Nesting habits of flightless *wh*-phrases*

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Abstract

The focus of this paper is a construction involving what Heim (1994) calls nested *which*-phrases, and lessons for a compositional account *wh*-interrogatives. The central puzzle under consideration is the unavailability of the pair-list interpretation when an *in-situ wh*-phrase is nested inside of the moved *wh*-phrase, despite the fact that the pair-list interpretation obtains when the *in-situ wh*-expression is contained in an island. Even under the surviving single-pair reading, nested *which*-phrases pose some well-known problems relating to the semantics of pied-piping, as discussed by von Stechow (1996), Sternefeld (2001) and Sauerland & Heck (2005). We aim to show that nested *which*-phrases are problematic for current compositional accounts of *wh*-interrogatives. We go on to propose a new account, which combines Cable's (2010) syntax for interrogatives with a semantics based on Charlow's (2015) system for composing alternatives. We show that this system is powerful enough to derive pair-list readings across islands, via covert pied-piping, and the single-pair reading of nested *which*-phrases, via trace conversion. On the other hand, the pair-list reading of nested *which*-phrases is shown to be impossible to generate, given some well-motivated syntactic restrictions on covert movement.

1 Introduction

There is a significant body of work, on the status of the *in-situ wh*-expression(s) in multiple questions, such as the following:

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(1) Which student likes which teacher?

On the interpretive side, the central issue is the mechanism via which the *in-situ wh*-expression *which teacher* scopes into the question. The traditional approach (Karttunen 1977, Dayal 1996) is to treat the *in-situ wh*-expression as a quantificational expression that takes scope via covert movement (i.e., Quantifier Raising (QR); May 1977)

(2) Which teacher$_j$ Which student$_i$ t_i likes t_j

Subsequent work has argued that this view is too restrictive, given well known restrictions on movement generally, such as island-sensitivity, and on QR specifically, such as clause-boundedness. Reinhart (1998), for example, proposes a genuinely *in-situ* analysis of *wh-in-situ*, according to which the *in-situ wh*-expression introduces a choice-functional variable, which may be existentially bound. Beck (2006), Kotek (2014) and others on the other hand develop a non-movement analysis of *wh-in-situ*, according to which *in-situ wh*-expressions introduce alternative sets, which are "passed up" via Hamblin-semantic composition.

In §2, we provide the background necessary for appreciating what is at stake; in §2.1 we give some background on multiple questions, and the Hamblin/Karttunen question semantics we assume in this paper. In §2.2 we go into somewhat more depth concerning the semantics of multiple questions, focusing specifically on Dayal's (1996, 2002) important work on the distinction between the single-pair and pair-list interpretations. In §3, we introduce the basic compositional system assumed here for *wh*-interrogatives, and how it derives both single-pair and pair-list interpretations for multiple questions. In §4 we introduce the nested *which*-phrases construction, the core empirical focus of the paper, and outline the problems in poses for compositional accounts of *wh-in-situ*.

2 Background

2.1 Multiple questions

I use the term *multiple question* to refer to constituent questions involving $n \geq 2$ *wh*-expressions which take scope together. A simple example of a multiple question is given in (3). Note that in English, at most a single *wh*-expression may move overtly to a left-peripheral position in the interrogative.[1]

[1] This is a well-known locus of cross-linguistic variation, with some languages, such as Bulgarian, allowing fronting of multiple *wh*-expressions, others such as Chinese, requiring all *wh*-expressions to remain *in-situ*, and yet other languages, such as French, displaying optionality in this regard.

(3) [Which student]$_i$ t_i admires which teacher?

Throughout, I shall be assuming a standard Hamblin/Karttunen semantics for questions, according to which the denotation of an interrogative is (the characteristic function of) a set of propositions, namely the set of possible answers to the questions.

(4) $$[\![\text{which student left early?}]\!] = \lambda p_{\langle s,t\rangle} \,.\, \exists x \begin{bmatrix} \text{student}_{@}(x) \\ \wedge\ p = \underbrace{\lambda w \,.\, x \text{ left early in } w}_{\text{question nucelus}} \end{bmatrix}$$

If, in @, *Jeff (J)*, *Abed (A)*, and *Britta (B)* are students, then (4) is the characteristic function of the set in (5).

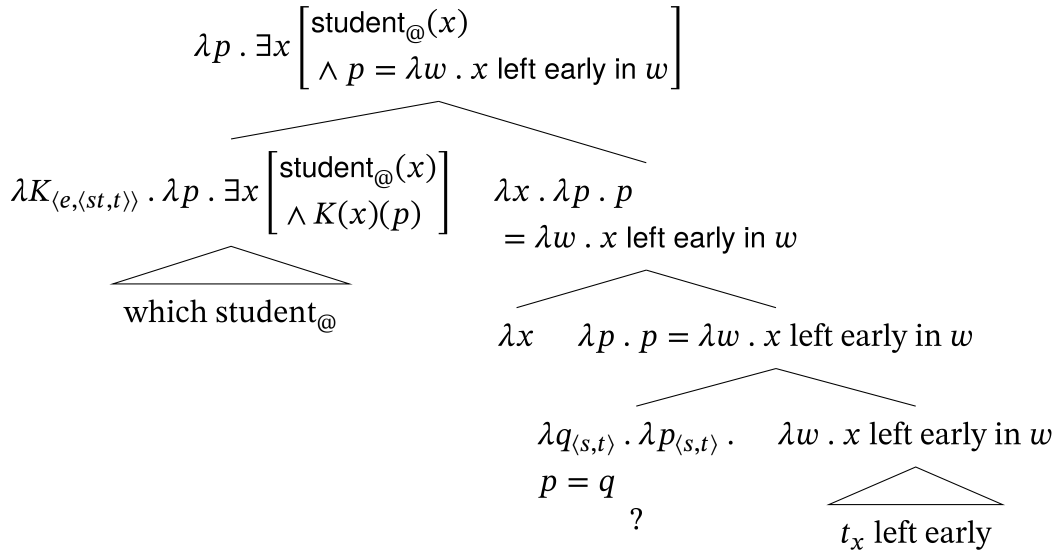
(5) $$\begin{Bmatrix} \lambda w \,.\, \text{J left early in } w, \\ \lambda w \,.\, \text{A left early in } w, \\ \lambda w \,.\, \text{B left early in } w \end{Bmatrix}$$

Following von Stechow (1996), I refer to the subformula immediately following '$p =$' as the *question nucleus*. Note that in order to derive a Hamblin/Karttunen answerset the scope of the *wh*-expression, here corresponding to an existential quantifier, is outside of the question nucleus. Were the *wh*-expression to take scope in the question nucleus, we would end up with the following singleton set as our question denotation.

