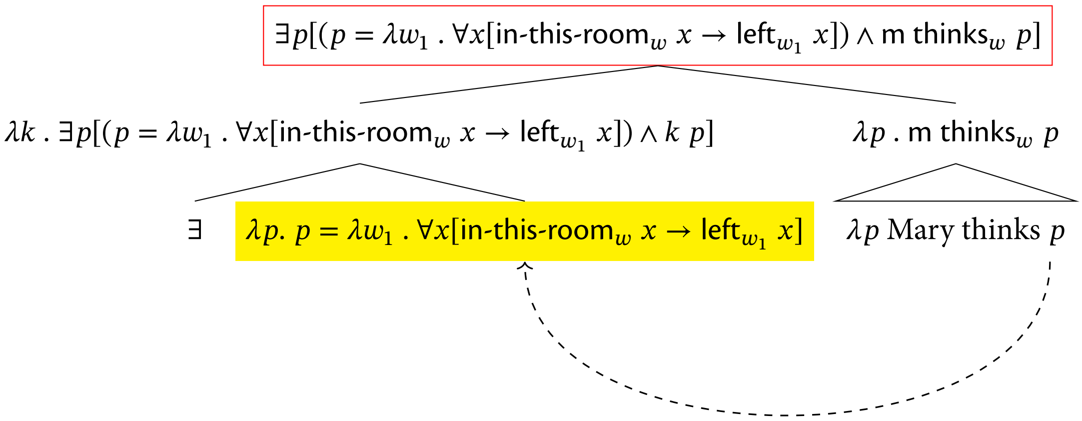


Figure (23): Scope out the embedded clause via ∃



Since $\exists x \in \{ x \} [k\ x]$ is equivalent to $k\ x$, this amounts to the attested reading of the sentence, where *in this room* is interpreted relative to the utterance evaluation world. Thereby, at the cost of some additional compositional complexity, the ∃-theory achieves the same results as the flexible scope theory.

An immediate conceptual issue with the ∃-theory, which the flexible scope theory doesn't face, is that it fails to derive the semantic predicate generalization in a principled way. Recall that in the flexible scope theory, the semantic predicate generalization falls out as a function of how semantic composition *must* proceed, given the available type shifters (*bind*, *up*, and *cotraverse*). In the ∃-theory however, this is not the case. First, note that computing the *de re* reading of *everyone in this room* necessitates leaving behind a higher-type trace. As shown by Demirok, it *must* leave behind a higher-type trace, because otherwise the following truth-conditions are derived, which Demirok describes as "anomalous". The reason is that, if the restrictor of the universal is non-empty, there is no single proposition of the form *x left* for every member of the restrictor set.

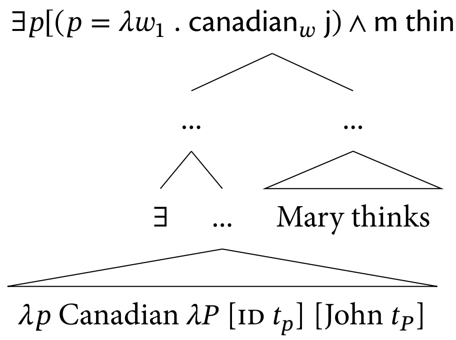
(87) $\exists p[\forall x[\textsf{in-this-room}_w\ x \rightarrow (p = \lambda w_1\ .\ \textsf{left}_{w_1}\ x)] \wedge \textsf{m thinks}_w\ p]$

Unfortunately however, an expression of *any* type can scope out leaving behind a higher-type trace, including a semantic predicate. This means that a *de re* interpretation for *Canadian* can straightforwardly be derived for the following example, in violation of Percus's main predicate constraint.

(88) Jo believes that Mary is Canadian.

A schematic LF is given below. I leave it to the reader to fill in the details:

Figure (24): Scoping out a predicate on the ∃-theory



The ∃-theory must therefore rely on ad-hoc syntactic restrictions on movement. It's not clear that a ban on moving (and semantically reconstructing) main predicates follows from anything principled, since main predicates can be overtly fronted.

(89) Canadian, John (certainly) is.

On the flexible scope theory, on the other hand, the availability of *de re* interpretations follows from incompatibility with *bind*. There is no need to syntactically constrain predicate fronting, it's just that, a predicate can only scope out if it *fully reconstructs*, thus predicting the absence of *de re* reading.

More generally, there's a conceptual issue with the ∃-theory — it obscures the fact that *world-sensitivity* belongs to a broader class of "effects" which exhibit exceptional scope behavior.[33] On the ∃-theory, an account of exceptional *de re* is completely parasitic on machinery tailored to account for pied-piping in *wh*-questions.

