Towards a Middle Ground between Engdahl and Heim on Functional Readings of *Wh*-Questions[‡]

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Abstract

Engdahl (1986; *Constituent Questions*, D. Reidel Publishing Company) accounted for functional readings of *wh*-questions like *Which picture of herself$_1$ did no girl submit$_1$?* by positing a polymorphic *which* and a covert operator that binds *herself* in the higher copy. Heim (2019; Functional Readings without Type-Shifted Noun Phrases, in *Reconstruction Effects in Relative Clauses*, p. 283-301, de Gruyter) pointed out ϕ-featural and Binding Theoretic problems that arise from the fact that Engdahl's operator acts as a binder itself, and proposed to solve them by having the entire NP restrictor *picture of herself in situ*, while having a unary *which* attach to the question skeleton. In this paper, I make the novel observation that, to account for functional readings of sentences like *Which picture that John$_1$ liked did he$_1$ show no girl?*, a covert type-shifting operator formulated in Jacobson (2002; Direct Compositionality and Variable-Free Semantics: The Case of Binding into Heads, in *Proceedings of SALT 12*, p. 144-163, Cornell University) and is quite similar to, but still critically different from, Engdahl's is necessary to type-shift the relative clause containing *John* because it must be interpreted only upstairs to account for the lack of disjoint reference effect. Then, I propose a metasemantic constraint that has the effect of ruling out operators like Engdahl's while still allowing mine, so that the problems pointed out by Heim can remain resolved.

Keywords: reconstruction, late merge, question semantics, functional reading.

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1 Introduction

This paper is a reflection on Heim (2019), given certain antireconstruction facts. Heim (2019) was, in turn, a reflection on Engdahl (1986), and the antireconstruction data I'll discuss here haven't been considered in the context of the Engdahl-Heim dialectic before. Engdahl (1986) was concerned with what has come to be known as *functional readings* of *wh*-questions. The *wh*-questions that bring such readings out can be exemplified by (1). The possibility of a functional reading is seen when this question is interpreted as one that can be responded to by saying "Her wedding picture".

(1) Which picture of herself$_1$ did no girl$_1$ submit?
Functional reading:
Which function, f_{ee}, that maps entities to a pictures of those entities,
is such that, for no girl, x, x submitted $f(x)$?
Possible response:
Her wedding picture.

[Heim (2019), (1): 283; indices mine]

The way Engdahl (1986) derived such readings involved having the pronoun *herself* bound by a covert morpheme upstairs. That is, there's no actual binding of *herself* by *no girl*. Heim (2019) pointed out that such "illusory" binding is problematic (for reasons I'll discuss below) and proposed to have the whole restrictor *picture of herself in situ,* while *which* would be a unary, and therefore, unrestricted, existential quantifier simply attached to the question skeleton. I will argue in this paper that an unrestricted, unary *which* is inadequate to account for antireconstruction effects in *wh*-question, *viz.,* examples involving modifiers adjoined to the NP restrictor which contain an R-expression coreferent with a pronoun inside the question skeleton, and, therefore, can't be interpreted downstairs. That is, the NP restrictor and its modifier must be separated from each other for interpretive purposes, and the modifier needs to be upstairs, restricting *which*. This is what, I will argue, prevents *which* from just being a unary, unrestricted quantifier.

Moreover, we need to do all of this, while deriving functional readings of *wh*-questions. I will show that, in order to do that, a covert morpheme that was formulated in Jacobson (2002), very similar to the one Engdahl proposes, but still crucially differing from it, must be postulated. That is, we can't break away from Engdahl as neatly as Heim proposed. And therefore, I will have to address the question: how do we constrain how much of Engdahl's machinery to keep and how much of Heim's machinery. A reflection on this reveals that there should be a metasemantic constraint on the lexical entries of variable binders available to natural language, which is that assignment functions can't be modified in the metalanguage, unless during Predicate Abstraction. That is, Predicate Abstraction is the only rule that allows for the possibility of modifying assignment functions in the metalanguage.

Equivalently, λ-binders are the only variable binders available to natural language.[1] This, I will propose as the *Assignment Modifiability Hypothesis* and discuss how various ways of getting around it are blocked by other constraints independently proposed elsewhere. The benefit of this exercise is that it will help make concrete certain limits beyond which we can't push the system of syntax, semantics, and their interface.

The following is how the paper is organized. Section 2 is devoted to laying out the semantic and syntactic background. In section 2.1, I explain Engdahl's (1986) and Heim's (2019) framework, and Heim's reason for modifying Engdahl's system. In section 2.2, I lay out the way Neglect, an interface operation, can ignore parts of copies and thereby derive reconstruction and antireconstruction effects in *wh*-movement in general. Here, I also describe some basic antireconstruction facts about *wh*-movement which establishes the background necessary to understand the crucial data driving my proposal. In section 3, I introduce the crucial cases involving antireconstruction. Here, I show that functional readings are available in these sentences as well. In section 4, I show why this is a problem for Heim's system and why certain elements of Engdahl's accounts need to be preserved after all. In section 5, I point out that the solution is a type-shifting covert morpheme formulated in Jacobson (2002) that's able to generate just the right readings but doesn't overgenerate, as Engdahl's does. In section 6, I discuss several implications these observations and this new covert operator I propose. I propose a general hypothesis regarding why Engdahl's type-shifter might be banned in natural language, which I dub *the Assignment Modifiability Hypothesis*. After exploring some ways of getting around this, I point out independent constraints proposed elsewhere in the literature, blocking such possibilities. In section 7, I address a potential issue concerning reconstruction for Condition C and then conclude the paper. This paper, thus, teaches us certain limits of natural language that can't be appreciated unless antireconstruction in functional readings of *wh*-questions is taken into consideration.

2 Background

2.1 From Engdahl (1986) to Heim (2019)

As Heim (2019) has elaborated, Engdahl (1986) proposed three innovations to derive functional readings of *wh*-questions. They're reproduced below from Heim's paper. In this paper, I follow Heim's (2019) way of presenting Engdahl's ideas for presentational purposes.

(2) ***Engdahl's innovations***

a. ***Pronoun-binding within NP***
The pronouns inside the NP restricting *which* is bound by a covert type-shifting morpheme attached at the edge of the NP. It shifts the type of the NP from a predicate of individuals to a predicate of functions of type $\langle e, e\rangle$.

1. Upon a suggestion made by an anonymous reviewer, I strengthen the constraint even more in a later, more final, statement.

b. ***Polymorphic* which**
The semantics of *which* is type-flexible/polymorphic, so it can quantify over both e-type individuals and $\langle e, e\rangle$-type functions.

c. ***Layered traces***
There's an option of having covert arguments inside the traces of *wh*-movement. One part of the trace us bound by the *wh*-phrase, and the other, by something else in the clause, for instance, a quantifier.

[Heim (2019: 285)]

Let's see how all of this works with our representative example form the introduction, repeated in (3). In terms of the question semantics of Hamblin (1973), Karttunen (1977), the existential quantifier in the question denotation of (3) can't range over e-type entities, but, as we know from Engdahl (1986), the quantification must be over $\langle e, e\rangle$-type functions. Informally speaking, these are functions that map girls to pictures of themselves. This is crucial to derive a functional reading of this sentence. Engdahl (1986) would do this with the help of a covert variable binder cum type-shifter that binds the pronoun *herself*. As before, I continue to follow Heim's (2019) way of presenting Engdahl's ideas.

(3) Which picture of herself$_1$ did no girl$_1$ submit?

[Heim (2019), (1): 283]

(4) is the LF for (3). Notice that the whole restrictor *picture of herself* is interpreted only upstairs and there's no "copy" of it downstairs, in the trace position. The trace, however, does contain a complex index "$f(x)$". This is Engdahl's third innovation. f is the $\langle e, e\rangle$-type function "that is bound in the usual way by the moved phrase", and x is the variable that is "bound from elsewhere", *viz.,* in the case at hand, by *no girl*.

(4) ***LF for (3)***
$[\lambda_p$ [which $[E^{\mathscr{E}}{}_y$ [picture$_{w_@}$ of herself$_y$] λ_f [[$Q(p)$]
[λ_w [[no girl$_{w_@}$] [λ_x [t_x submit$_w$ $t_{f(x)}$]]]]]]]]

[Heim (2019), (7): 284]

But then, how is *herself* bound, if it's never interpreted in the scope of *no girl*? This is where Engdahl's first innovation comes in. Her E operator, which I call "$E^{\mathscr{E}}$" and whose denotation is given in (5), binds *herself* upstairs. This is what makes the binding of *herself* "illusory"; that is, $E^{\mathscr{E}}$ has the capacity to mimic the effect of syntactic binding. This formulation of $E^{\mathscr{E}}$, crucially, is syncategorematic.