(6) $$\left\{ \lambda w \,.\, \exists x[\text{boy}_{@}(x) \wedge x \text{ left early in } w] \right\}$$

Since *wh*-expressions in simple constituent questions move overtly, it is straightforward to give a compositional account of how we derive the Hamblin/Karttunen answer set from the LF of an interrogative. Here I sketch one way of doing this, following Heim (1994) and Cresti (1995).

(7) Which student left early?



What is important here is that the question nucleus is introduced via Karttunen's question operator '?'. The *wh*-expression moves overtly to a position above the question operator, and thus takes scope outside of the question nucleus.

Things get a little more interesting when we consider cases involving $n \geq 2$ *wh*-expressions, since in English, maximally one *wh*-expression may move overtly to a given scope position. A standard Hamblin/Karttunen denotation for a simple multiple question is given in (8).

(8) $[\![\text{which student admires which teacher}]\!] = \lambda p \,.\, \exists x, y \begin{bmatrix} \text{student}_@(x) \\ \wedge\ \text{teacher}_@(y) \\ \wedge\ p = \lambda w \,.\, x \text{ admires } y \text{ in } w \end{bmatrix}$

If, in @, *Jeff*, *Abed*, and *Britta* are students, and *Ian* and *Michelle* are teachers, then (8) is the characteristic function of the set in (9).

(9) $\left\{ \begin{array}{l} \lambda w \,.\, \text{J admires I in } w, \lambda w \,.\, \text{J admires M in } w, \\ \lambda w \,.\, \text{A admires I in } w, \lambda w \,.\, \text{A admires M in } w, \\ \lambda w \,.\, \text{B admires I in } w, \lambda w \,.\, \text{B admires I in } w \end{array} \right\}$

Again, it is crucial that *both* *wh*-expressions take scope outside of the question nucleus. One way of achieving this is to have the *in-situ* *wh*-expression undergo covert movement to a position above the ? operator, resulting in the LF in (10).

(10) Which student admires which teacher?

$$\lambda p_{\langle s,t\rangle} \,.\, \exists x, y \begin{bmatrix} \text{student}_{@}(x) \\ \wedge\ \text{teacher}_{@}(y) \\ \wedge\ p = \lambda w \,.\, x \text{ admires}_{w}\ y \end{bmatrix}$$

$$\lambda K_{\langle e,\langle st,t\rangle\rangle} \,.\, \lambda p_{\langle s,t\rangle} \,.\, \exists x \begin{bmatrix} \text{student}_{@}(x) \\ \wedge\ K(x)(p) \end{bmatrix} \qquad \lambda x_e \,.\, \lambda p_{\langle s,t\rangle} \,.\, \exists y \begin{bmatrix} \text{teacher}_{@}(y) \\ \wedge\ p = \lambda w_s \,.\, x \text{ admires}_{w}\ y \end{bmatrix}$$

which student

$$\lambda x \qquad \lambda p_{\langle s,t\rangle} \,.\, \exists y \begin{bmatrix} \text{teacher}_{@}(y) \\ \wedge\ p = \lambda w_s \,.\, x \text{ admires}_{w}\ y \end{bmatrix}$$

$$\lambda K_{\langle e,\langle st,t\rangle\rangle} \,.\, \lambda p_{\langle s,t\rangle} \,.\, \exists x \begin{bmatrix} \text{teacher}_{@}(x) \\ \wedge\ K(x)(p) \end{bmatrix} \qquad \lambda y_e \,.\, \lambda p_{\langle s,t\rangle} \,.\, p = \lambda w_s \,.\, x \text{ admi}$$

which teacher

$$\lambda y \qquad \lambda p_{\langle s,t\rangle} \,. = \lambda w_s$$

$$\lambda q_{\langle s,t\rangle} \,.\, \lambda p_{\langle s,t\rangle} \,. \quad p = q$$

?

2.2 The semantics of multiple questions

Dayal's (1996) major contribution to the question semantics literature is the observation that a flat answer-set as in (9) is not sufficiently structured in order to account for the interpretive properties of the **PL!** (**PL!**) interpretation. First, a brief outline of the distinction between **PL!** and **SP!** (**SP!**) interpretations.

(11) a. Which student admires which teacher?

b. Britta admires Ian. **SP!**

c. Jeff admires Ian, Abed admires Michelle, and Britta admires Ian too. **PL!**

Dayal (1996) observes that the question in (11a) has a reading on which it presupposes the existence of a unique student x and a unique student y such that x admires y, corresponding to the possible answer in (11b). Dayal (1996) captures this reading by positing an answerhood operator, which I label $\text{Ans}_{\text{Dayal}}$, and applying it to the flat Hamblin/Karttunen answerset, as outlined in the previous section.[2]

(12) $$[\![\text{Ans}_{\text{Dayal}}]\!] = \lambda w_s \,.\, \lambda Q_{\langle st,t\rangle} \,.\, \iota p \begin{bmatrix} p(w) \wedge Q(p) \\ \wedge \forall p'[[p'(w) \wedge p \in Q] \rightarrow \forall w'[p(w') \rightarrow p'(w')]] \end{bmatrix}$$

$\text{Ans}_{\text{Dayal}}$ takes as its arguments a Hambling/Karttunen answer set Q, and a world of evaluation w and returns *true* iff there exists a unique member of the set that is both true in w and maximally informative, i.e., that entails every other member of Q that is true in w. Dayal (1996) shows in detail how applying the answerhood operator to a flat Hamblin/Karttunen answerset derives the uniqueness presupposition of the SP reading.