7. Conclusion and open issues

This paper primarily focused on constraints on *de re*. This overlooks one of the most important recent discoveries in the literature on *de re*/*de dicto* ambiguities: the existence of so-called *bound de re* readings (Charlow & Sharvit 2014). As shown in detail by Charlow & Sharvit (2014) a simple intensional fragment based on possible worlds, like the one developed here, isn't expressive enough to account for *bound de re*. Something more is required — Charlow & Sharvit (2014) use concept generators (Percus & Sauerland 2003), but see, e.g., Cable (2018) for a semantics based on a counterpart ontology (see also Sauerland 2014). Despite the fact that we have assumed a possible world semantics with transworld individuals in this paper, the primary focus has been on the combinatorics of an intensional grammar. I am optimistic that the general strategy outlined here for "upgrading" a fragment could be used to deliver a fragment with sufficient expressive power for accounting for bound *de re*, perhaps along the same lines as Cable 2018.

To loop back round to where we began, we've bootstrapped a novel theory of intensionality — the *flexible scope theory of intensionality* — which preserves and generalizes the core insight of Keshet's *split intensionality*: that *de re* requires scope to an edge position. The resulting grammar was shown to be sufficiently flexible to account of *exceptional de re*, without sacrificing the virtues of a scope-based theory of intensionality more generally, such as an explanatory account of Romoli & Sudo's *nested* DP *constraint*, as well as the ban on *de re* readings of semantic predicates.

Interestingly, it turned out that a type-shifter necessary for accounting for DP-internal composition provided the key ingredient for an upgraded intensional grammar, in which intensional scope and quantificational scope are systematically divorced. We showed in detail that, once we're equipped with both *bind* and *cotraverse*, we can account for a range of interactions between intensional and quantificational scope otherwise problematic for classical scope theories. In general, bind and cotraverse give rise to a system in which either (a) intensional and quantificational effects scope together, or (b) intensional effects outscope quantificational effects, but *not* vice versa.

Zooming out, the flexible scope theory constitutes a case study in how to go about upgrading a grammar in a modular fashion, using machinery inspired by the literature on functional programming and category. As such, the flexible scope theory of intensionality slots into a growing body of work arguing that *monads* have a crucial role to play in our understanding of natural lanuage semantics (see, e.g., Shan 2002b, Shan 2005, Giorgolo & Asudeh 2012, Charlow 2014, Asudeh & Giorgolo 2016, a.o.).

[33] Essentially, effects which are modeled by a *monad* are expected to exhibit exceptional scope behavior. See, e.g., Charlow (2014) on indeterminacy and state-sensitivity (used to model indefinites and dynamic binding respectively), and Giorgolo & Asudeh (2012) on conventional implicature.

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A. Monadic fragment with continuations

Below are our type constructor for intensional types, alongside up and bind, presented as a monad, where our up-shifter is monadic unit, and our bind-shifter is monadic bind. The monad laws are suppressed here, since S is just an instantiation of the `Reader` monad.

(90) $(\mathsf{S}, ^\wedge, ^\star)$ is a *monad*, where:

a. $\mathsf{S\ a} \coloneqq \mathsf{s} \to \mathsf{a}$

b. $a^\wedge \coloneqq \lambda w\,.\,a$ $\qquad {}^\wedge : \mathsf{a} \to \mathsf{S\ a}$

c. $m^\star \coloneqq \lambda k\,.\,\lambda w\,.\,k\,(m\,w)\,w$ $\qquad {}^\star : \mathsf{S\ a} \to (\mathsf{a} \to \mathsf{S\ b}) \to \mathsf{S\ b}$

Charlow (2014) pioneered a technique in linguistic semantics whereby an inhabitant of a monad m can be lifted into an inhabitant of a continuation applicative via m's monadic bind. The pure and ap of the applicative are just the standard operations associated with the continuation applicative.[34] Note that the pure of a continuation applicative is just Montague's Lift, and we'll call it lift in the following.