(5) **$\mathbf{E}^{\mathscr{E}}$ *is a covert variable binder and type-shifter of type* ⟨et, ⟨ee, t⟩⟩**
$[\![E^{\mathscr{E}}{}_y\, \zeta]\!]^g = \lambda f_{ee}\, .\, \forall x\, .\, [\![\zeta]\!]^{g^{x/y}}(f(x)) = 1$

[Heim (2019), (8): 285]

The Q operator and the *which* quantifier are the two remaining crucial parts of the LF. Q encodes Karttunen's "proto-question" formation and *which* is a binary existential quantifier. *Which* is also polymorphic — the second of Engdahl's innovations — so we can quantify over $\langle e, e\rangle$-type functions, and not just e-type entities.

(6) a. **Q *encodes Karttunen's "proto-question" formation***
$[\![Q]\!] = \lambda p_{st}\, .\, \lambda q_{st}\, .\, p = q$

b. **Which *is a polymorphic binary existential quantifier***
$[\![\text{which}]\!] = \lambda P_{\sigma t}\, .\, \lambda Q_{\sigma t}\, .\, \exists x_\sigma[P(x) = 1 \wedge Q(x) = 1]$,
where σ is any type.

[Heim (2019, (3)-(4): 283-285); slightly modified]

With all of this machinery, we end up with the following denotation for (3).

(7) ***Denotation for the LF in (3)***
$\{p : \exists f_{\langle e,\, e\rangle}\ [\forall x\, .\, \textsc{picture-of}_{w_@}(f(x), x) = 1 \wedge$
$p = \lambda w_s\, .\, \neg\exists x[\textsc{girl}_{w_@}(x) = 1 \wedge \textsc{submit}_w(x, f(x)) = 1]]\}$

[Heim (2019), (6): 284]

For reasons Heim (2019) elaborates in her section 5 and also described in the introduction, having the pronoun bound upstairs and making it not depend on the ϕ-features and structural position of the quantificational DP *no girl* give rise to morphological and Binding Theoretic problems. Firstly, if *herself* being bound by *no girl* is really an illusion and if *herself* is actually bound upstairs, inside the NP, then what prevents it form being *himself* or *themselves*? That is, how do we make sure that the ϕ-features of the bound pronoun "agrees" with those of the quantifier? Secondly, whether the bound pronoun will be a reflexive or a non-reflexive depends on Binding Theoretic considerations about the structural relationship between the quantifier and the bound pronoun. This is shown in (8). In (8), the antecedent, that is, the quantifier *no girl,* doesn't c-command the trace of the moving *wh*-phrase and this correlates with the unacceptability of the reflexive form of the bound pronoun in this case. If Engdahl is right, then this c-command relationship shouldn't matter because local binding within the NP always happens upstairs.

(8) Which picture of {them$_1$/* each other$_1$} did no pair of boys'$_1$ mother$_2$ choose?

[based on Heim (2019), (40): 297][2]

To remove this issue, Heim proposes to have the NP containing the bound pronoun *in situ* and attaching a unary *which* to the question skeleton, creating existential quantification, thereby basically undoing the machinery that achieves (2a). She proposes the alternative LF, given in (9).

(9) ***LF for (3)***
$[\lambda_p$ [which $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[no girl$_{w_@}$] $[\lambda_y$ $[t_y$ submit$_w$
[THE picture$_{w_@}$ of herself$_y$ IDENT $[f\ pro_y]]]]]]]]]]$

[Heim (2019), (28): 291]

Notice that *which*, here, is unrestricted and only takes one argument. This is done by positing the following unary lexical entry for *which*. The lexical entry for *which*, with other relevant parts of the LF, is given in (10).[3]

(10) a. ***Polymorphic, unary* which**
$[\![\text{which}]\!] = \lambda P_{\sigma t} \, . \, \exists x_\sigma [P(x)]$
where σ is any type.

b. ***THE***
$[\![\text{THE}]\!] = \lambda P_{et} : \exists! x_e [P(x)] \, . \, \iota x_e [P(x)]$

c. ***IDENT***
$[\![\text{IDENT}]\!] = \lambda x_e \, . \, \lambda y_e \, . \, x = y$

[Heim (2019), (27): 291]

THE and IDENT are needed to interpret the trace through Trace Conversion, in the sense of Fox (2002). Let's now see how that happens. [THE picture$_{w_@}$ of herself$_y$ IDENT $[f\ pro_y]]$ is the converted trace of the *wh*-phrase. Trace Conversion basically converts a quantificational trace into an *e*-type trace by replacing the quantificational determiner with the definite determiner THE. Since this happens at LF, it doesn't have any phonological consequences (which is indicated by the small caps); that is, it's the quantificational determiner that's pronounced, not the definite determiner. The other thing that happens in this process is that an $\langle e, t\rangle$-type predicate like "$\lambda x_e \, . \, x = g(y)$" is attached to the NP of the trace, where g is the assignment function and y is the variable that's bound from the left edge of the question. The process of Trace Conversion is given in (11).

2. As an anonymous reviewer notes, Heim herself writes that the argument from ϕ-features is pretty weak because ϕ-features have been argued to be presuppositional (Sudo 2012, *inter alia*) and those presuppositions will project universally in questions, leading to violation of Maximize Presupposition or presupposition failure. For this reason, an example involving a reciprocal has been used.

3. Heim gives polymorphic entries for THE and IDENT as well. Since they are not necessary for my purposes here, I give the monomorphic entries I need.

(11) **Trace Conversion**

a. ***Variable Insertion:***
(Det) Pred $\longrightarrow$ (Det) [Pred $\lambda y\ .\ y = x$]

b. ***Determiner Replacement:***
(Det) [Pred $\lambda y\ .\ y = x$] $\longrightarrow$ the [Pred $\lambda y\ .\ y = x$]

[Fox (2002), (10): 67]

Unlike Fox, Heim breaks down the inserted predicate into the bound index and the polymorphic function IDENT that can turn this index into a predicate of type IDENT $\langle e, t\rangle$. In the case of the functional reading, the trick is to have the index be complex, in the sense that it won't be just any random entity, but, more specifically, an output of a function that maps entities to entities. This function is the bound variable function f. This takes the variable bound by *no girl*, mapping it to entities that are pictures of the girl argument fed to it. The question then asks: what kind of function is this? Is this a function mapping entities to their wedding pictures or graduation pictures or anniversary pictures or something else? This is summarized in (12).

(12) ***The converted trace***
$[\![[\textsc{the}\ \text{picture}_{w_@}\ \text{of herself}_y\ \textsc{ident}\ [f\ pro_y]]]\!]^g = g(f)(g(y))$
if $g(y) \in \text{dom}(g(f)) \land \textsc{picture-of}_{w_@}(g(f)(g(y)), g(y)) = 1$,
otherwise undefined.

Next, the presupposition of this converted trace projects up to the λ-abstract, as shown in (13).

(13) ***Presupposition projection in the λ-abstract***
$[\![[\lambda_y\ [t_y\ \text{submit}_w\ [\textsc{the}\ \text{picture}_{w_@}\ \text{of herself}_y\ \textsc{ident}\ [f\ pro_y]]]]]\!]^g$
$= \lambda y : y \in \text{dom}(g(f)) \land \textsc{picture-of}_{w_@}(g(f)(y), y) = 1\ .$
$\quad \textsc{submit}_{g(w)}(y, g(f)(y)) = 1$

Assuming universal projection from under *no girl*, we derive the meaning in (14) for the node immediately dominating λ_w.

(14) **No girl** ***projects universal presupposition from its nuclear scope***
$[\![[\lambda_w\ [[\text{no girl}_{w_@}]\ [\lambda_y\ [t_y\ \text{submit}_w\ [\textsc{the}\ \text{picture}_{w_@}\ \text{of herself}_y\ \textsc{ident}\ [f\ pro_y]]]]]]]\!]^g$
$= \lambda w : \forall y[\textsc{girl}_{w_@}(y) = 1 \longrightarrow y \in \text{dom}(g(f)) \land \textsc{picture-of}_{w_@}(g(f)(y), y) = 1]\ .$
$\quad \neg\exists y[\textsc{girl}_{w_@}(y) = 1 \land \textsc{submit}_w(y, g(f)(y)) = 1]$

This presupposition results in the intersection of the two sets in the final denotation of the question in (15). The empty set is the pathological element of propositional type ($\#_{st}$), which encodes the possibility of presupposition failure.