Fox (2012) (see also Nicolae 2013, Kotek 2014). Fox (2012) shows that we can account for the **PL!** reading if we allow multiple questions to denote higher order questions.[3]

(13) $$\lambda Q_{\langle st,t\rangle} \,.\, \exists x \begin{bmatrix} \mathsf{student}_{@}(x) \\ \wedge\, Q = \lambda p_{st} \,.\, \exists y[\mathsf{teacher}_{@}(y) \wedge p = \lambda w \,.\, x \text{ admires } y \text{ in } w] \end{bmatrix}$$

If in @ again *Jeff, Abed* and *Britta* are the students, then (13) will be the characteristic function of the set in (14).

(14) $$\left\{ \begin{array}{l} \text{Which teacher does Jeff admire?}, \\ \text{Which teacher does Abed admire?}, \\ \text{Which teacher does Britta admire?} \end{array} \right\}$$

Fox's intuition is that the answerhood conditions on the **PL!** reading are achieved by taking $\text{Ans}_{\text{Dayal}}$ and applying it pointwise to each member of the set in (14), and

[2] $\text{Ans}_{\text{Dayal}}$ is independently necessary in order to account for the uniqueness presupposition of singular *which* questions. It has subsequently been invoked in work on weak islands (see Abrusán 2014 for an overview).

[3] Dayal (1996) on the other hand develops an analysis according to which, under the **PL!** reading, a multiple question is a question about a function, where the overtly-moved *wh*-expression provides the domain, and the *in-situ wh*-expression provides the range of the function (see also Chierchia 1992). We do not adopt Dayal's particular analysis here, since it involves positing an ad-hoc ambiguity in the interrogative complementizer which (to our knowledge) is not manifested morphologically in any language.

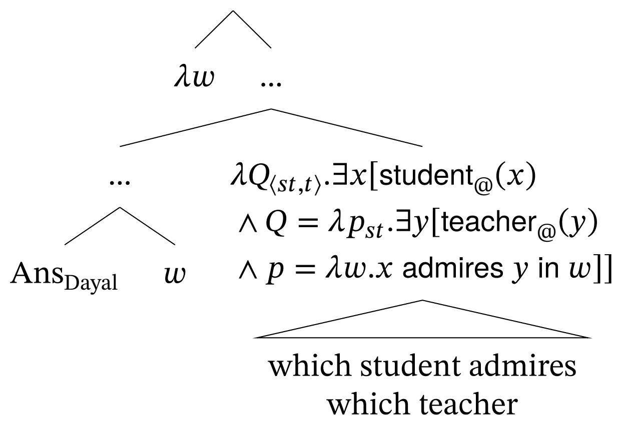
conjoining the resulting propositions. Fox shows in detail that this captures the presuppositions of the **PL!** reading discussed by Dayal (1996, 2002): *Domain Exhaustivity* and *Pointwise Uniqueness*. We can cash this out by adopting a recursive definition of $\text{Ans}_{\text{Dayal}}$ (after Kotek 2014).

(15) **A recursive formulation of $\text{Ans}_{\text{Dayal}}$**

a. $[\![\text{Ans}_{\text{Dayal}}]\!](w)(Q_{\langle st,t\rangle}) = \iota p \left[p(w) \wedge Q(p) \wedge \forall p' \begin{bmatrix} p'(w) \wedge Q(p) \\ \rightarrow \forall w'[p(w') \rightarrow p'(w')] \end{bmatrix} \right]$

b. $[\![\text{Ans}_{\text{Dayal}}]\!](w)(K_{\langle \sigma t\rangle}) = \forall P_{\sigma}[K(P) \rightarrow [\![\text{Ans}_{\text{Dayal}}]\!](w)(P)]$

(16)
$$\lambda w\,.\,\forall Q \begin{bmatrix} \exists x \begin{bmatrix} \textsf{student}_{@}(x) \\ \wedge\, Q = \lambda p\,.\,\exists y[\textsf{teacher}_{@}(y) \\ \wedge\, p = \lambda w\,.\,x \textsf{ admires } y \textsf{ in } w] \end{bmatrix} \\ \rightarrow \iota p \begin{bmatrix} p(w) \wedge Q(p) \wedge \forall p'[[p'(w) \wedge Q(p)] \\ \rightarrow \forall w'[p(w') \rightarrow p'(w')]] \end{bmatrix} \end{bmatrix}$$



redo this!

The important take-home message is that, in order to derive the PL reading of a multiple question and its interpretive properties, we need a semantic object with more structure than a flat Hamblin/Karttunen set. The implementation of this I have chosen to adopt is due to Fox 2012, as this boils down primarily to considerations of theoretical parsimony, as it will allow us ultimately to give a compositional account which uses the bare minimum logical machinery.

3 Constituent questions in Charlow's (2017) alternative semantics

In order to compute the meanings of both simple and multiple constituent questions compositionally, I adopt Charlow's (2017) system for composing alternatives, and marry it with Cable's (2010) syntax for interrogatives. Unlike proposals by Beck (2006) and more recently Kotek (2014, 2016), the system outlined here does not make use Rooth's (1985) bidimensional semantics for association with focus. This has some advantages and some drawbacks, which I discuss towards the end of the section.

3.1 Simple constituent questions

3.1.1 *wh*-expressions

I shall assume that *wh*-expressions denote (characteristic functions of) alternative-sets, as in (17).[4]

(17) a. $[\![\text{which boy}]\!] = \lambda x_e \,.\, \mathsf{boy}_{@}(x)$

b. $[\![\text{who}]\!] = \lambda x_e \,.\, \mathsf{person}_{@}(x)$

3.1.2 η and $\ggcurly$

In addition, we shall need two type-flexible operators. The first is Partee's (1986) IDENT operator, which here we can think of as a generalized version of Karttunen's (1977) question operator. Following Charlow (2017) I label this operator η. The denotation is given in (18).