(91) $(\mathsf{Cont.S}_b, \uparrow, \circledast)$ is an *applicative functor*, where:

a. $\mathsf{Cont.S_b\ a} \coloneqq (\mathsf{a} \to \mathsf{S\ b}) \to \mathsf{S\ b}$

b. $a^{\uparrow} = \lambda k \,.\, k\ a$ $\qquad \mathsf{a} \to \mathsf{Cont.S_b\ a}$

c. $m \circledast n \coloneqq \lambda k \,.\, m\ (\lambda x \,.\, n\ (\lambda y \,.\, k\ (\mathsf{A}\ x\ y)))$ $\qquad \mathsf{Cont.S_b\ (a \to r) \to Cont.S_b\ a \to Cont.S_b\ r}$
$\mathsf{Cont.S_b\ a \to Cont.S_b\ (a \to r) \to Cont.S_b\ r}$

A value of type $\mathsf{S\ a}$ can be lifted into a value of type $\mathsf{Cont.S_b\ a}$ (a scope-taker) via ☆. We can use this to compose a definite description *in situ* using the applicative operations. A sample derivation is provided below. We use Barker & Shan's *tower notation* to abbreviate continuized values.[35]

[34] Charlow (2014) presents this as a continuation *monad*, although in fact only ever uses the operations of a continuation applicative.

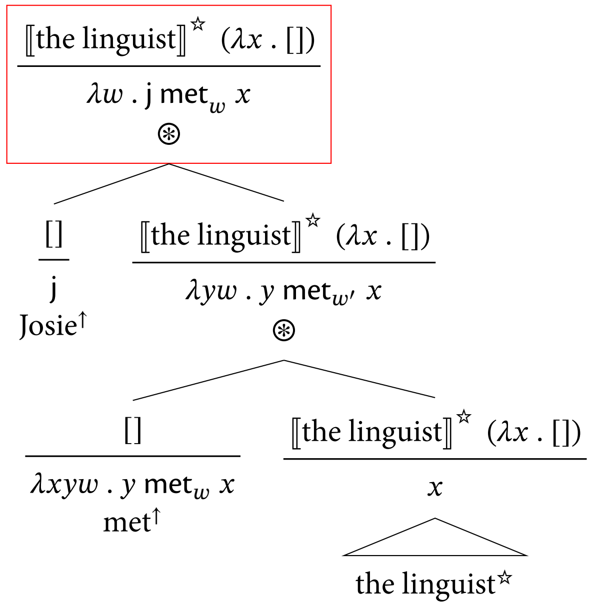
An applicative functor is similar to a monad in that it provides machinery for threading effectful meaning components through the computation. It provides a way of doing function application in the enriched type-space (ap) alongside pure, which provides a way of lifting an a into an inhabitant of the enriched type-space with trivial effects. An applicative functor is weaker than, and in fact *entailed by* a monad, and is subject to a number of somewhat less stringent laws. See Mcbride & Paterson (2008) for the programming perspective, and applications to natural language semantics by, e.g., Kiselyov (2017), Charlow (2018), and Elliott (2019).

Unlike other applicative functions, the continuation applicative has an interesting property - it entails the existence of a continuation monad, because m^{μ} can be defined as $m \circ (\uparrow)$). There is in fact no difference in expressive power between the continuation applicative and monad.

[35] In order to simplify the presentation in terms of towers, we take advantage of the following lambda-theoretic equivalence:

$$[\![\mathrm{XP}]\!]^{☆} \equiv \lambda k \,.\, [\![\mathrm{XP}]\!]^{☆}\ (\lambda x \,.\, k\ x)$$

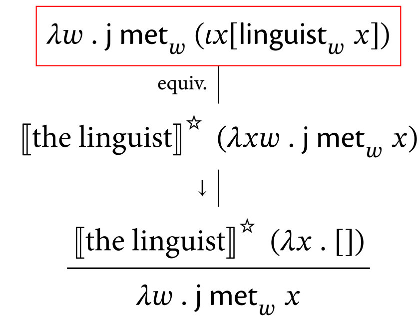
Figure (25): Josie met the linguist



The resulting value is of type $\mathsf{Cont.S_t\ S\ t}$, which can be de-sugared into $(\mathsf{S\ t} \to \mathsf{S\ t}) \to \mathsf{S\ t}$. In the literature on continuation semantics, it is standard to define an operation *lower* to get back an ordinary value from a continized value. Lower simply feeds in the identity function, as defined in (92).[36] As the final step in the derivation, we lower the result of figure (25), as in figure (26).

(92) Lower (def.)
$m^{\downarrow} := m\ id$

Figure (26): Lowering the result



[36] The definition of *lower* is an interesting point of departure from the continuized monadic grammar outlined in Charlow 2014 — there, lower is defined as the unit of the inner monad. Here, *lower* is just the identity function. The difference stems from the fact that, in Charlow 2014's grammar, predicates do not themselves return effectful values.

Setting scope islands to one side, ordinary *de re/de dicto* ambiguities can be accounted for by *lowering* either above or below the embedding verb/modal, giving rise to a *de re* or a *de dicto* reading respectively. In this sense, derivations involving the continuation applicative are isomorphic to representations involving QR, with *lower* corresponding to the landing site of movement.