(15) ***The set of propositions which is the meaning of the question***

$$\{p : \exists f[\forall y[\textsc{girl}_{w_@}(y) = 1 \rightarrow y \in \mathrm{dom}(f) \wedge \textsc{picture-of}_{w_@}(f(y), y) = 1] \wedge p = \lambda w_s\,.\,\neg\exists y[\textsc{girl}_{w_@}(y) = 1 \wedge \textsc{submit}_w(y, f(y)) = 1]]\} \cup \{\varnothing\}$$

Crucially, Engdahl and Heim don't confront a set of facts that we might call *Late Merge phenomenology* (henceforth, "LM" phenomenology). To be able to talk about that — which I will need to in this paper — we need to establish some baselines; so let's do that in the next subsection.

2.2 Antireconstruction and Neglect

It has long been established in the literature that the NP restrictor of a DP undergoing $\overline{\text{A}}$-Movement shows Binding Theoretic connectivity effects. This is shown by the fact that, in (16), *wh*-movement can't bleed Condition C (van Riemsdijk & Williams 1981, Freidin 1986, Lebeaux 1988, Fox 1999, *inter multa alia*).

(16) * Which aspect of Alma$_1$ does she$_1$ despise?

However, there are parts of this NP restrictor that can escape reconstruction. For instance, (17), the R-expression *Alma* in the CP *that Alma wrote* doesn't cause a Condition C violation, which is unexpected, given (16).

(17) Which paper that Alma$_1$ wrote did she$_1$ later publish?

There is a variety of explanations that have been proposed for this pattern of antireconstruction. One approach, championed in Lebeaux (1988), and represented in Lebeaux (1990, 2000, 2009), Chomsky (1993), Fox (1999, 2002, 2017), Fox & Nissenbaum (1999), Overfelt (2015), *inter alia*, is that there is countercyclic Merge, usually referred to as *Late Merge,* (henceforth, "LM") of the relative clause (henceforth, "RC") to the NP of the moved DP *which paper*, as shown in (18).

(18) Which [paper [$_{\text{RC}}$ that Alma$_1$ wrote]]
did she$_1$ later publish ⟨which paper⟩?

Sportiche's (2016) explanation of the LM phenomenology is Neglect. The concept can also be found under the name *distributed deletion* in Fanselow & Ćavar (2002) and under the name *scattered deletion* in Bošković (2015). According to Sportiche (2016), (17b) is good because the entire lower copy is neglected at PF (19a), and *paper* in the higher copy and *which* and the RC in the lower copy are neglected at LF (19b).

(19) a. **PF:**
Which [paper [$_{RC}$ that Alma$_1$ wrote]]
did she$_1$ later publish ~~which [paper [$_{RC}$ that Alma$_1$ wrote]]~~?

b. **LF:**
Which [paper [$_{RC}$ that Alma$_1$ wrote]]
did she$_1$ later publish ~~which~~ [paper ~~[$_{RC}$ that Alma$_1$ wrote]~~]?

According to an approach like Neglect, for a question like (20), syntax produces something like (21a). Then, parts of copies are selectively neglected at PF and LF, creating the effect of the neglected parts never having existed in the neglected positions at their respective interfaces. This is shown in (21b-c). In (21b), we see that PF neglects the lower occurrence of *which side of itself*, therefore, the higher occurrence of it is pronounced and the pronunciation of (20) is derived. In (21c), we see that LF neglects the higher occurrence of *side of itself* and preserves its lower occurrence, so Condition A can be satisfied. This is, therefore, how Neglect works.

(20) Which side of itself$_1$ did the sofa$_1$ fall on?

(21) a. ***Syntax:***
[which side of itself$_1$] did the sofa$_1$ fall on [which side of itself$_1$]

b. ***PF:***
[which side of itself$_1$] did the sofa$_1$ fall on ~~[which side of itself$_1$]~~

c. ***LF:***
[which ~~side of itself$_1$~~] did the sofa$_1$ fall on [~~which~~ side of itself$_1$]

Now, crucially, we need to block Neglect operations like the ones in (22), regardless of the interface. The question is how.

(22) ~~[which side of itself$_1$]~~ did the sofa$_1$ fall on ~~[which side of itself$_1$]~~

Sportiche proposes to block the Neglect of all copies of a chain based on Chomsky's (1995) **Principle of Full Interpretation (FI)**. Chomsky's insight in FI is that there shouldn't be any superfluous symbols in a syntactic object. Therefore, if all of the copies in a chain are deleted/neglected at any interface, then that means that they never needed to be merged in the first place, that is, they were always superfluous symbols — which are not allowed. Sportiche builds this insight into his formulation of Neglect, given in (23), while FI can be as in (24). (This is slightly modified from Sportiche's version). Here, *syntactic object* is to be understood not as individual occurrences of a chain, but as an entire chain itself. That is, it amounts to saying that at least one occurrence of each chain must be interpreted at each interface. The Neglect operations in (22) violate FI because none of the copies of the *wh*-chain is interpreted.

(23) **Neglect**
Any material at any interface can be ignored up to crash.

(24) **Principle of Full Interpretation (FI)**
Interpret every syntactic object at least once.

What FI does is put a constraint on *how much* of a chain can be neglected. That is, it blocks too much Neglect, so that at least one occurrence of all parts of the moving object is interpreted at both interfaces.

We've now been through two theoretical backgrounds: that of the Engdahl-Heim dialectic, on the one hand, and the LM phenomenology and the Neglect approach to it, on the other. These pieces will now help us understand the data discussed in the next section, which involves functional readings arising from *wh*-questions that show the LM phenomenology.

3 Functional readings in the functional LM sentences

Consider the following sentence in (25), which I will call *the functional LM sentence*. Compare this sentence with (3), *Which picture of herself$_1$ did no girl$_1$ submit?*. (3) was a relatively simpler sentence in that the NP restrictor *picture of herself* isn't modified by anything, as opposed to the functional LM sentence below, where the NP restrictor *picture* is modified by the RC *that John liked*. This is the first dimension of complexity. The second dimension of complexity lies in the fact that *John* and *he* are coindexed. Therefore, just as we saw in (17b), this RC mustn't be interpreted downstairs, and the LF for this sentence should be something like (25c). Crucially, a functional reading is available for this sentence (whence the name *functional LM sentence*). This reading is paraphrased in (25b).

(25) a. Which picture that John$_1$ liked did he$_1$ show no girl?

b. ***Possible functional reading:***
Which function, f_{ee}, that maps entities to entities that John liked,
is such that, for no girl, x, John showed $x\,f(x)$?
Possible response:
The picture she hated.

c. ***LF for this function reading:*** *(to be revised)*
[λ_p [which [that John$_1$ liked]] [λ_f [[$Q(p)$] [λ_w [[no girl$_{w@}$] [λy [he$_1$ showed t_y
[THE [picture IDENT [f pro_y]]]]]]]]]]

Let's represent this functional LM sentence with the schema in (26), for ease of talking. We're interested in the functional reading in (25b).

(26) ***Schema for the functional LM sentence***
[which [PICTURE [MOD-JOHN]]]$_3$ no girl NUCLEUS-HE?

I will show that, if we have a reading like (25b) to derive, then *which* can't be unary, contra Heim (2019), and a covert morpheme very similar to Engdahl's — but not exactly the same as hers — must be postulated, so we're able to basically type-shift MOD-JOHN upstairs.[4]

In this respect, therefore, one contribution of this paper is to point out that the neat choice point we thought existed between Engdahl and Heim actually doesn't exist: the functional LM sentence shows us that we need a little bit of both because we need a method to derive functional readings of *wh*-questions where *which* can't be unrestricted, unlike in the cases discussed by Heim. This might seem to be a less-than-ideal situation because the resulting system seems to be equipped with machinery from both Engdahl and Heim. The question that will emerge from this discussion is: **how to distinguish between the kind of covert morpheme Engdahl posited and the kind of covert morpheme the functional LM sentence forces us to posit?** This leads to a crucial metasemantic observation about variable binders of natural language, which I will introduce towards the end of the paper. In the following section, I go through the semantic composition of the functional LM sentences and illustrate the actual problem itself.