(18) $$\eta(a) = \begin{cases} \lambda b \in D_\tau . a = b & \text{function talk} \\ \{a\} & \text{set talk} \end{cases}$$

The second operator takes an alternative generator (such as a *wh*-expression), and scopes it into a second argument f. Following Charlow (2017) I label this operator $\ggcurly$.[5]

[4]To simplify, I shall be assuming unless noted otherwise that all nominal predicates are interpreted *de re*.

[5]

(19) For any types σ, τ

$$\gg\!= (X) = \lambda f \in D_{\langle \sigma, \tau t \rangle} . \begin{cases} \lambda b \in D_\tau . \exists x_\sigma [X(x) \wedge f(x)(b)] & \text{function talk} \\ \{ b \in D_\tau \mid \bigcup\limits_{x \in X} f(x)(b) \} & \text{set talk} \end{cases}$$

3.1.3 Composition

In the syntax, the derivation of a simple constituent question is taken to be as follows: the *wh*-phrase first combines with $\gg\!=$, forming a QP. The QP-complex undergoes movement to specCP, and η applies to the remnant.[6] The resulting LF and details of its composition are given in (20).[7]

(20)

- $\lambda p . \exists x \begin{bmatrix} \text{boy}_@(x) \\ \wedge\ p = \lambda w . x \text{ left early}_w \end{bmatrix}$
  - $\lambda f . \lambda b . \exists x \begin{bmatrix} \text{boy}_@(x) \\ \wedge\ f(x)(b) \end{bmatrix}$
    - $\lambda X . \lambda f . \lambda b . \exists x \begin{bmatrix} X(x) \\ \wedge\ f(x)(b) \end{bmatrix}$ — $\gg\!=$
    - $\lambda x . \text{boy}_@(x)$ — which boy$_@$
  - $\lambda x . \lambda p = \lambda w . x \text{ left early}_w$
    - λx
    - $\lambda p . p = \lambda w . x \text{ left early}_w$
      - $\lambda a . \lambda b . a = b$ — η
      - $\lambda w . x \text{ left early}_w$ — t_x left early

Stuff here about how Charlow shows that together these two operators constitute a monad.

[6] We note that it may seem natural at this point to take η as the denotation of the interrogative complementizer C_Q. Subsequently we will see clear reasons for not identifying it with any particular piece of interpreted syntactic structure. Instead we assume that, ontologically, η is more akin to Partee & Rooth's (2012) type-shifters, and may be freely inserted at LF up to interpretability. We take C_Q to be semantically vacuous, serving only to drive overt movement of a QP to its specifier.

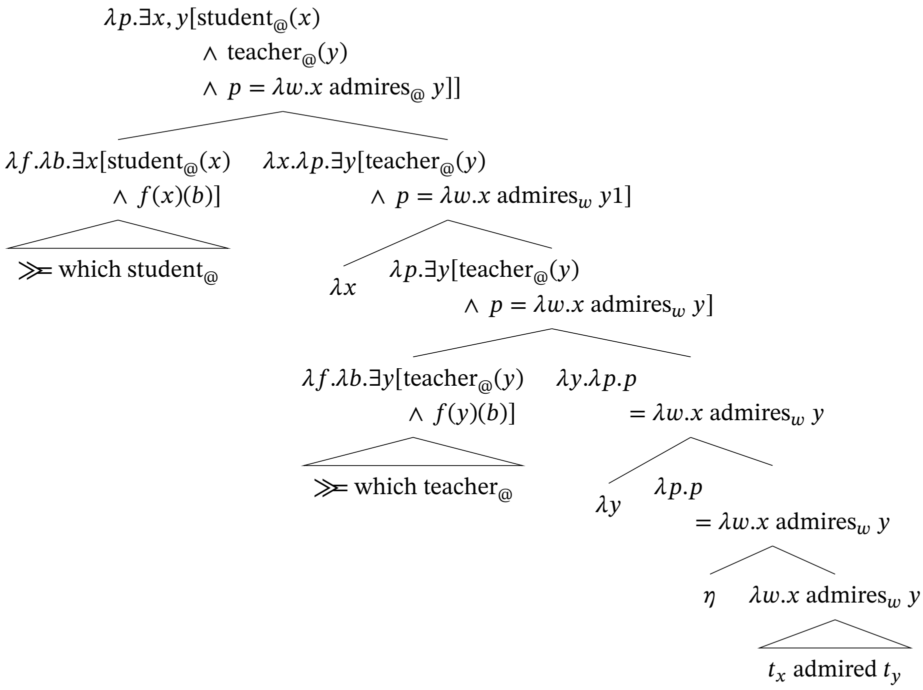
[7] Note that composition of $\gg\!=$ with the *wh*-expression is equivalent to the denotation that Cresti (1995) proposes for *wh*-expressions. Later we'll see that factoring out and generalizing Cresti's suggestion as $\gg\!=$ has certain advantages.

3.2 Multiple questions

Since η and $\ggcurly$ are type-flexible, we can derive Fox's (2012) higher-order interpretation for a multiple question via stacking η. Under the **SP!** reading, we simply have a single occurrence of η. Importantly, we do not need additional syntactic or semantic machinery for this.