The continuized fragment is compatible with the denotational theory of scope islands outlined in Charlow (2014), according to which scope islands are constituents which must denote a *fully lowered* type. In our fragment, this amounts to the requirement that an embedded clause be lowered to type t at some stage in the derivation. This blocks bona fide island-violating scope via the continuation applicative. Instead, parallel to the QR account, if a definite description is scoped over an up-shifter, a lowered scope island can be re-lifted into the continuation applicative via $\star$, and scoped out itself. A sample derivation is given below:

(93) Josie hopes that the linguist leaves.

Figure (27): [The linguist leaves].

$$\lambda w_1 w_2 \,.\, \mathsf{leaves}_{w_2}\,(\iota x[\mathsf{linguist}_{w_1}\; x])$$

equiv.

$$[\![\text{the linguist}]\!]^{\star}\;(\lambda x w_1 w_2 \,.\, \mathsf{leaves}_{w_2}\; x)$$

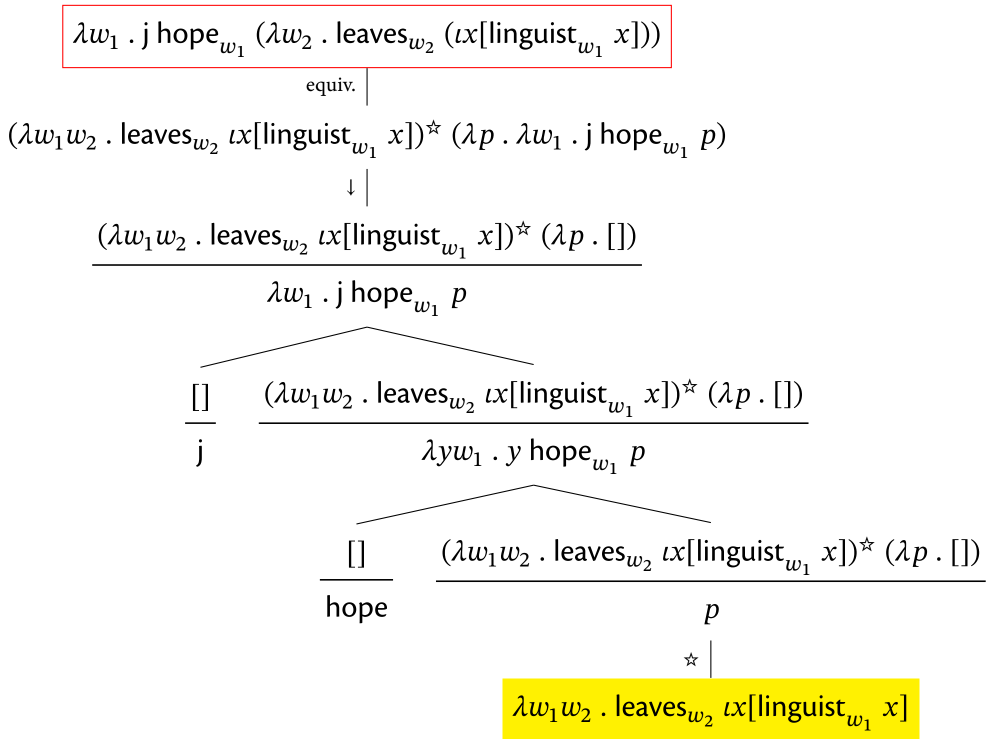
$\downarrow$

$$\frac{[\![\text{the linguist}]\!]^{\star}\;(\lambda x \,.\, [\,])}{\lambda w_1 w_2 \,.\, \mathsf{leaves}_{w_2}\; x}$$

$\circledast$

$$\frac{[\,]}{\wedge} \qquad \frac{[\![\text{the linguist}]\!]^{\star}\;(\lambda x \,.\, [\,])}{\lambda w_2 \,.\, \mathsf{leaves}_{w_2}\; x}$$

Figure (28): Josie hopes [that the linguist leaves].



In our continuized fragment, we can think of cotraverse as a method for lifting an extension scope-taker into a scope-taker which expects and returns intensional values; we repeat the definition of cotraverse in (94), with a type signature using the continuation constructor. As emphasized by Wadler (1994) (see also Shan 2002a and Barker & Shan 2014) we can provide a general characterization of scope-takers via the indexed continuation applicative Cont_b^c. The definitions of pure and ap are the same as those for the vanilla continuation applicative, but the types have been generalized.

