ENGINEERING WORLD-SENSITIVITY IN THE GRAMMAR[1]

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Reading

- Kai von Fintel & Irene Heim. 2021. Intensional semantics. Unpublished textbook. MIT. https://github.com/fintelkai/fintel-heim-intensional-notes: chapter 5
- Patrick D. Elliott. 2020. A flexible scope theory of intensionality. lingbuzz/005107. MIT. https://ling.auf.net/lingbuzz/005107

1 *Class goals*

THE PHENOMENA: when a DP occurs in the scope of an *intensional operator*, such as an attitude verb, we observe a *de re/de dicto* ambiguity.[2]

[2] Instead of *de re/de dicto*, *transparent/opaque* is often used (e.g., Fodor 1970)

(1) Neil wants [$\overbrace{\boxed{\text{the Newcastle players}}\text{ to win the match}}^{\text{intensional context}}$].

De re: Neil is watching a soccer match — he doesn't know anything about soccer, and mistakenly thinks that Sunderland players wear black and white jerseys. He wants Sunderland to win. Neil's desire doesn't pertain to *Newcastle players*, but rather to a group of people who (unbeknownst to him) happen to be Newcastle players.[3]

Figure 1: The Newcastle team colors

[3] N.b. we can force the *de re* interpretation with examples such as the following:

(2) Neil thinks $\overbrace{\text{that }\boxed{\text{the people inside}}\text{ are outside.}}^{\text{intensional context}}$

De dicto: Neil is a Newcastle fan — his desire pertains to *Newcastle players*.

Theoretically, this is often cashed out by giving *Newcastle players* a world-sensitive meaning (see, e.g., von Fintel & Heim 2021).

- Under the *de re* reading, *Newcastle players* is interpreted relative to the same world at which the truth of the sentence is evaluated.
- Under the *de dicto* reading, *Newcastle players* is interpreted relative to the intensional environment created by *want*; namely, relative to Neil's *desire worlds*.

The existence of intensional environments and *de re/de dicto* ambiguities motivate an *enrichment* of the grammar; the meaning of certain expressions is *world-sensitive*.

The goal of this talk will be to develop a *design pattern* incorporating enriched meanings into the grammar, based on some austere methodological principles — namely, let's do as much as we can with just Function Application (fa) and Quantifier Raising (qr).

We'll use this design pattern to develop a *restrictive* account of *de re/de dicto* ambiguities, using independently motivated mechanisms made available by the grammar.

> This isn't a conference talk, and I'm not going to spend a lot of time pitting different approaches to *de re/de dicto* ambiguities against one another, aside from some passing remarks. The main goal of this class will be to learn how to approach engineering an *enriched* grammar, using familiar tools.

Roadmap

- §2 is devoted to *bootstrapping a scopal theory of intensionality* in terms of a type-shifter, *bind*.
  - **Encoding world-sensitivity:** In §2.1-2.3, we'll encode world-sensitivity in the lexicon, in the process motivating a new type-shifter — *bind* ($\star$) — for composing predicates with world-sensitive DPs.
  - ***De re* via scope:** In §2.3-2.4, we'll see that *bind creates a scope-taker* — a subset of *de re/de dicto* ambiguities fall out thanks to qr.
  - **Exceptional *de re*:** In §2.5 we'll tackle an immediate under-generation problem — *de re* is unexpectedly insensitive to ordinary constraints on scope-taking and movement more generally. We'll see that the key is an additional type-shifter, alongside a *generalization* of our existing, scopal strategy — *island scoping* (Demirok 2019).
- **Restricting *de re*:** In §3, we'll see how our intensional grammar accounts straightforwardly for two restrictions on *de re* readings: (i) the *nested DP constraint* (Romoli & Sudo 2009), and (ii) the *semantic predicate generalization* (Percus 2000, Keshet 2008).
- **Intensional scope and quantificational scope**: In §4, we'll be motivate a new type-shifter *cotraverse* ($\mathscr{F}$), in order to deal with DP-internal composition. As we'll see, this predicts a systematic disconnect between intensional and quantificational scope, which turns out to be essential for handling

Fodor's (1970) third reading.
- **Enrichments beyond world-sensitivity:** In §5, I'll point towards other instantiations of the general design pattern for handling enrichments laid out here (Charlow 2014, 2019c, Demirok 2019), before concluding.

An important note about how to read this handout:

> Although I will spend some time on technical details, I'll periodically pause and give a sense of what we've achieved in more informal terms.

2 *Bootstrapping an intensional fragment*

Methodological principles:

- There is just one mode of semantic composition: Function Application (FA) (Heim & Kratzer 1998); let's avoid positing new composition principles, unless we *absolutely* have to.[4]

- Expressions may freely take scope via QR (May 1977); we'll do our best to maintain a conservative picture, according to which QR is subject to the constraints we're familiar with (clause-boundedness, etc.), regardless of what is being QR-ed.[5]

2.1 *World-sensitivity and compositionality*

We know that there are certain environments where sentences must contribute *propositions* as their semantic values, such as the complements of attitude verbs.