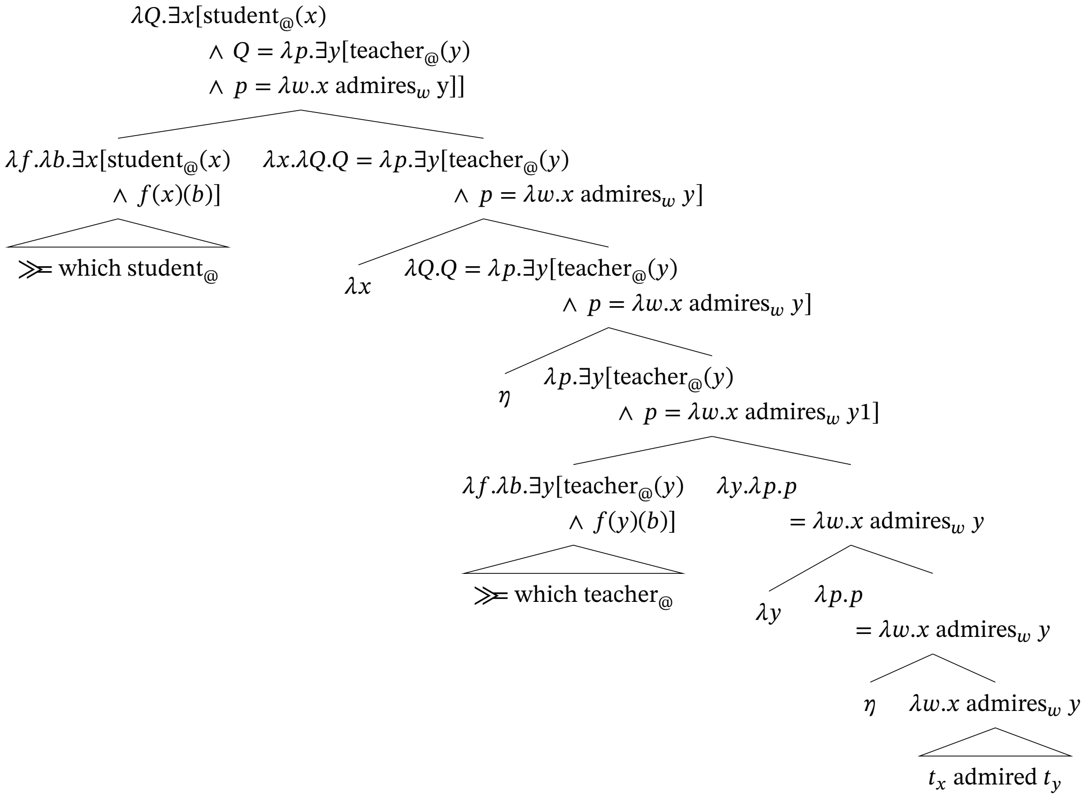
3.2.1 SP! reading

(21) Which student admired which teacher? Single-Pair reading



3.2.2 PL! reading

(22) Which student admired which teacher **PL!** reading



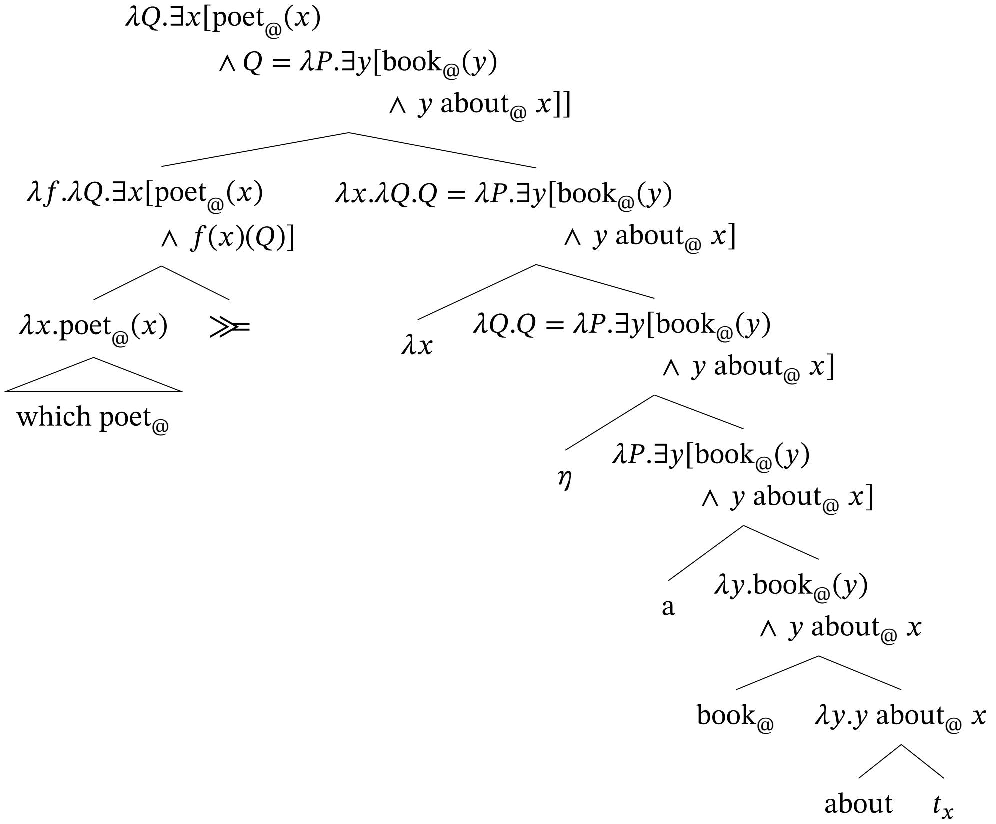
3.3 Pied-piping

One interesting feature of this system is that it is sufficiently powerful to capture pied-piping of arbitrary material. To illustrate, we show in detail below how an instance of massive pied-piping (Safir 1986) such as (23) can be interpreted.

(23) ?[$_{\text{DP}}$ A book about which poet] did you read?