4 The problem

Let's repeat the representative functional LM sentence, and its functional reading, its LF, and its schema in (27).

4. The fact that functional readings in *wh*-questions could arise even when *which* needs to be restricted was also observed in the data below from Sauerland (1998), which I will come back to later on. Sauerland's observation was that when there are two adjuncts modifying an NP, only the outer RC can be LMed and, if it can't — *e.g.,* because it contains a pronoun that must be bound by a quantifier downstairs — then the inner one can't either. But this specific reconstruction asymmetry or possible ways of deriving it isn't relevant for us in the context of this paper. The crucial point to take note of here is that, just as in (25), while the modifier with the bound pronoun must be interpreted downstairs, the modifier with the R-expression must be LMed, and interpreted upstairs; that is, the modifier with the R-expression becomes the restrictor of *which*, thereby not letting it be unary anymore. So, we end up with the same problem as before.

(i) a. [Which [[computer [compatible with his$_2$]] that Mary$_1$ knew how to use]]$_3$ did she$_1$ tell every boy$_2$ to buy t_3?

b. * [Which [[computer [compatible with Mary's$_1$]] that he$_2$ knew how to use]]$_3$ did she$_1$ tell every boy$_2$ to buy t_3?

(ii) a. ? Tell me which books describing Kant's$_1$ views that were published every woman said he$_1$ agreed with.

b. * Tell me which books describing Kant's$_1$ views that she$_2$ published every woman$_2$ said he$_1$ agreed with.

[Sauerland (1998), (2.37-2.38): 52; (2.40b-c): 53]

(27) a. Which picture that John_1 liked did he_1 show no girl?

b. ***Possible functional reading:***
Which function, f_{ee}, that maps entities to entities that John liked, is such that, for no girl, x, John showed $x\, f(x)$?
Possible response:
The picture she hated.

c. ***LF for this function reading:*** *(to be revised)*
$[\lambda_p$ [which [that John_1 liked]] $[\lambda_f\ [[Q(p)]\ [\lambda_w\ [[\text{no girl}_{w_@}]\ [\lambda y\ [\text{he}_1$ showed t_y [THE [picture IDENT $[f\ pro_y]]]]]]]]]]$

d. ***Schema for the functional LM sentence***
[which [PICTURE [MOD-JOHN]]]$_3$ no girl NUCLEUS-HE?

To generate the structures for this question in the syntax, I would resort to Sportiche's (2016) concept of Neglect (for representational purposes only)[5]. If we have the schema for our representative example in (28a), then, in the syntax, the *wh*-movement can be represented as in (28b). At PF, only the higher copy is pronounced, so the lower copy is totally neglected, as shown in (28c). However, at LF, different parts of different copies are interpreted in different positions. This is shown in (28d). Following Heim (2019), the restrictor *picture* is to be interpreted *in situ*, which we know from the Condition C effect in (16). Therefore, the higher occurrence of *picture* is shown to be neglected.[6] MOD-JOHN contains the R-expression *John*, coreferent with *he*, which is inside NUCLEUS-HE. Therefore, to account for the fact that there's no Condition C effect in these sentences, MOD-JOHN must be interpreted only upstairs, and not downstairs. This is shown in the downstairs Neglect of MOD-JOHN. This provides an initial window to the basic interpretive needs that the LF needs to fulfill.

(28) a. ***Schema for the functional LM sentence***
[which [PICTURE [MOD-JOHN]]]$_3$ no girl NUCLEUS-HE?

b. ***Syntax:***
[which [PICTURE [MOD-JOHN]]]$_3$ no girl NUCLEUS-HE
[which [PICTURE [MOD-JOHN]]]$_3$

5. Here, I will assume a fully broad option space for Neglect operations. That is, I won't consider what constraints, apart from FI, must be put on Neglect, when we look close enough at an empirical landscape that's broad enough. In ongoing work, I argue that partial Neglect, as opposed to total Neglect, leads to undesirable results, and lacks explanatory power, and therefore, it should be abandoned, with the hope that better alternatives can be developed. Here, I would disregard all such considerations precisely because the question of functional readings is independent of how to deploy partial Neglect, and the alternative that replaces partial Neglect can be applied to the account of the functional LM sentences as well. Therefore, the reader is cautioned to interpret partial Neglect as a placeholder for a yet-to-be-developed better theory of partial reconstruction in *wh*-movement.

6. *Picture* could also go unneglected in the higher position, but this is not a relevant choice point for us because *picture* contains neither a bound pronoun nor an R-expression. I, therefore, neglect the higher occurrence for the sake of simplicity, and to keep things uniform, given the background from Heim (2019).

c. ***PF:***
[which [PICTURE [MOD-JOHN]]]$_3$ no girl NUCLEUS-HE
~~[which [PICTURE [MOD-JOHN]]]$_3$~~

d. ***LF:*** *(to be revised)*
[which [~~PICTURE~~ [MOD-JOHN]]]$_3$ no girl NUCLEUS-HE
[which [PICTURE ~~[MOD-JOHN]~~]]$_3$

However, this LF is way too crude. Remember, we're trying to derive the functional reading of this sentence. Therefore, all the machinery from Heim (2019) has to be added to the mix. When we do that, we seem to get (29). Binding indices are suffixed to predicates for perspicuity.

(29) ***LF for (28a)*** *(to be revised)*
$[\lambda_p$ [[which [MOD-JOHN]] $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[no $\text{girl}_{w_@}$] $[\lambda_y$ $[t_y$ NUCLEUS-HE_w
[THE $\text{picture}_{w_@}$ IDENT $[f\ pro_y]]]]]]]]]]$

Very much like the composition shown in (12)-(15), we can see in (30) how semantic composition would work until the node immediately dominating λ_w, given universal projection from under *no girl*.

(30) **No girl** ***projects universal presupposition from its nuclear scope***
$[\![[\lambda_w$ [[no $\text{girl}_{w_@}$] $[\lambda_y$ $[t_y$ NUCLEUS-HE_w
[THE $\text{picture}_{w_@}$ IDENT $[f\ pro_y]]]]]]]]\!]^g$
$= \lambda w : \forall y[\text{GIRL}_{w_@}(y) = 1 \rightarrow y \in \text{dom}(g(f)) \wedge \text{PICTURE}_{w_@}(g(f)(y), y) = 1]\ .$
$\neg\exists y[\text{GIRL}_{w_@}(y) = 1 \rightarrow \text{NUCLEUS-HE}_w(y, g(f)(y)) = 1]$

The first problem appears here. Heim (2019) proposed a unary *which*. But, as can be seen in the LF in (29), *which* takes two arguments: the predicate MOD-JOHN and the node immediately dominating λ_f. So, we need to go back to its old binary semantics from Engdahl, and, as before, we also need to keep it polymorphic, to account for functional readings. This can be done as in (31).

(31) ***Polymorphic binary*** **which*****; an existential quantifier***
$[\![\text{which}]\!] = \lambda P_{\sigma t}\ .\ \lambda Q_{\sigma t}\ .\ \exists x_\sigma[P(x) = 1 \wedge Q(x) = 1]$,
where σ is any type.

Now appears the second problem. Observe here that the first argument of both the first and the second argument of *which* must be of the same type, which, in the case of the non-functional readings of *wh*-questions, will be type *e*. Since we have functional readings here, this type has to be $\langle e, e\rangle$. Therefore, in the case of functional readings, the type of *which* must be $\langle\langle ee, t\rangle, \langle\langle ee, t\rangle, t\rangle\rangle$. That is, its first argument must be of type $\langle ee, t\rangle$. But the sister of *which* is MOD-JOHN. This is not a predicate of $\langle e, e\rangle$-type functions; it's a predicate of *e*-type entities. So, we have a type-related problem and, crucially, **this problem arises precisely because the *which* quantifier can't remain unrestricted, since the modifier containing *John* must be interpreted upstairs, as its restrictor.** To remind the reader, Engdahl dealt with this problem by positing the $E^{\mathscr{E}}$ operator, while Heim did so, by keeping the whole restrictor *in situ* — which, as the R-expression serves to show, is not an option for the case at hand.