The simplest way of intensionalizing our grammar in a systematic fashion, without inventing new composition principles, is to assume that predicates return *propositions* rather than truth-values.[6]

(3) a. $[\![\text{hungry}]\!] \coloneqq \lambda x \,.\, \boxed{\lambda w \,.\, x \text{ is hungry in } w}$ $\langle e, \langle s, t \rangle \rangle$

b. $[\![\text{steal}]\!] \coloneqq \lambda x \,.\, \lambda y \,.\, \boxed{\lambda w \,.\, y \text{ steals } x \text{ in } w}$ $\langle e, \langle e, \langle s, t \rangle \rangle \rangle$

[4] We're going to play fast and loose with our representation of abstraction, so we won't explicitly use Heim & Kratzer's *predicate abstraction* rule. Maybe we need that too, but there's a way of doing abstraction completely categorematically (Sternefeld 2001, Kobele 2010, Charlow 2019a).

[5] It's likely that a more fine-grained view is necessary. See Barker (2020) for a recent empirical argument to this effect.

[6] For those of you with vivid memories of von Fintel & Heim (2021), or earlier incarnations, you're probably more used to parameterizing the interpretation function to an evaluation world, and positing a new composition principle; here, we're charting a different course.

A USEFUL WAY OF THINKING ABOUT THIS — predicates are functions from “boring” individuals to *fancy* (i.e., world-sensitive) truth-values. This apparently innocent choicepoint will have ramifications for the restrictiveness of the resulting intensional grammar.

For expressions, like proper names, which simply pick out individuals, composition proceeds straightforwardly.[7,8]

(4)
✓$\langle s, t\rangle$
λw . Rygel is hungry in w
- e: Rygel
- $\langle e, \langle s, t\rangle\rangle$: hungry

The descriptive component of a DP introduces an additional layer of world-sensitivity.[9]

(5) $[\![\text{the Hynerian}]\!] = \boxed{\lambda w \,.\, \text{the-Hynerian}_w}$ $\langle s, e\rangle$

(6)
✗
- $\langle s, e\rangle$: the Hynerian
- $\langle e, \langle s, t\rangle\rangle$: hungry

We’re in a bind!

A way of thinking about this problem: in our nascent intensional grammar, we have certain expressions which carry an outer layer of fanciness.

We need an algorithm for composing a fancy x, with a function f that’s looking for an x and returns a fancy t.

(7) $\boxed{a} := \langle s, a\rangle$

An informal description of what we want to do: (i) separate x out from its accompanying fanciness, (ii) compose f with *unfancied* x via FA, (ii) merge the fanciness left behind by x with the fancy t returned by $f(x)$.

(8)
?
- $\boxed{e}$
- $e \rightarrow \boxed{t}$

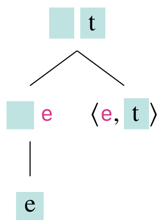
[7] This glosses over a number of issues involving the semantics of proper names, for expository purposes.

[8] e the type of an individual, t the type of a truth value, s the type of a world, and $\langle a, b\rangle$ a function type.

[9] I’m assuming a *Fregean* analysis of definite descriptions, according to which they pick out individuals. Actually, nothing in the final system will be incompatible with a Russellian (i.e., a quantificational) analysis, but quantificational expressions will introduce a raft of interesting complications, as we’ll see.

Figure 2: A *Hynerian*

(9)



2.2 *Getting out of the bind, via **bind***

Let's define a *type-shifter* that reifies our informal algorithm. The official definition is given below; we'll go through how it works more slowly.[10]

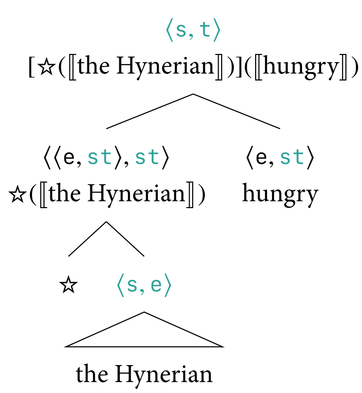
Bind (def.)

$☆ := \lambda i \;.\; \lambda P \;.\; \lambda w \;.\; k(i(w))(w)$ $\quad\langle\langle s, e\rangle, \langle\langle e, st\rangle, st\rangle\rangle$

> Intuition — *Bind* composes takes a fancy x, and returns a higher-order function from an f that returns a fancy t, to a fancy t.

Let's first make sure the types work out:

(10)



Now, we'll go through the computation step-by-step, starting from the bind-shifted subject:

(11) ☆(⟦the Hynerian⟧) *lexicon*

Step 1A: Replace bind and the definite description with their denotations:

(12) $\boxed{\lambda i \;.\; \lambda P \;.\; \lambda w \;.\; P(i(w))(w)}$ $\lambda w' \;.\; \text{the-Hynerian}_{w'}$ *reduce*

[10] Although the definition of *bind* will not change, its type signature will; we've started by giving bind a conservative type signature, but as we'll see later, generalizing it will have an immediate payoff.

You should of course be wondering — *why this type-shifter*? We won't get back to this question until the very end of class, but *bind* turns out to be an instantiation of a more general operation; another instantiation has been used in the semantics of questions.

Step 1B: *the Hynerian* is fed in as the first argument of bind:

(13) $\lambda P \,.\, \lambda w \,.\, P\left(\boxed{\lambda w' \,.\, \text{the-Hynerian}_{w'}}\ w\right)(w)$ *reduce*

Step 1C: *the Hynerian* is saturated by a world argument bound by the outer λw; the resulting bind-shifted description is a function from a predicate P, which saturates P with an unfancied individual.