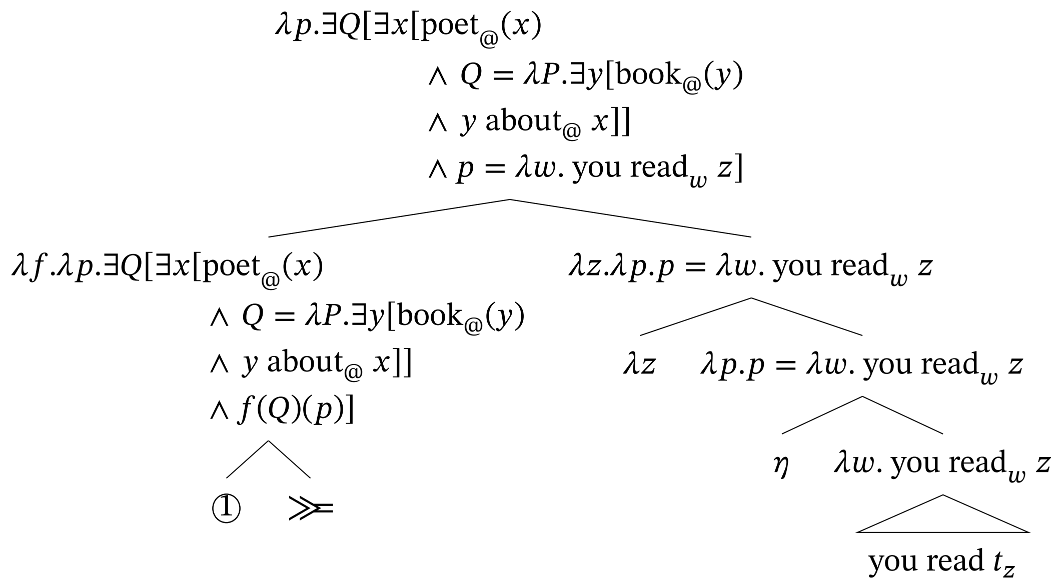
First we give the interpretation and LF of the pied-piped DP in (24). In order to derive the correct interpretation, the pied-piped *wh*-expression must combine with a $\gg\!=$ operator and move to the left-edge of the pied-piped material. Free insertion of η allows the pied-piped *wh*-expression to scope in. The result is that the pied-piped expression is itself converted into an alternative-generator, where the alternatives vary according to *poets*.

(24) [A book about which poet]



The alternative generator we have just computed from the pied-piped material, indicated here as ①, now *itself* combines with a $\gg\!=$ operator and scopes into the question.

(25) A book about which poet did you read?



3.4 The *wh*-triangle

The logical machinery introduced here is naturally sufficiently powerful to interpret pied-piping of an embedded clause, or even an island such a relative clause, via the same procedure of first scoping the pied-piped *wh*-expression to the edge of the pied-piped material.[8]

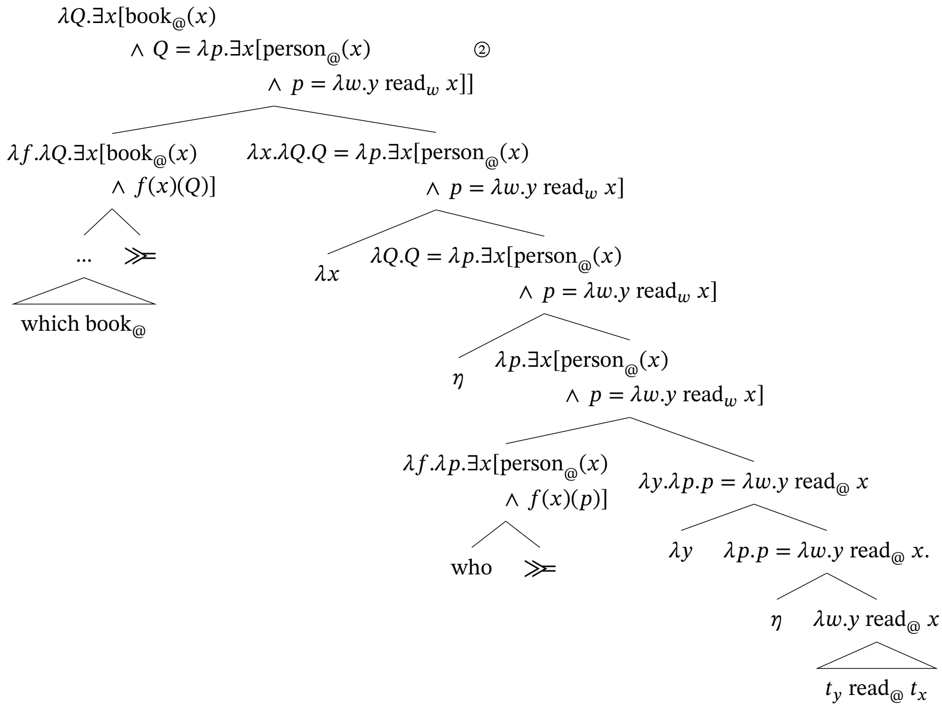
Allowing for the possibility of covert pied-piping, we can account for both SP and PL readings across finite clause boundaries and even islands without violating constraints on locality. In order to illustrate, we show how a PL interpretation across a *wh*-island may be derived (Dayal's 1996 *wh*-triangle configuration).

(26) Which librarian knows who read which book?

First, the pied-piped material:

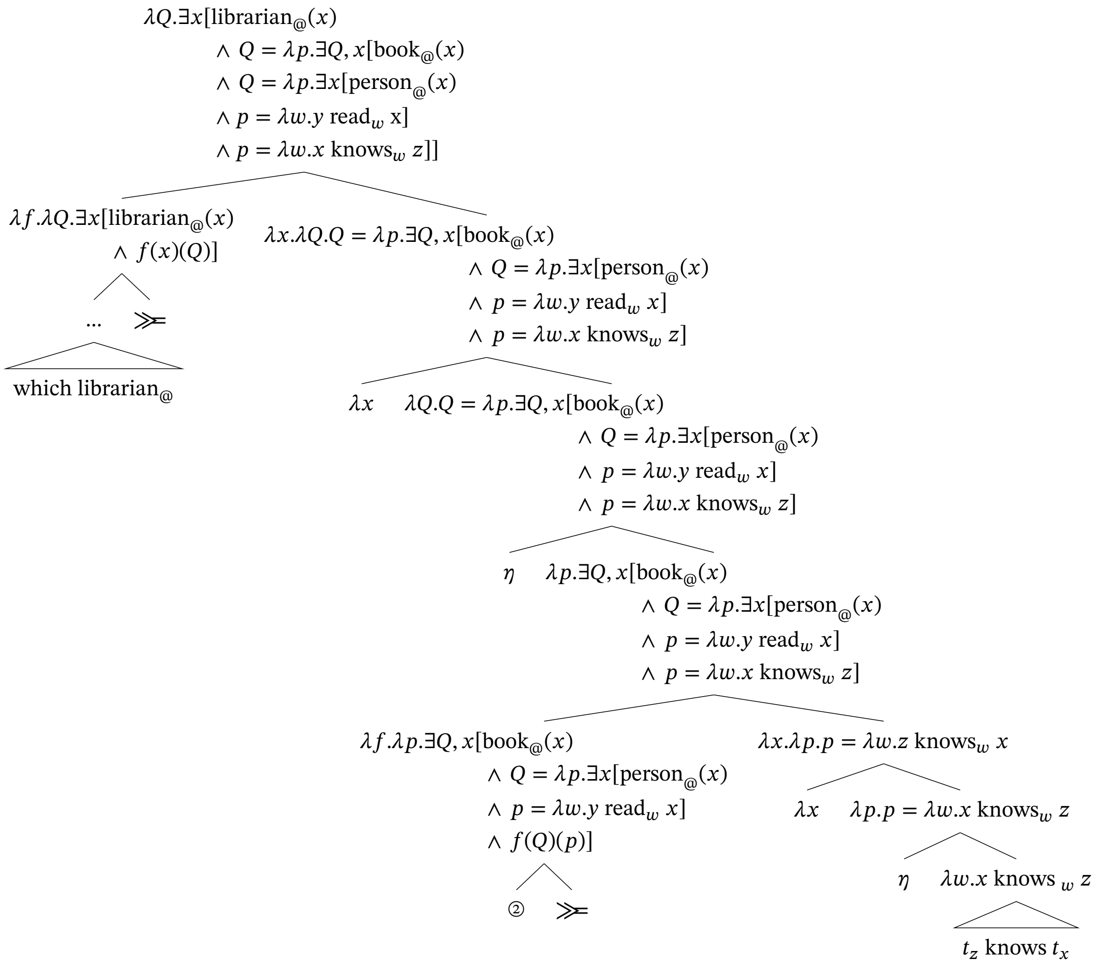
[8] Since the quantificational force of *wh* is factored out into ≫=, this approach to the semantics of pied-piping, like other ≫=-based approaches, avoids von Stechow's (1996) objection to pied-piping of islands, at LF (see, e.g., Nishigauchi 1990). The objection was premised upon the (at the time, standard) assumption that *wh*-expressions themselves are quantificational expressions. It was pointed out that, even were island pied-piping available in the grammar, there must be a subsequent movement step that scopes out the contained *wh*-expression at LF, in order for the resulting structure to be interpretable. The Q-based account is not vulnerable to this suggestion, since it is not *wh*-expressions that take scope *per se*, but rather QPs.

(27)



The pied-piped *wh*-island denotes a set of questions of the form "who read x?", where x is a book. Now the pied-piped island, which we label in the tree below as ②, itself acts as an alternative generator, combining with $\gg=$ and scoping into the question.

(28)



4 Nested *which*-phrases

The core focus of this paper will be nested *which*-phrases. I use this term to refer to a complex *which*-phrase with another, *in-situ which*-phrase nested inside of it. As a notational convenience, I shall refer to the complex *which*-phrase as the *wh*-container, and the *which*-phrase nested inside of it as the *wh*-containee, as illustrated in (29). Consider the following example adapted from von Stechow (1996).

(29) $\overbrace{\text{[Which mountain in } \underbrace{\text{[which country]}}_{wh\text{-containee}}\text{]}}^{wh\text{-container}}$

(30) Which mountain in which country did you climb?

a. #The Dom.

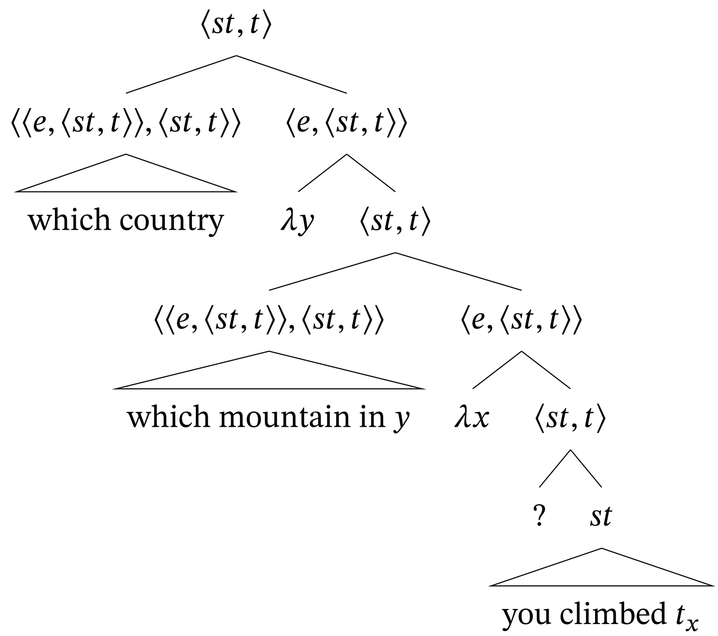
b. The Dom, which is in Switzerland.