(94) $f^{\mathcal{F}} \coloneqq \lambda k \,.\, k^{\star} \circ^{\mathsf{C}} (\lambda P \,.\, (f\ P)^{\wedge})$ $\qquad \mathcal{F} : \mathsf{Cont}_{\mathsf{b}}^{\mathsf{c}}\ \mathsf{a} \rightarrow \mathsf{Cont.S}_{\mathsf{b}}^{\mathsf{c}}\ \mathsf{a}$

$\coloneqq \lambda k w \,.\, f\ (\lambda x \,.\, k\ x\ w)$

(95) Cont_b^c is an *indexed applicative functor* where:

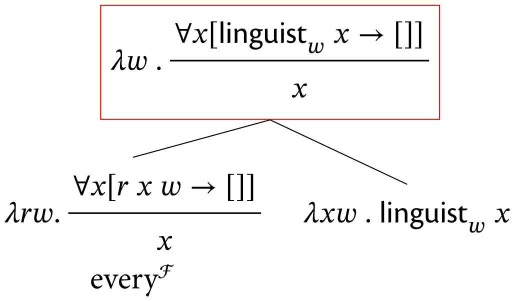
a. $\mathsf{Cont}_b^c \coloneqq (\mathsf{a} \rightarrow \mathsf{b}) \rightarrow \mathsf{c}$

b. $a^{\uparrow} = \lambda k \,.\, k\ a$ $\qquad \uparrow : \mathsf{a} \rightarrow \mathsf{Cont}_{\mathsf{b}}^{\mathsf{b}}\ \mathsf{a}$

c. $m \circledast n \coloneqq \lambda k \,.\, m\ (\lambda x \,.\, n\ (\lambda y \,.\, k\ (\mathsf{A}\ x\ y)))$ $\qquad \circledast : \mathsf{Cont}_{\mathsf{b}}^{\mathsf{c}}\ (\mathsf{a} \rightarrow \mathsf{b}) \rightarrow \mathsf{Cont}_{\mathsf{c}}^{\mathsf{d}}\ \mathsf{a} \rightarrow \mathsf{Cont}_{\mathsf{b}}^{\mathsf{d}}\ \mathsf{b}$

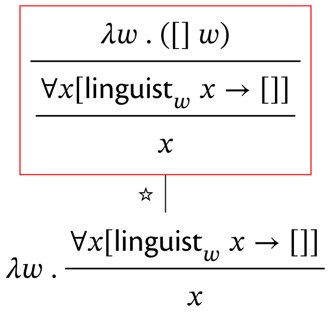
Cotraverse takes something of type $\mathsf{Cont}_{\mathsf{b}}^{\mathsf{c}}\ \mathsf{a}$ and gives back something of type $\mathsf{Cont.S}_{\mathsf{b}}^{\mathsf{c}}\ \mathsf{a}$. $\mathsf{Cont.S}_b^c$ is the same as $\mathsf{Cont.S}_b$ with the types generalized as above. This allows us to incorporate determiners into our fragment as shown below.

Figure (29): every linguist



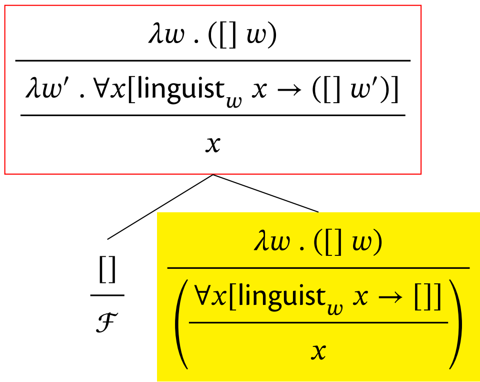
In order to compose a world-sensitive QP, we simply bind-shift it — this gives rise to a *higher-order* continuation, or a "two story tower", to use Barker & Shan's terminology, where the intensional effects inhabit the top story, and the quantificational effects the lower story.

Figure (30): Bind shifting a QP into a two-story tower



Finally, we shift the inner scope-taker via cotraverse. This can be achieved straightforwardly by lifting cotraverse, and applying it to our two-story tower via ap. The result, essentially, is a *split-scope taker*; the world-sensitivity associated with the restrictor can either be lowered at the same point as we lower the quantifier, or at some later point in the derivation. Accounting for Fodor's non-specific *de re* reading, or Bäuerle's puzzle is as simple as lowering the bottom of the tower, below some intensional operator, and deferring lowering of the top story until later on.

Figure (31): Mapping cotraverse into a two-story tower



In order to lower *two-story* towers, we'll define an additional lower operation for convenience: *internal lower* (this is in fact just lifted *lower*):

(96) $\left(\dfrac{f\ []}{m}\right) := \dfrac{f\ []}{m^{\downarrow}}$