(14) ① $\lambda P \,.\, \lambda w \,.\, P(\text{the-Hynerian}_w)(w)$ $\langle\langle \mathtt{e}, \mathtt{st}\rangle, \mathtt{st}\rangle$

Step 2A: Now that we have our bind-shifted description, we can apply it to the VP.

(15) [①]($[\![\text{hungry}]\!]$)

Step 2B: Let's replace the subject with its semantic value:

(16) $\boxed{\lambda P \,.\, \lambda w \,.\, P(\text{the-Hynerian}_w)(w)}\ [\![\text{hungry}]\!]$ *reduce*

Step 2C: The predicate saturates the outer argument of the bind-shifted description:

(17) $\lambda w \,.\, [[\![\text{hungry}]\!]](\text{the-Hynerian}_w)(w)$ *lexicon*

Step 2D: Now let's replace the predicate with its denotation; a function from an x to a fancy t:

(18) $\lambda w \,.\, \boxed{\lambda x \,.\, \lambda w \,.\, \text{hungry}_w(x)}\ \text{the-Hynerian}_w\ (w)$ *reduce*

Step 2E: We can now saturate the predicate with the unfancied individual introduced by the description:

(19) $\lambda w \,.\, \boxed{\lambda w \,.\, \text{hungry}_w(\text{the-Hynerian}_w)}\ w$ *reduce*

Step 2F: Finally, the world argument of the predicate is saturated by w bound by the outer λw, thereby combining the fanciness of the individual concept, with the fanciness of the proposition returned by the predicate.

(20) ✓ $\lambda w \,.\, \text{hungry}_w(\text{the-Hynerian}_w)$

> Bind takes advantage of the fact that when we have *two* layers of world sensitivity (i.e., two λw operators), there's a straightforward way of merging them — we saturate each layer with *co-bound* world arguments.

2.3 ***Bind*** *creates a scope-taker*

Let's look at the type of a bind-shifted description:

(21) $\langle\langle \mathtt{e}, \mathtt{st}\rangle, \mathtt{st}\rangle$

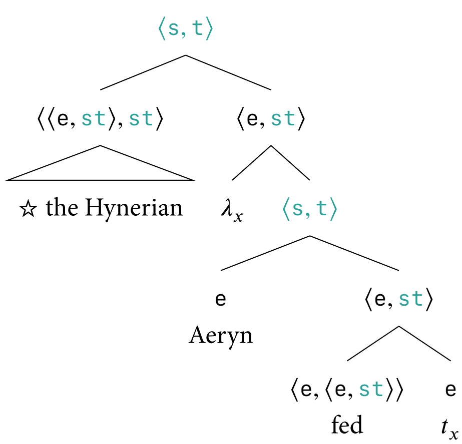
Expressions that undergo QR are generally of type $\langle\langle \mathtt{a}, \mathtt{b}\rangle, \mathtt{b}\rangle$, leaving behind a trace of $\mathtt{a}$, and requiring a scope site of type $\mathtt{b}$.[11]

This gives us a window into what bind is doing: it's taking a world-sensitive individual, and returning something that *scopes* an individual at a proposition.

In fact, a definite description in object description must be *bind-shifted and* QR*-ed* in order to be interpreted. This is schematized for (22) in (23).

(22) Aeryn fed the Hynerian .

(23)



2.4 De re/de dicto *as a scopal ambiguity*

Scoping a definite description out of an intensional environment, such as the complement of the desire verb *want*, ensures that the descriptive component is evaluated relative to the matrix evaluation world.

(24) Aeryn wants to feed the Hynerian .

[11] The scope-takers we're most familiar are quantificational DPs, of type $\langle\langle \mathtt{e}, \mathtt{t}\rangle, \mathtt{t}\rangle$; as emphasized by, e.g., Wadler (1994) and Barker & Shan (2014), this is an instantiation of a more general schema.

(25) *De re* interpertation:

$$\langle \mathtt{s}, \mathtt{t}\rangle$$
$$\lambda w\,.\,\text{aeryn wants}_w\ \boxed{\lambda w'\,.\,\text{feed}_{w'}\ \text{the-Hynerian}_w}$$

$$\langle\langle \mathtt{e}, \mathtt{st}\rangle, \mathtt{st}\rangle$$
$$\lambda P\,.\,\lambda w\,.\,P(\text{the-Hynerian}_w)(w)$$

☆ the Hynerian

$$\langle \mathtt{e}, \mathtt{st}\rangle$$
$$\lambda x\,.\,\lambda w\,.\,\text{aeryn wants}_w\ \boxed{\lambda w'\,.\,\text{feed}_{w'}(x)}$$

λx Aeryn wants to feed t_x

By *bind-shifting* a description, we turn it into an *intensional scope-taker*; QR a *bind-shifted* expression determines its *intensional scope*. At this point, you're probably wondering how this interacts with quantificational scope. Don't worry, we're getting there!

By thinking through the problem of how to compose a *world-sensitive individual* with a *function from an individual to a world-sensitive truth-value*, we've bootstrapped a simple *scope theory of intensionality*.

We now have a theory according to which *de re* interpretations are dependent on QR. We now straightforwardly predict that *de re* interpretations should be constrained by the same factors that constrain scopal ambiguities more generally (clause-boundedness, etc. etc.). As you may already know, this is not the case!