5 The solution: The $E^{\mathscr{J}}$ operator (from Jacobson 2002)

The previous discussion teaches us that we do need an Engdahl-style type-shifter after all. **Such a type-shifter has already been proposed in Jacobson (2002),** who needed to shift NPs of type $\langle e, t\rangle$ to functions of type $\langle ee, t\rangle$ in a very similar scenario.[7] In the case at hand, we also need a type-shifter which takes a function of type $\langle e, t\rangle$ and returns a function of type $\langle ee, t\rangle$ that returns true if and only if its first argument of type $\langle e, e\rangle$ only outputs members of the characteristic set of the first argument of itself. Thus, what we need is Jacobson's (2002) type-shifter, rendered in the Heim & Kratzer (1998) system as in (32), a special case of which will be a type-shifter of type $\langle et, \langle ee, t\rangle\rangle$. Because this originated in Jacobson's work, I'll call this type-shifter $E^{\mathscr{J}}$.[8]

(32) ***Generalized definition:***
$[\![E^{\mathscr{J}}]\!] = \lambda P_{\langle \tau, t\rangle} \,.\, \lambda f_{\langle \mathrm{e}, \tau\rangle} \,.\, \forall x[x \in \mathrm{dom}(f) \rightarrow P(f(x)) = 1]$
The special case of* E$^{\mathscr{J}}$ *we need:
$[\![E^{\mathscr{J}}]\!] = \lambda P_{et} \,.\, \lambda f_{ee} \,.\, \forall x[x \in \mathrm{dom}(f) \rightarrow P(f(x)) = 1]$

With the help of $E^{\mathscr{J}}$, we can revise the LF in (29) as the one in (33). All I've done here is attach $E^{\mathscr{J}}$ to MOD-JOHN. This shifts MOD-JOHN to type $\langle ee, t\rangle$. So, when *which* takes it as its first argument, the quantification is over functions of type $\langle e, e\rangle$, which ensures a functional reading.

7. I'm grateful to an anonymous reviewer for pointing out this precedent.

8. An anonymous reviewer suggests an alternative to $E^{\mathscr{J}}$, which is to make the trace of the relative operator inside the RC of type $\langle e, e\rangle$ and type-shift the predicate inside the RC that takes the RC-internal trace as its argument. They suggest that this can be done, if we assume the principle of derived predication discussed in Hulsey & Sauerland (2006, (64): 132) that allows us to combine a function of type $\langle e, t\rangle$ with a function of type type$e$, e, which would eventually take us to a meaning abstracting over $\langle e, e\rangle$-type functions without the $E^{\mathscr{J}}$ operator. I believe that, for the purposes of the paper, which is above all to point out the need for a middle ground between Engdahl and Heim, these two can be treated as notational variants and the central observation of my paper stands regardless of which way one goes. Although, I should point out that doing it the way the reviewer suggests involves allowing the syntax to combine something of type $\langle e, t\rangle$ with something of type $\langle e, e\rangle$. This violates Hirsch's (2017) Strong Linking Condition (SLC), which I discuss in section 6. There are costs associated with abandoning the SLC as a constraint on structure, which are too complicated to be discussed here, but, in short, have to do with when parasitic gaps can or cannot associate with a *wh-in-situ* (Nissenbaum 2000). I, therefore, keep to having $E^{\mathscr{J}}$ as the solution.

(33) ***LF for (28a)*** *(final version)*
$[\lambda_p$ [which $[E^{\mathscr{I}}$ [MOD-JOHN]]] $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[no $\text{girl}_{w@}$] $[\lambda_y$ $[t_y$ NUCLEUS-HE_w
[THE $\text{picture}_{w@}$ IDENT $[f\ pro_y]]]]]]]]]$

We can now compute the denotation of the node [which $[E^{\mathscr{I}}$ [MOD-JOHN]]]. This is done in (34), as I just described above.

(34) a. $[\![[E^{\mathscr{I}}\ [\text{MOD-JOHN}]]]\!]^g$
$= [\lambda P_{et}\ .\ \lambda f_{ee}\ .\ \forall x[x \in \text{dom}(f) \rightarrow P(f(x)) = 1]](\text{MOD-JOHN})$
$= \lambda f_{ee}\ .\ \forall x[x \in \text{dom}(f) \rightarrow \text{MOD-JOHN}(f(x)) = 1]$

b. $[\![[\text{which}\ [E^{\mathscr{I}}\ [\text{MOD-JOHN}]]]]\!]^g$
$= [\lambda P_{\langle ee,\,t\rangle}\ .\ \lambda Q_{\langle ee,\,t\rangle}\ .\ \exists f_{ee}[P(f) = 1 \wedge Q(f) = 1]]$
$(\lambda f_{ee}\ .\ \forall x[x \in \text{dom}(f) \rightarrow \text{MOD-JOHN}(fx) = 1])$
$= \lambda Q_{\langle ee,\,t\rangle}\ .\ \exists f_{ee}[[\forall x[x \in \text{dom}(f) \rightarrow \text{MOD-JOHN}(f(x)) = 1]] \wedge Q(f) = 1]$

When this node combines with its sister, following (15), we get the following denotation for the entire question. This is the attested functional reading.[9, 10]

9. Note that this $\mathcal{E}$ operator also correctly predicts functional readings of the (a) examples of (i)-(ii) in footnote 4, cited from Sauerland (1998). As Sauerland (*ibid.,* chapter 2, section 2.2, p. 43-54) showed, even when part of the restrictor of a moving *which*-phrase must be interpreted downstairs in order for a variable inside it to get bound by a quantifier in the question nucleus, another part of the restrictor might have to, therefore, in principle, can, be interpreted only upstairs. In all of the (a) examples of (i)-(ii) in footnote 4, the inner modifiers must be interpreted downstairs, that is, in the scope of the quantifiers inside the question nuclei (which are *every boy* and *every woman*, respectively), but the outer modifiers contain R-expressions coindexed with pronouns inside the question nuclei as well (which are *Mary* and *Kant*, respectively). The functional paraphrases that will arise from these sentences are exemplified in (i) for (ia).

(i) ***Paraphrase of the functional reading of (ia) in footnote 4***
Which function, f_{ee}, that maps entities to entities that Mary knew how to use
is such that Mary told every boy, x, to buy
$f(x)$, $f(x)$ being a computer compatible with x's?

Such a functional reading can be derived from an LF like the one in (iib), assuming a schema like (iia). The semantic composition will be completely parallel to the one for the functional LM sentence. Crucially, the modifier containing the bound variable *his*, schematized as MOD-HIS, is interpreted only downstairs, while the modifier containing the R-expression *Mary*, schematized as MOD-MARY, is interpreted only upstairs, with the help of the $E^{\mathscr{I}}$ operator, just as in the case of the functional LM sentence.

(ii) a. ***Schema for the (ia) in footnote 4***
[which [[COMPUTER [MOD-HIS]] MOD-MARY]]$_3$ every boy NUCLEUS-SHE?

b. ***LF for (ia) in footnote 4***
$[\lambda_p$ [which $[E^{\mathscr{I}}$ [MOD-MARY]]] $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[every $\text{boy}_{w@}$] $[\lambda_y$ $[t_y$ NUCLEUS-SHE_w
[THE $\text{computer}_{w@}$ MOD-HIS_y IDENT $[f\ pro_y]]]]]]]]]$

10. An alternative proposal is to posit a lexical ambiguity between Heim's unary *which* (say, $which_{\text{un}}$) and a different, binary entry of *which* (say, $which_{\text{bin}}$). Even under such an alternative, if Engdahl's and my proposal are to be discussed under equivalent assumptions, then a similar lexical ambiguity would have to be posited

(35) $[\![[\lambda_p \text{ [which } [E^{\mathscr{I}} \text{ [MOD-JOHN]]] } [\lambda_f \text{ [[}Q(p)] \text{ } [\lambda_w \text{ [[no girl}_{w_@}] \text{ } [\lambda_y \text{ } [t_y \text{ NUCLEUS-HE}_w$
$\text{[THE picture}_{w_@} \text{ IDENT } [f \text{ } pro_y]]]]]]]]]]\!]^g$
$= \{p : \exists f_{ee}[[\forall x[x \in \text{codom}(f) \rightarrow \text{MOD-JOHN}(x) = 1]] \wedge$
$[\forall y[\text{GIRL}_{w_@}(y) = 1 \rightarrow y \in \text{dom}(f) \wedge \text{PICTURE}_{w_@}(f(y), y)]] \wedge$
$p = \lambda w_s \,.\, \neg\exists z[\text{GIRL}_{w_@}(z) = 1 \wedge \text{NUCLEUS-HE}_w(z, f(z)) = 1]]\}$
$\cup \{\varnothing\}$

One concern that remains is that, if *which* is binary and must always be restricted, then we'll face a problem deriving the functional reading for the very first example that we started with in the introduction, that is, (1): *Which picture of herself$_1$ did no girl$_1$ submit?*. This is a question in which nothing needs to be, and, in fact, can be, interpreted upstairs, as the restrictor of *which*. This is because there's no modifier attached to *picture of herself* containing an R-expression coindexed with a pronoun in the question nucleus; moreover, *picture of herself* must be interpreted only downstairs, or *herself* won't be able to get bound. That is, for (1), we want to have an LF like the one in (36). But we can't interpret this because *which* is unrestricted.