2.5 *Exceptional de re*

The problem of exceptional *de re* (see Keshet 2011, Demirok 2019 for extensive discussion) is best motivated by cases like the following:

(26) If $\overbrace{\text{the people in this room}\ \text{were outside}}^{\text{strong island}}$, it would be empty.

The problem is more general than this: attitude verbs often select for finite clausal complements, and finite clauses are thought to be *scope islands*. *De re* is nevertheless still possible.

(27) Aeryn believes $\overbrace{\text{that the people in this room are outside}}^{\text{scope island}}$.

Island insensitive *de re* is apparently unbounded (see Grano 2019; Keshet 2011 for a dissenting view).

(28) Aeryn believes
[that John hopes [that the people in this room are outside]].

Clearly, bind + QR is not enough, if we'd like to maintain that QR is constrained as usual; In order to derive exceptional *de re*, we're going to need an additional type-shifter, which happens to be much simpler than bind.[12]

[12] This type-shifter will play a similar role to Keshet's $\wedge$, therefore, we'll also call it $\wedge$ (pronounced *up*).

2.5.1 *Introducing* up

Our up-shifter simply takes some value x and turns it into a *trivially* intensional value by adding a vacuous λw.

Up (def.)

$$\wedge \coloneqq \lambda x\,.\,\boxed{\lambda w\,.\,x} \qquad \wedge : \langle a, \langle s, a\rangle\rangle$$

A couple of things to note at this point:

- Anything can, in principle, be given a trivial layer of world-sensitivity, and this is reflected in the fact that up has a *polymorphic* type signature; a is a variable over types.[13]
- Up may seem weird/unnatural...it's not really doing anything! But, we actually see this design pattern instantiated in a bunch of different areas, e.g.:
  - The question operator ?, part of the semantics of *wh*-expressions in the Hamblin/Karttunen approach, takes a proposition and returns a *trivial* question (i.e., a singleton set):[14]

[13] Polymorphic type signatures like $\langle a, \langle s, a\rangle\rangle$ can be understood as follows: *for any type* a, *there is a way of instantiating the type of* $\wedge$ *as* $\langle a, \langle s, a\rangle\rangle$.

[14] See von Fintel & Heim 2021: chapter 8 for details.

(29) a. $? = \lambda p\,.\,\{\,p\,\}$
b. $? : \langle a, \{\,a\,\}\rangle$

– Montague LIFT (Partee 1986) takes an individual and returns a *trivial* generalized quantifier. It is often used to account for the possibility of conjoining names and QPs.[15]

[15] This operator is also underlies Barker & Shan's *in-situ* approach to scope-taking:

(30) a. LIFT $:= \lambda x \,.\, \lambda k \,.\, k(x)$
b. LIFT $: \langle \mathtt{a}, \langle\langle \mathtt{a}, \mathtt{b}\rangle, \mathtt{b}\rangle\rangle$

2.5.2 *Generalizing* bind

Let's think through how to apply this new machinery to a case of *exceptional de re*.[16]

[16] This example itself isn't the strongest motivation for exceptional *de re*, but the machinery we motivate generalizes to stronger islands, such as conditional antecedents.

(31) Aeryn believes that the Hynerian is hungry .

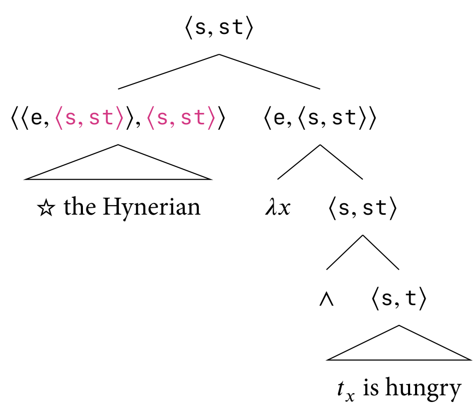
Our schema for deriving exceptional *de re*; the core idea is that the scope-island itself is the right kind of thing for bind-shifting and scoping out.[17]

[17] See Demirok (2019) for another account of exceptional *de re* in terms of island scoping, with some interesting similarities and differences.

(32) ☆ the Hynerian $\lambda x \wedge t_x$ is hungry λp Aeryn believes p

Step 1: We'll begin by scoping our bind-shifted description to the *edge* of the scope island over an up-shifter. Let's first make sure the types work out:

(33)



Bind (polymorphic ver.)

$☆ := \lambda i \,.\, \lambda P \,.\, \lambda w \,.\, k(i(w))(w)$ $\quad \langle\langle \mathtt{s}, \mathtt{a}\rangle, \langle\langle \mathtt{a}, \mathtt{sb}\rangle, \mathtt{sb}\rangle\rangle$

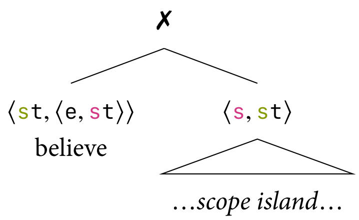
The result is a *doubly world-sensitive proposition*, i.e., a truth-value with two additional layers of fanciness; the description is linked to the outermost layer.

(34) $[☆([\![\text{the Hynerian}]\!])](\wedge([\![x \text{ is hungry}]\!]))$ $\quad \langle \mathtt{s}, \langle \mathtt{s}, \mathtt{t}\rangle\rangle$

$= \lambda w \,.\, \lambda w' \,.\, \text{the hynerian}_w \text{ is hungry}_{w'}$

If we try to compose the doubly world-sensitive proposition with an attitude verb such as *believe*, which is looking for an argument of type $\langle \texttt{s}, \texttt{t} \rangle$, we get a type-mismatch *isomorphic to the one which first motivated bind*. This should tell us the shape of the solution!

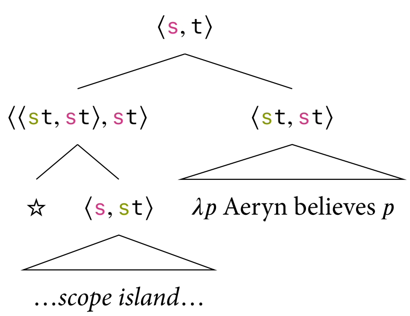
(35)



Step 2: In fact, bind is the exactly the tool to solve this type mismatch; the new, polymorphic type allows bind to apply to the proposition, resulting in an intensional scope taker of type $\langle\langle \texttt{st}, \texttt{st}\rangle, \texttt{st}\rangle$.

If we now QR the bind-shifted scope-island, the trace itself will be of a propositional type, resolving the type-mismatch.

(36)



(37) a. $= [\star(\lambda w \,.\, \lambda w' \,.\, \text{the hynerian}_w \text{ is hungry}_{w'})](\lambda p \,.\, \lambda w \,.\, \text{aeryn believe}_w\ p)$

b. $= \lambda w \,.\, \text{aeryn believe}_w\ (\lambda w' \,.\, \text{the hynerian}_w \text{ is hungry}_{w'})$

We've now learned that a grammar based on *bind* and *up* is *extremely expressive*; it can even give rise to the illusion of island-insensitivity via the conspiracy of island scoping. In the next section, we'll convince ourselves that, nevertheless, our scopal grammar accounts for restrictions on *de re*.

3 *Interlude: restrictions on de re*

3.1 *Nested DPs: evidence for scope*

Romoli & Sudo (2009) discuss possible readings of examples involving a DP nested inside of another DP.

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

Their claim:

	president *de re*	president *de dicto*
wife *de re*	✓	✗
wife *de dicto*	✓	✓

Context 1: *Mary is watching television and sees Joe Biden, 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.*

(39) ✓Mary thinks that the wife of the president is nice.
wife: *de dicto*, president: *de re*

Context 2: *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.* (Romoli & Sudo 2009: p. 430)

(40) ✗ Mary thinks that the wife of the president is nice.
wife: *de re*, president: *de dicto*

> A way of thinking about this: in a configuration [D NP [D NP]], the intensional scope of NP must be *at least* as high as NP

Why should this be? We have a ready answer according to the theory we're developing:

The attested mixed reading can be derived by QR-ing the contained DP over an up-shifter, while scoping the remnant container below the up-shifter:[18]

[18] It's also possible to derive this reading by scoping the contained DP to the *edge* of the container and no further, but this derivation involves some additional compositional complexities.

(41) ✓ ☆ the president $\lambda x \wedge$ [☆ the wife of x λy y is nice].

The *unattested* mixed reading, on the other hand, would require scoping the contained DP *below* an up-shifter, while scoping the remnant container above it.

(42) ✗ ☆ the wife of x $\lambda y \wedge$ [☆ the president λx y is nice]

The resulting LF must be disallowed on independent grounds, since it results in an unbound trace.[19]

[19] There is nevertheless substantial evidence that the syntax should be able to generate so-called *remnant movement* configurations, such as (42), but remnants must reconstruct for reasons of interpretation — see Sternefeld (2001) for discussion.

3.2 *The semantic predicate constraint*

Percus (2000) and Keshet (2008) have argued that neither main predicates, adverbs, nor intersective modifiers can be interpreted *de re*.[20,21]

[20] Sudo (2014) discusses a class of apparent exceptions to Percus's (2000) main predicate generalization. I won't have time to discuss this here.

[21] In his discussion of adverbs, Percus focuses on quantificational adverbs, which introduce additional complications. We'll defer our discussion of the interaction between intensional and quantificational scope until §4.

Context: *There is a group of individuals who, unbeknownst to Mary, are Canadian. Mary thinks that John is a member of this group, but isn't opinionated about his nationality.*

(43) #Mary thinks [that John is Canadian].

Context: *Mary has misguided views about diet and health. For example, she thinks that vegetables are unhealthy, and she knows that John is a vegetarian.*

(44) #Mary thinks [that John eats healthily].

It's tempting to conclude that only DPs can be interpreted *de re* — but definite descriptions, under certain conditions, may function semantically as predicates (Rieppel 2013), in which case they can't be interpreted *de re*.

Context: *John isn't funny, but has a twin brother, Harvey, who is. Aeryn has no idea that Harvey is funny, but rather thinks that both brothers are dull. She confuses Harvey for John.*

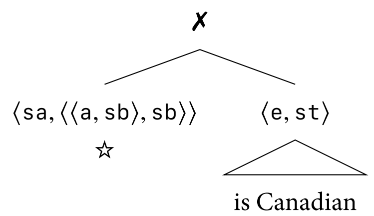
(45) #Aeryn thinks that John is tall, handsome, and the funniest person here .

> The putative generalization that this data suggest is that *semantic predicates* cannot be interpreted *de re*.