(36) ***LF for (1)*** *(to be revised)*
$[\lambda_p \text{ [which] } [\lambda_f \text{ [[}Q(p)] \text{ } [\lambda_w \text{ [[no girl}_{w_@}] \text{ } [\lambda_y \text{ } [t_y \text{ submit}_w$
$\text{[THE picture}_{w_@} \text{ of herself}_y \text{ IDENT } [f \text{ } pro_y]]]]]]]]$

A discussion of this issue and ramifications thereof are beyond the scope of this paper. However, what I can preliminarily propose in order to resolve this issue is **having a domain restriction variable, say $\mathcal{R}$,** attached to *which*, as its first argument. Domain restriction is independently necessary in quantification. Therefore, this is not an outlandish proposal. This will give us an LF like (37).

(37) ***LF for (1)*** *(final version)*
$[\lambda_p \text{ [which } [E^{\mathscr{I}} \text{ } \mathcal{R}]] \text{ } [\lambda_f \text{ [[}Q(p)] \text{ } [\lambda_w \text{ [[no girl}_{w_@}] \text{ } [\lambda_y \text{ } [t_y \text{ submit}_w$
$\text{[THE picture}_{w_@} \text{ of herself}_y \text{ IDENT } [f \text{ } pro_y]]]]]]]]$

I would, therefore, conclude this section here. But the nature of the issue that an LF like (36) raises is not trivial and it merits further reflection. Especially, we need to understand the generality of this issue, that is, where else we encounter the same interpretive problem. I would leave this to future research.

for Engdahl. Otherwise, the issue would become orthogonal. That is, for her, there would be an entry for *which* that would have no assignment modification in it (that is, wouldn't lexicalize the effect of *E*; say $which_{\neg E}$), and there would be another entry for it that would have such assignment modification (that is, would lexicalize the effect of *E*; say $which_E$). Then, the relevant juxtaposition would be between $which_E$ and $which_{\text{bin}}$, just as we're now juxtaposing Engdahl's *E* with $E^{\mathscr{I}}$. That is, as far as the purposes of this paper are concerned, positing different covert type-shifting morphemes and positing lexical ambiguity for *which* end up being notational variants. Thanks to Kai von Fintel for bringing up this issue.

6 Implications

To summarize, we learn from Heim (2019) that Engdahl's $E^{\mathscr{E}}$ operator, repeated below in (38a) (with explicit manipulation of assignment functions, to make the parallel between $E^{\mathscr{E}}$ and $E^{\mathscr{I}}$ clearer; I'll use "γ" to represent the type of assignment functions), creates problems of ϕ-feature agreement and Binding Theoretic effects — unexpected if the bound pronoun in the NP restrictor of the *wh*-phrase doesn't rely on the quantifier for getting bound; and from considerations about examples with modifiers on the moving *wh*-phrase that mustn't be reconstructed teach us that a very similar operator is needed after all, which I call $E^{\mathscr{I}}$, repeated in (38b). But the question we therefore must ask is: **what is the underlying principle that blocks a type-shifter like $E^{\mathscr{E}}$ but allows on like $E^{\mathscr{I}}$?** Is there perhaps something at least descriptive about this state of affairs that we can say?

(38) a. ***Engdahl's* E$^{\mathscr{E}}$ *is a covert variable binder and type-shifter of type* ⟨et, ⟨ee, t⟩⟩; *it modifies the assignment function***

$$[\![E^{\mathscr{E}}{}_{\gamma}(\zeta_{\langle\gamma,\, et\rangle})(g_{\gamma})]\!] = \lambda f_{ee}\ .\ \forall x[x \in \mathrm{dom}(f) \rightarrow \zeta(g[i \rightarrow x])(f(x)) = 1]$$

b. **E$^{\mathscr{I}}$ *is also a type-shifter of type* ⟨et, ⟨ee, t⟩⟩; *but it doesn't modify the assignment function***

$$[\![E^{\mathscr{I}}(P_{et})]\!] = \lambda f_{ee}\ .\ \forall x[x \in \mathrm{dom}(f) \rightarrow P(f(x)) = 1]$$

This is a metasemantic question about constraints on what the meaning of natural language operators, functions, or type-shifters might be. There are ways such a constraint can be implemented. One is to propose the hypothesis in (39). The spirit of this hypothesis is that, since assignment modification is, in some sense to be made explicit, "too complex", natural language allows for the possibility of modifying an assignment function only when the relatively complex process of Predicate abstraction is already needed anyway because of a syntactically present λ-binder; otherwise, the modification of the assignment function is "too much", whence the name of the hypothesis.[11] That is, there's a certain impoverishment in the range of meanings natural language operators are able to express and enrichment can come about only when triggered by the syntax for independent reasons. This intuition is equivalent to restricting all possible variable binders of natural language to λ-binders; therefore, it's stated in that form.[12, 13]

11. I assume throughout that λ-binders are syntactically real and present. See Nissenbaum (2000) for empirical motivations for this assumption.

12. For the purposes of this paper, I will define variable binder as in (i). Thanks to Danny Fox for this simplified phrasing.

(i) **Variable binder**
α is a variable binder if there is a variable/index, i, such that, the denotation of the sister of α is dependent on the assignment to i and the mother of α isn't.

13. The AMH can be seen as inspired by observations made by Lechner (1998), about German scrambling. The point he makes there is that semantic reconstruction is allowed, but only as long as it doesn't mimic vari-

(39) **Assignment Modifiability Hypothesis (AMH)** *(first version)*
λ-binders in the LF are the only variable binders available to natural language.[14]

Even when we make this hypothesis, there are ways in which one could try to create configurations syntactically that would basically produce the lexical effect of Engdahl's $E^{\mathscr{E}}$ operator through syntax.[15] The first option is to freely insert λ-binders without there being any movement in the syntax. If we were allowed to do that, then we would be able to generate configurations like (40), where the denotation of F is given in (41).

(40) $[_{\langle ee,\, t\rangle}\ F_{\langle\langle e,\, et\rangle,\, \langle ee,\, t\rangle\rangle}\ [_{\langle e,\, et\rangle}\ \lambda_2\ [_{\langle e,\, t\rangle}$ picture of herself$_2$]]]

(41) $[\![F]\!] = \lambda Z_{\langle e,\, et\rangle}\ .\ \lambda f_{ee}\ .\ \forall x[Z(x)(f(x)) = 1]$

[Kai von Fintel, p.c.]

Once F is lexicalized in this manner and the structure in (40) is generated, the $\langle e, et\rangle$-type sister of F will basically act as the product of Engdahl's $E^{\mathscr{E}}$ operator — because of the syntactically present λ-abstraction — without it being an output of a lexical entry like the $E^{\mathscr{E}}$ operator. Here's how this comes about. The predicate *picture of herself* has the denotation in (42).

able binding, which can only come about through syntactic means, that is, syntactic reconstruction. This, he shows with the following observations: (a) a direct object, scrambled over an indirect object, can have narrow scope with respect to the indirect object, (b) a direct object, scrambled over both an indirect object and a subject, can syntactically reconstruct between the subject and the indirect object, but not under the indirect object, (c) it follows from (a) and (b) that when a direct object, scrambled over an indirect object, takes narrow scope with respect to the indirect object, it can do so only via semantic reconstruction, and (d) moreover, when a direct object, scrambled over an indirect object, takes narrow scope with respect to the indirect object, pronominal variables inside the scrambled direct object can't be bound by the indirect object under which the direct object takes scope. The conclusion from (a)-(d) is that semantic reconstruction can't resolve variable binding, that is, it can't mimic variable binding. And that's exactly what Engdahl's E operator is able to do, but my $\mathcal{E}$ operator isn't able to do. Therefore, although the AMH is merely a hypothesis, I believe it's based on a reasonable understanding of semantic simplicity that's consistent with empirical facts already discussed in Lechner (1998). Poole & Keine (2023, (53): 32) reach the same conclusion based on Hindi-Urdu Long Distance Scrambling data. Specifically, they show that an R-expression inside a long distance scrambled nominal that has moved past a coindexed pronoun prevents a variable inside the same nominal from being bound by a quantifier the nominal has also moved past. And this could only be made sense of if variable binding required syntactic reconstruction (that is, Neglect of the higher copy), which could, therefore, be sabotaged by Condition C connectivity effects. Crucially, if semantic reconstruction were able to mimic variable binding, then syntactic reconstruction wouldn't be necessary for variable binding and the R-expression would be able to be evaluated for the purposes of Binding Theory in the scrambled nominal's landing site, thereby creating no Condition C effect. Also see von Fintel & Heim (2021, chapter 5, section 5.5, p. 98-99) where they reach similar conclusions for world variables based on non-specific readings of raised quantificational subjects (*e.g., somebody from New York* in *Somebody from New York is likely to win the lottery*).