This is a fundamental asymmetry that is *precompiled* into our grammar —

arguments have an *outer* layer of world sensitivity, whereas predicates have an *inner* layer of world sensitivity.[22]

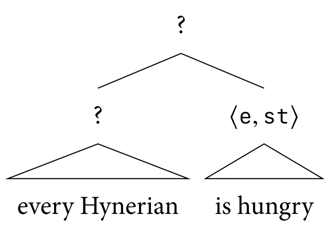
(46)



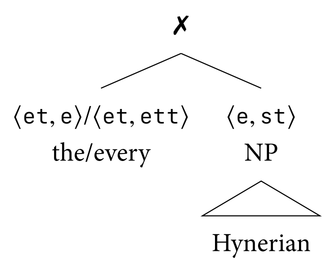
4 *Intensional scope and quantificational scope*

The intensional grammar we've developed so far has some nice properties, but right now, we don't know how to handle quantificational determiners; there are two compositionality issues which will turn out to be related: *composing QPs* (47) and *DP-internal composition* (48).

(47)



(48)



We'll begin with DP-internal composition — it will turn out that solving this issue will provide the solution to QP composition too, while systematically divorcing intensional and quantificational scope.

4.1 *DP-internal composition*

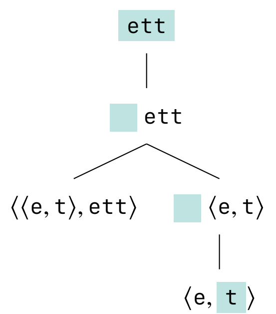
The first thing to note is that determiners don't have any world-sensitivity inherent to their semantics; they just relate sets of individuals.

[22] QR-ing predicates won't help at all — they must fully semantically reconstruct for composition to proceed.

(49) $[\![\text{every}]\!] \coloneqq \lambda P \,.\, \lambda k \,.\, \mathsf{every}(P)(k)$ $\quad\langle \mathtt{et}, \langle \mathtt{et}, \mathtt{t}\rangle\rangle$

> Our puzzle is how to apply *every* to a function from an individual to a "fancy" truth-value. The intuition we'll pursue is that, if we move the fanciness outwards, we can apply *every* to the set of individuals contained inside, and then reapply the fanciness. Schematically:

(50)



First we'll define a helper function **C** — this just flips arguments. We'll use it to get push a predicate's world sensitivity outwards.

(51) $\mathbf{C}\ P \coloneqq \lambda w \,.\, \lambda x \,.\, P(x)(w)$ $\quad\mathbf{C} : \langle\langle \mathtt{a}, \langle \mathtt{b}, \mathtt{c}\rangle\rangle, \langle \mathtt{b}, \langle \mathtt{a}, \mathtt{c}\rangle\rangle\rangle$

(52) $\mathbf{C}\,[\![\text{Hynerian}]\!] = \boxed{\lambda w \,.\, \lambda x \,.\, \mathsf{hynerian}_w(x)}$ $\quad\langle \mathtt{s}, \mathtt{et}\rangle$

We'll define another helper function *map*, which bypasses outer world sensitivity, and allows us to apply a function of type $\langle \mathtt{a}, \mathtt{b}\rangle$ to an *intensional* $\langle \mathtt{s}, \mathtt{a}\rangle$, getting back an $\langle \mathtt{s}, \mathtt{b}\rangle$.[23]

(53) $\mathsf{map} \coloneqq \lambda Q \,.\, \lambda P \,.\, \lambda w \,.\, Q(P(w))$ $\quad\langle \mathtt{ab}, \langle \mathtt{sa}, \mathtt{sb}\rangle\rangle$

[23] *Map* can be defined in terms of ☆ and ∧ — see Elliott 2020 for details.

> THE INTUITION — *map* allows a function to *bypass* an outer "wrapper" of world sensitivity:
>
> $$\mathsf{map}(f)\ \boxed{\lambda w \,.\, i(w)} = \boxed{\lambda w \,.\, f(i(w))}$$

Our new type-shifter *cotraverse* ($\mathscr{F}$), applies to a function f, and a predicate P, pushes P's world-sensitivity outwards via **C**, and maps f into P.

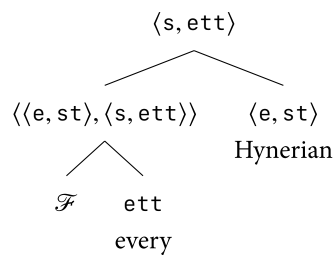
(54) $\mathscr{F} \coloneqq \lambda f \, . \, \lambda P \, . \, \mathsf{map}(f)(\mathbf{C}(P))$ $\qquad \langle\langle\langle \mathtt{a}, \mathtt{b}\rangle, \mathtt{c}\rangle, \langle\langle \mathtt{a}, \mathtt{sb}\rangle, \mathtt{sc}\rangle\rangle$

We can use cotraverse to shift a determiner into something that can compose with a predicate.

(55) $\mathscr{F}(⟦\text{every}⟧) = \lambda P \, . \, \lambda w \, . \, ⟦\text{every}⟧ \, ((\mathbf{C}(P))(w))$ $\qquad \langle\langle \mathtt{e}, \mathtt{st}\rangle, \langle \mathtt{s}, \mathtt{ett}\rangle\rangle$

When we apply our shifted determiner to a predicate, we get — a world-sensitive QP!

(56)



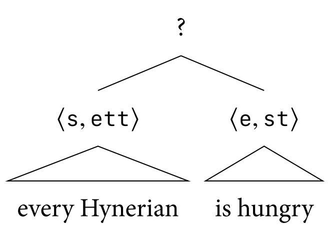
(57) $\lambda w \, . \, ⟦\text{every}⟧ \, ((\mathbf{C}(⟦\text{Hynerian}⟧))(w))$ $\qquad \langle \mathtt{s}, \mathtt{ett}\rangle$

$= \lambda w \, . \, \lambda k \, . \, \mathsf{every}(\mathsf{hynerian}_w)(k)$

4.2 QP composition

> Haven't we just exchanged one compositionality puzzle for another? Now we know what the type of a QP is in our intensional grammar, but we don't know how to compose it with a predicate. This doesn't look like the kind of thing we can solve with *bind*.

(58)



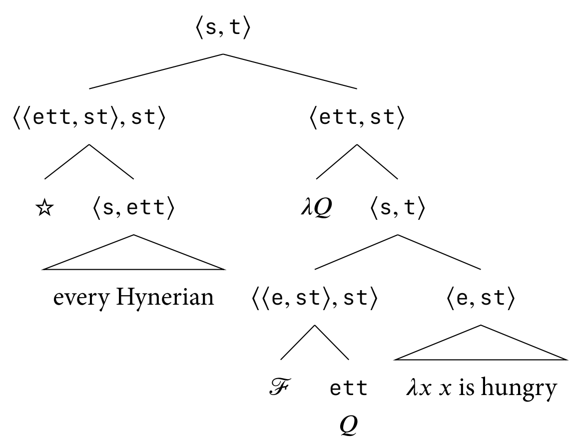
It turns out we actually already have everything we need, once we recognize the existence of *higher-order traces*.

Schematic for composing QPs:

(59) ☆ every Hynerian $[\lambda t_Q \; (\mathscr{F}\, Q) \; [\lambda x \; t_x$ is hungry]].

We simply QR our bind-shifted QP twice, leaving behind an intermediate higher-type trace of type `ett`. The higher type trace can be *mapped* into the derived predicate via cotraverse.

(60)



(61) $[\star([\![\text{every Hynerian}]\!])](\lambda Q\ .\ \lambda w\ .\ Q(\lambda x\ .\ \mathsf{hungry}_w(x)))$

$= \lambda w\ .\ \mathsf{every}(\mathsf{hynerian}_w)(\mathsf{hungry}_w)$

> Composing QPs by leaving behind a higher-order trace *systematically divorces the expression's intensional scope, and its quantificational scope*. Intuition: the final scope site represents an expression's intensional scope, and the scope site of the higher-type trace represents its quantificational scope.

This suggests that an expression may be interpreted *high* with respect to intensional scope, and *low* with respect to quantificational scope (but not necessarily *vice versa*). This is exactly what we find...[24]

[24] There is still some controversy regarding the availability of higher-order traces in the grammar, although note that we need a stipulation to rule them out. See Romero 1998, Fox 1999, Poole 2017 for critical discussion.

4.3 *Third readings*

Fodor (1970) discussed examples like (62).[25] As she famously observed, (62) is three way ambiguous.

[25] This particular example taken from von Fintel & Heim 2021: p. 89.

(62) Mary wanted to buy a hat just like mine .

Reading 1: *Specific de re* — There is a hat that is actually just like mine, and Mary wants to buy it. Mary doesn't necessarily know that it resembles my hat.

In our terms, this involves *wide intensional + quantificational scope*. We can derive this by bind-shifting a hat just like mine , and scoping it out, leaving a higher-order trace above *want*.

(63) Specific *de re* schema:
☆ a hat like mine λQ $\mathscr{F}\ t_Q$ [λx Mary wanted to buy t_x]

Reading 2: *Non-specific de dicto* — Mary's desire consists of the following: *buying a hat just like mine; any such hat will do.*

In our terms, this involves *narrow intensional + quantificational scope*. We can derive this by bind-shifting a hat just like mine, and scoping it below *want*.

(64) Non-specific *de dicto* schema:
Mary wanted [☆ a hat like mine λQ $\mathscr{F}\ t_Q$ λx Mary wanted to buy t_x]

Reading 3: *Non-specific de re* — Mary has a desire to buy any hat that satisfies a particular condition, e.g., one that suits her. Unbeknownst to Mary, my hat happpens to suit her. She may not be aware of it, but her desires encompass my hat.

In our terms, this involves *wide intensional scope* but *narrow quantificational scope*. We can derive this by bind-shifting a hat just like mine, scoping it above *want*, and leaving a higher order trace below *want*.[26]

(65) Non-specific *de dicto* schema:
☆ a hat like mine λQ Mary wanted [$\mathscr{F}\ t_Q$ λx to buy t_x]

(66) $= \lambda w\ .\ \text{mary want}_w\ (\lambda w'\ .\ \text{some(hat like mine in } w))(\text{mary buy in } w')$

✗Reading 4: *Specific de dicto* — There is a particular hat that Mary wants to buy, and she wants to buy it under the description "a hat just like mine".

Were this available, this would involve wide quantificational scope, and narrow intensional scope. In our system, this is in fact *impossible to generate*, unless we allow for determiners quantifying over individual concepts.

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

The availability of this reading is however a matter of some controversy. See, e.g., Szabó 2010.