14. One ought to remind themselves at this point that quantifiers don't bind variables in the Heim & Kratzer (1998) system; the λ-binders immediately dominated by their sisters do.

15. These observations owe greatly to discussions with Kai von Fintel and Danny Fox.

(42) $[\![\text{picture of herself}_2]\!]^g = \lambda y_e \,.\, y \text{ is a picture of } g(2)$

Therefore, the $\langle e, et\rangle$-type λ-abstract will have the meaning in (43).

(43) $[\![[\lambda_2 \text{ [picture of herself}_2]]]\!]^g = \lambda x_e \,.\, \lambda y_e \,.\, y \text{ is a picture of } x$

When this meaning is taken by F as its argument, the meaning in (44) is yielded. This is exactly the meaning that polymorphic *which* needs to take as its argument to generate the functional reading.

(44) $[\![[F\ [\lambda_2 \text{ [picture of herself}_2]]]]\!]^g$
$= \lambda f_{ee} \,.\, \forall x[[\lambda y_e \,.\, y \text{ is a picture of } x](f(x)) = 1]$
$= \lambda f_{ee} \,.\, \forall x[f(x) \text{ is a picture of } x]$

This teaches us that the effect the AMH is trying to prevent can be produced in the syntax without running afoul of the AMH, **if λ-binders are freely insertable in the syntax without there being any movement.** What I want to point out here is that attaching λ_2 to its $\langle e, t\rangle$-type sister is ruled out by Hirsch's (2017) Strict Linking Condition (SLC), given in (45). Hirsch considers the SLC for his own purposes, and also, there are several consequential ramifications of the SLC, discussing which will take me too far afield. See section 3.2.2 of chapter 7 of his dissertation for more. The SLC produces similar results as the combination of May's (1977) Predicate Condition and Condition on Quantifier Binding (*ibid.*, p. 22).

(45) **Strict Linking Condition (SLC)**
If an expression α has a meaning of type $\langle\sigma, \tau\rangle$ and is externally merged with its sister β, then β must have a meaning of type σ.

[Hirsch (2017); (35): 300]

Crucially, λ_2 is being externally merged here, as I have assumed throughout the paper that λ-binders are separately merged into the structure for the purposes of Predicate Abstraction whenever movement results in scope-shifting. But, given the SLC, the $\langle e, t\rangle$-node *picture of herself* demands that an e-type object be fed to it. Regardless of what the type of λ-binders is — if they have any meaning at all; as far as my interests here are concerned, it doesn't affect me either way and I can remain agnostic about this — λ-binders are not objects of type e. Therefore, attaching λ_2 to *picture of herself* is a clear violation of the SLC. Therefore, the observation here is that nothing new needs to be proposed to prevent structures like (40). The relevant restriction falls out of the SLC. It should also be noted that I could not have banned all insertions of λ-binders in the syntax whenever they're not triggered by movement. This is because of attested cases of resumption discussed in Sichel (2014) among others — and referred to as *true resumption* in Aoun, Choueiri & Hornstein (2001) — where the resumptive pronoun and a quantificational DP binding it are separated by an island boundary, which signals that the construction could not have come about through movement and only pure binding of the pronoun could have yielded the structure. This is shown in (46). Here, crucially, externally merging λ_1 to its t-type sister is vacuously consistent with the SLC because t is a saturated type.

(46) $[\text{DP}_{\langle et,\, t\rangle}\ [_{\langle e,\, t\rangle}\ \lambda_1\ [_t \ldots [_{island} \ldots pro_1]]]]$

One apparent way to get around both the AMH and the SLC, and still produce a similar effect through syntax — and I will immediately problematize it below — is to basically move the F operator but to have a trace that denotes an identity function on its sister (that is, a trace that ends up being semantically vacuous). To see why, consider what will happen if we attached F to the predicate *picture of herself* and then moved it, in an attempt to create the λ-abstract it needs to be fed. The structure we will generate is the one in (47). However, crucially, the trace of F, t_2, must be semantically vacuous, that is, it must be an identity function on its sister. This is because, if t_2 is an identity function on its sister, then it will take its sister's meaning — the meaning of *picture of herself* — and output the same meaning for the sister of the λ-binder λ_2, introduced by the movement of F.

(47) $[_{\langle ee,\, t\rangle}\ F_{\langle\langle e,\, et\rangle,\, \langle ee,\, t\rangle\rangle}\ [_{\langle e,\, et\rangle}\ \lambda_2\ [_{\langle e,\, t\rangle}\ t_{\langle 2,\, \langle et,\, et\rangle\rangle}\ [_{\langle e,\, t\rangle}\ \text{picture of herself}_2]]]]$

However, this is not a permissible LF. Observe that both t_2 and *herself* bear the index "2", despite the fact that the former is an identity function of type $\langle et, et\rangle$, while the latter is an object of type e. Therefore, this is an LF that violates Heim's (1997) No Meaningless Coindexation condition. If we were to consider an LF that doesn't violate that condition, then, in that LF, either t_2 must be of type e or the index of the trace must be something other than "2", say, "3". If t_2 is of type e, the λ-abstract becomes of type $\langle e, t\rangle$, thereby making the movement of F fruitless. If the index of t is, say, "3", then the λ-binder binding the trace t_3, which will be λ_3, will no longer bind *herself* along with t_3, that is, *herself* will be free, and we won't achieve the core goal of getting it bound in the higher copy. Therefore, this way of getting around the constraints doesn't work.

There's still another thing that could happen that would get around the AMH. *Viz.,* the movement of F could still happen, but its trace could be neglected at LF. That would produce an LF like (48).

(48) $[_{\langle ee,\, t\rangle}\ F_{\langle\langle e,\, et\rangle,\, \langle ee,\, t\rangle\rangle}\ [_{\langle e,\, et\rangle}\ \lambda_2\ [_{\langle e,\, t\rangle}\ \cancel{t_2}\ [_{\langle e,\, t\rangle}\ \text{picture of herself}_2]]]]$

However, recall from (19) that partial Neglect in a movement trace/lower copy of movement is necessary to explain antireconstruction facts under the Neglect account. But, even in that case, what didn't happen is total Neglect of the entire trace. That is, it seems that the lowermost copy in a movement chain can't be totally neglected.[16] This is because if the lowermost copy of a movement chain can be totally neglected, then we again end up with a system that

16. Intermediate copies or the uppermost copy of a movement chain might sometimes need to be neglected, to account for total reconstruction of raised quantificational subjects, like *somebody from New York* in *Somebody from New York is likely to win the lottery*. Before any Neglect, the LF of this can be approximated to (i).

can get around the AMH. But observe that, in (48), once t_2 is neglected at LF, the sister of *picture of herself* effectively ends up being λ_2. λ_2 isn't internally merged with its sister. What is being internally merged in this LF is F. Therefore, λ_2 meets the criterion to act as β in (45), while its $\langle e, t\rangle$-type sister acts as α. And this should be ruled out by the SLC for the same reason (40) is ruled out by it. Therefore, the necessary ban on deleting lowermost copies of movement also falls out of the SLC.

As a reviewer points out, there's another interesting way to think about the effect we're trying to capture with the AMH, which, in fact, has been alluded to in Heim (2019: 297). This alternative strategy is to not try to directly block operators like Engdahl's and instead build the relevant restriction into the general descriptive statement capturing Weak Crossover. For instance, let's imagine, as Heim, suggests, that cases of Weak Crossover is subsumed under the generalization in (`[wco]`). This is also what's suggested in Heim (1998, (5): 208).

(49) **Binding from A-positions (BAP)**
A pronoun can only be bound by a λ-binder that is attached to the structure when a quantifier is merged into an A-position.