4.4 *Third readings and islands*

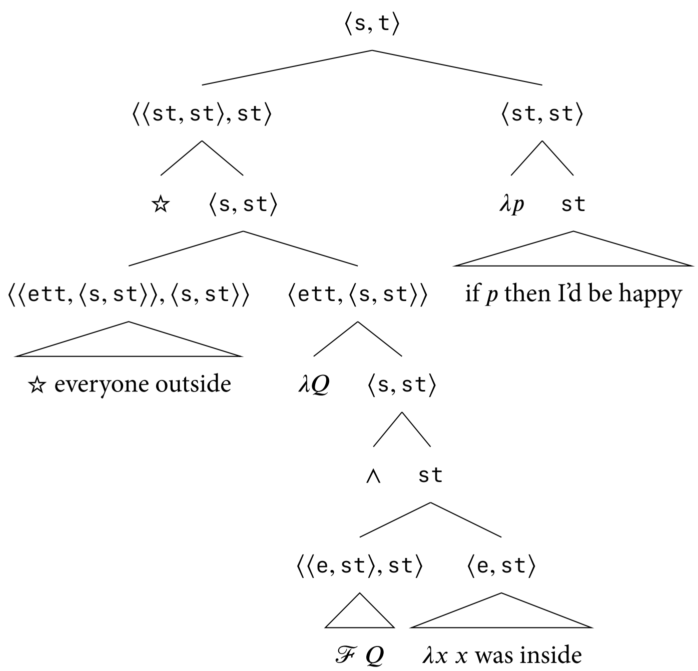
As observed by Percus (2000), quantificational scope and intensional scope come clearly apart in conditional antecedents.

[26] This is an example of what Schwager calls the *transparent evaluation* strategy — see Schwager 2009 for details. As acknowledged by Schwager, even if the analysis of *non-specific de re* must be refined, transparent evaluation may still be independently necessary for the data discussed in (4.4).

(68) If $\boxed{\text{everyone outside was inside}}$,
I'd be happy.

We can derive this straightforwardly by applying our technique for exceptional *de re*. The quantificational scope of the DP automatically *semantically reconstructs* into the conditional antecedent.

(69)



(70) Island:
$= \lambda w \,.\, \lambda w' \,.\, \text{every}(\text{outside}_w)(\text{inside}_{w'})$

(71) $\boxed{☆(\lambda w \,.\, \lambda w' \,.\, \text{every}(\text{outside}_w)(\text{inside}_{w'}))}\ \lambda p \,.\, \lambda w \,.\, \text{if } p \text{ then I'd be happy}$
$= \lambda w \,.\, \text{if } (\lambda w' \,.\, \text{every}(\text{outside}_w)(\text{inside}_{w'})) \text{ then I'd be happy}$

5 *Beyond world-sensitivity*

Exceptional scope of indefinites:

(72) $\overbrace{\text{If a friend of mine wins the lottery,}}^{\text{strong island}}$ I'll be rich too. $\exists >$ if…then…

Exceptional scope of *wh-in-situ*

(73) a. Who will be happy $\overbrace{\text{if which friend of theirs wins the lottery?}}^{\text{strong island}}$
b. Josie will be happy if Sarah wins the lottery, etc.

The Charlow (2019c)/Demirok 2019 analysis: *indefinites* and *wh*-expressions necessitate an *enrichment* of the grammar — namely, the grammar needs to incorporate machinery for dealing with *indeterminacy* (i.e., alternatives).

(74) $[\![\text{which boy}]\!] = [\![\text{some boy}]\!] = \{\, x \mid x \text{ is a boy} \,\}$ $\{\, e \,\}$

Charlow (2019c) develops an analysis of exceptional scope that rely on two type-shifters — *bind* and *return* — which, when generalized, predict the possibility of island scoping.[27]

[27] See Demirok (2019) for an isomorphic analysis in terms of existential quantification.

Charlow's schema for exceptional scope.

(75) $\star$ $\boxed{\star \text{ a friend of mine } \lambda x \ ?\ x \text{ wins the lottery}}$ λp if p then I'll be happy.

> Charlow's bind and return are an instantiation of the same general design pattern developed here; concretely his bind and return characterize the *monad of indeterminacy*, and our bind and up characterize the *monad of world-sensitivity*. The operators have parallel logical properties, which facilitate island-scoping in each domain (see Charlow 2019c and Elliott 2020 for details).

If these theories are on the right track, it tells us something significant about a universal design pattern made available by the grammar for dealing with enriched meanings.[28]

[28] See also Shan (2002) and Asudeh & Giorgolo (2020) for work along these lines.

To wrap up, we've developed a way of thinking about world sensitivity, starting from very minimal means, and achieved some interesting results.

- Bind and up work in tandem to deliver a *scopal* grammar of world-sensitivity, with the expressive power to give the illusion of island-insensitivity via island scoping.
- Our scopal grammar is very powerful, but it does account for grammatical restrictions on *de re* in a principled way (cf. approaches which use world pronouns; Percus 2000).
- Solving the problem of DP-internal composition motivated an enrichment of our grammar — *cotraverse* — which gave rise to a systematic divorce between intensional scope and quantificational scope. This separation was born out by the existence of *third readings*.

Adopting an austere compositional regime as a methodological principle naturally leads us to see common *design patterns* in how the grammar deals with apparently disparate aspects of meaning.

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