BAP, whatever the underlying reason for it might be, captures well-known cases of Weak Crossover violation, for instance, in the case of QR. For example, in (`[wcoex]`), the only way to get the pronoun bound is to QR, *i.e.*, $\overline{\text{A}}$-move, *every boy*. That means that there's no quantifier in an A-position that introduces a λ-binder binding the pronoun, thus violating BAP.

(50) His$_{2/*1}$ mother loves every boy$_1$.

The interesting thing is that, if BAP is a correct descriptive generalization, then it itself can filter out LFs like the ones necessary under a view that includes Engdahl's operator, that is, for instance, (4), repeated below. This is because, in (4), *herself* violates BAP. That is, a grammar that doesn't block Engdahl's operator can still block LFs like (4) by virtue of having BAP as a filter.

(4) ***LF for (3)***
$[\lambda_p$ [which $[E_y$ [picture$_{w_@}$ of herself$_y$] λ_f $[[Q(p)]$
$[\lambda_w$ [[no girl$_{w_@}$] $[\lambda_x$ $[t_x$ submit$_w$ $t_{f(x)}]]]]]]]]$

[Heim (2019), (7): 284]

(i) [[somebody from New York]$_1$ is likely [[somebody from New York]$_1$ to [$_{vP}$ [somebody from New York]$_1$ win the lottery]]]

Depending on whether we want the *de re* or the *de dicto* reading, either the uppermost or the intermediate copy will be deleted. The lowermost, *vP*-internal copy, crucially, can't be neglected, both because of the SLC, and also because it serves the purpose of saturating the external argument of *win*.

Therefore, an instructive way to think about this is to revise the AMH into the new version in ([amh2]). This is stronger than the previous statement of the AMH in a way that incorporates BAP because of the specification about Internal Merge into A-positions. That is, as the reviewer points out, the AMH might have a deep link to the constraint on Weak Crossover in general.

(51) **Assignment Modifiability Hypothesis (AMH)** *(final version)*
λ-binders attached to the structure during the Internal Merge of a syntactic object into an A-position are the only variable binders available to natural language.

To summarize, what we've learned from the Engdahl-Heim dialectic considered in the context of the novel observation about antireconstruction in the functional LM sentences is that λ-binders attached to the LF during the Internal Merge of a syntactic object into an A-position are the only variable binders available to natural language (the AMH) and various ways of getting around this constraint is ruled out if we espouse Hirsch's (2017) SLC. The AMH can also be thought of as a manifestation of the general ban on structures involving Weak Crossover, as a reviewer points out, and, therefore, can be revised in a way that's able to block both Weak Crossover and type-shifters like Engdahl's. I would leave this as a ripe area for future thoughts.

7 An apparently open issue and conclusion

On a final note, let's briefly discuss a potential problem for my proposal. It might appear from the preceding discussion that having the operator $E^{\mathscr{I}}$ creates a problem, when we think of cases of *wh*-questions that (a) have functional readings, and (b) show reconstruction effects for Condition C. For instance, consider (52). Given we have the covert morpheme $E^{\mathscr{I}}$, we predict that the LF in (49b) is possible for (49a). Notice that the NP restrictor *book* is simply not interpreted downstairs at all. The functional reading arises because of the $E^{\mathscr{I}}$ operator that takes the NP restrictor as its sister upstairs.

(52) a. Which book did no girl read?
Functional reading:
Which function, f_{ee}, that maps entities to books,
is such that, for no girl, x, x read $f(x)$?
Possible response:
The book her mother gave her on her 10th birthday.

b. ***Possible LF:***
$[\lambda_p$ [which $[E^{\mathscr{I}}$ [book]]] $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[no girl$_{w_@}$] $[\lambda y$ $[t_y$ read
[the [ident $[f\ pro_y]]]]]]]]]]$

That is, the possibility of this $\mathcal{E}$ operator predicts that we're allowed to have LFs like (52b) because, unlike in Heim (2019), we don't need the restrictor *in situ* in order for the functional reading to arise. If this is a feature of the system, then we predict obviation of Condition C reconstruction effects in cases like (53), because the R-expression *John* is not c-commanded by the pronoun *he*, coreferent with it, anywhere in the structure. Arguably, this is an undesirable feature of systems with type-shifters like $\mathcal{E}$ because it would allow the NP restrictor to not be syntactically present downstairs, unlike in Heim's system, which forces an *in-situ* restrictor when we have functional readings.

(53) a. *Which picture of John_2 did he_2 show no girl_1?
Intended functional reading:
Which function, f_{ee}, that maps entities to pictures of John, is such that, for no girl, x, he showed $x\,f(x)$?
Possible response to this hypothetical reading:
The picture that she liked.

b. ***Necessary LF for this hypothetical reading:***
$[\lambda_p$ [which $[E^{\mathscr{I}}$ [picture of John_1]]] $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[no $\text{girl}_{w_@}$] $[\lambda y$ [he_1 showed t_y [THE [IDENT [f pro_y]]]]]]]]]]

In fact, a similar LF could be posited for the functional LM sentence (25a) as well, for instance, (54).

(54) ***Alternative LF for the functional LM sentence:***
$[\lambda_p$ [which $[E^{\mathscr{I}}$ [picture that John_1 liked]]] $[\lambda_f$ $[[Q(p)]$ $[\lambda_w$ [[no $\text{girl}_{w_@}$] $[\lambda y$ [he_1 showed t_y [THE [IDENT [f pro_y]]]]]]]]]]

Given this, I would like to argue that although such LFs are interpretable, they're not generable, because of pressures from the syntax. That is, I would say that, in $\bar{\text{A}}$-movement, the lower copy of the movement must always have a full restrictor. This is something we already know has to be the case from the literature from Lebeaux (1988), Romero (1998), Fox (1999), among others. That is, the pressure is not from the semantics, but from the syntax. What is the precise nature of this pressure? I'm not sure about that at the moment; it's something about $\bar{\text{A}}$-movement that needs to be explained in general. That is, whatever derives the unacceptability of (16), repeated below, is what derives the unacceptability of (53a). See Ruys (2015) for a similar discussion leading to an equivalent conclusion in the context of semantic reconstruction in general.

(16) *Which aspect of Alma_1 does she_1 despise?

To conclude, this paper was about how Engdahl's (1986), and then Heim's (2019), observations about functional readings of *wh*-questions must be informed by the consideration of certain specific *wh*-questions where the moving *wh*-phrase is modified by modifiers that show antireconstruction effects, that is, must be interpreted only in the higher copy. When we apply Heim's machinery to the interpretation of these sentences, we see that it doesn't work. Specifically, her unary lexical entry for *which* isn't adequate because a predicate, which is the modifier that must be interpreted only upstairs, needs to act as the first argument of *which*, and the question nucleus, the second. Therefore, **the first contribution of this paper is to show that a unary *which* doesn't work when we look at an empirical landscape that's broad enough.** Furthermore, when we allow a binary semantics for *which* and compute the meaning of the sentence, we need to posit a type-shifter of type $\langle et, \langle ee, t\rangle\rangle$. Engdahl's variable binder cum type-shifter was also of the same type. Therefore, **the second contribution of this paper is to show that a type-shifter very much similar to Engdahl's, formulated in Jacobson (2002), is needed after all.** The difference between Engdahl's and Jacobson's type-shifter lies in whether there's modification of the assignment function in the metalanguage of the type-shifter. Engdahl's has such a modification, while mine doesn't, and, in fact, doesn't need to. We had already learned from Heim (2019) that Engdahl's type-shifter overgenerates, precisely because of this kind of metalinguistic specification: it's too rich and powerful. But my type-shifter doesn't face those issues. It must be acknowledged that this is a less than desirable situation: we end up with a hybrid of Engdahl and Heim's systems. Then, we should ask: **what prevents the former and allows the latter?** As a completely preliminary answer to this, I proposed, on the basis of considerations of simplicity, the Assignment Modifiability Hypothesis (AMH), which says that the only variable binders available to natural language are λ-binders, thereby precludeing assignment modification in the metalanguage, unless as part of Predicate Abstraction. I consider some possible ways of replicating the effect of assignment modification through syntax. Based on these considerations, I show that Hirsch's (2017) SLC can rule these possibilities out. The AMH, supplemented by the SLC, is the implication of the Engdahl-Heim dialectic that can be appreciated once examples involving antireconstruction are considered. This is where I end the paper, addressing an issue about reconstruction for Condition C in *wh*-questions in general.

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