(31) a. $\lambda p \,.\, \exists x, y \begin{bmatrix} \text{mountain}_{@}(x) \\ \wedge\ \text{country}_{@}(y) \\ \wedge\ x \text{ in}_{@}\ y \\ \wedge\ p = \lambda w \,.\, \text{ you climbed}_{w}\ x \end{bmatrix}$

b. $\lambda p \,.\, \exists x \begin{bmatrix} \text{mountain}_{@}(x) \\ \wedge\ p = \lambda w \,.\, \text{ you climbed}_{w}\ x \end{bmatrix}$

Following von Stechow (1996), we can observe that the meaning in (31a), which is exactly what we would expect given a standard covert movement approach to *wh-in-situ*, is completely equivalent to the meaning in (31b), since every mountain is in a country. We therefore incorrectly predict that (30a) and (30b) should be equally good as answers to (30). To make this problem concrete, I give below the covert movement LF for (30), interpreted as (31a)

(32)



4.1 Sternefeld's (2001) analysis

Sternefeld (2001) observes that the same problem occurs for an approach to the semantics of *wh-in-situ* couched in the Alternative Semantics framework. The details are not relevant, since Sternefeld's solution to this problem generalizes to other frameworks. Sternefeld's proposal is as follows: the PP *in which country* is an appositive adjunct to the *wh*-expression *which mountain*, and furthermore, it is interpreted within the question nucleus, resulting in the following meaning for the question in (30).[9]

(33) $$\lambda p \,.\, \exists x, y \begin{bmatrix} \text{mountain}_x \\ \wedge\ \text{country}_{@}(y) \\ \wedge\ p = \lambda w \,.\, \text{you climbed}_w\ x \text{ and } x \text{ in } y \end{bmatrix}$$

4.2 Sauerland & Heck's (2005) analysis

Sauerland & Heck (2005) show that this solution cannot be fully general on the basis of examples such as the following:[10]

(34) Which relative of which child attended the potluck?

a. #Heidi

b. Nick's mother.

Since *relative* is a relational noun, it is not feasible to treat the PP *of which child* as an appositive modifier which receives a conjunctive interpretation in the Logical Form. Sauerland & Heck (2005) suggest that we can capture the same kind of intuition as Sternefeld (2001) by adopting the copy theory of movement, according to which the restrictor of a *wh*-expression is interpreted in its base position. Concretely, the LF for (34) is assumed to be as in (35).

(35) [Which relative of which child] ? [which relative of which child] attended the potluck

Since the structures generated via the copy theory of movement are not straightforwardly interpretable, a number of authors have suggested an algorithm dubbed *Trace Conversion*. See e.g., Sauerland 1998, Fox 2002, and Fox & Johnson 2016.

[9] Need to make a decision here about whether *in* is interpreted *de re* or *de dicto*. What hinges on this?

[10] In Sauerland & Heck's actual example, (34) is assumed to receive a Pair-List interpretation. The Single Pair reading however is sufficient in order to make the same point, and the reasons for not discussing putative Pair-List interpretations at this stage shall become obvious.

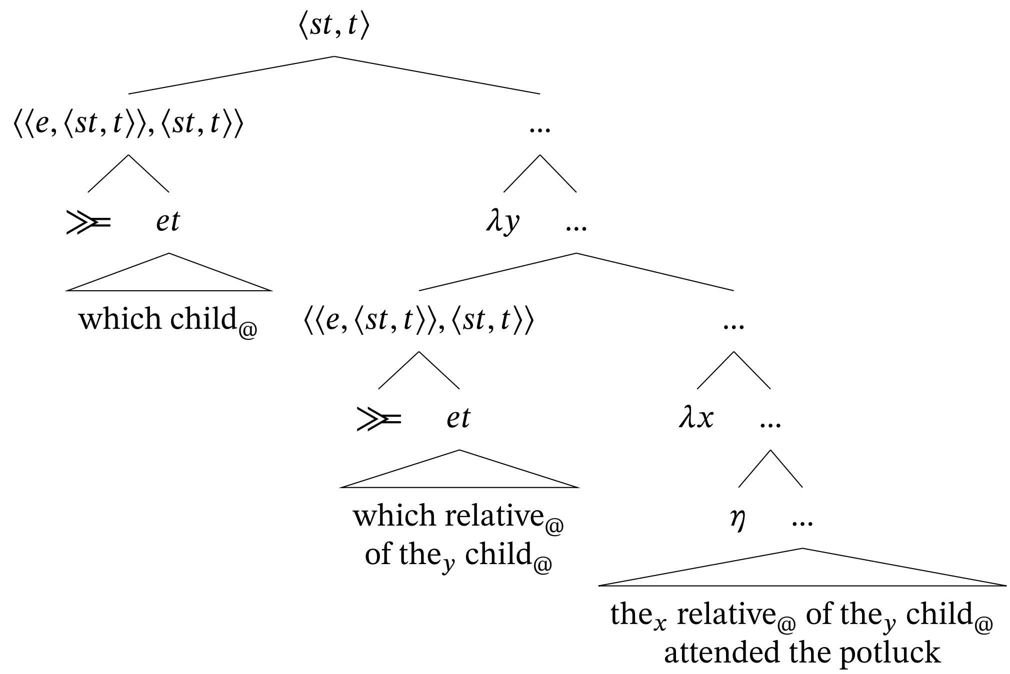
(36) Trace Conversion for QPs (Fox 2002, Moulton 2015)[11]

a. $\gg\!=$ removal: $[\ \mathrm{Q}\ [\ \alpha\ ]]_1 \rightsquigarrow [\ \alpha\ ]_1$

b. Index interpretation: $[\ \alpha\ ]_1 \rightsquigarrow [\ 1 : \alpha(1)\ ]$

(37) $[\![[\ 1 : \alpha(1)]]\!]^g = \mathrm{g}(1)$ iff $[\![\alpha]\!]^g(\mathrm{g}(1)) = 1$; undefined otherwise

(38) Which relative of which child attended the potluck?



The result of composing the LF in (38) is (the characteristic function of) a set of partial propositions. If, in @, John and Mary are Harry's only relatives, and Bill is Susan's only relative, this will be the set in (39).

(39)
$$\left\{ \begin{array}{r} \lambda w : \text{child}_{@}(\text{Harry}) \wedge \text{Harry is related to}_{@} \text{ John.} \\ \text{Harry attended the pot luck in } w, \\ \lambda w : \text{child}_{@}(\text{Harry}) \wedge \text{Mary is related to}_{@} \text{ John.} \\ \text{Harry attended the pot luck in } w, \\ \lambda w : \text{child}_{@}(\text{Susan}) \wedge \text{Bill is related to}_{@} \text{ John.} \\ \text{Susan attended the pot luck in } w \end{array} \right\}$$

[11]See Fox & Johnson (2016) for a uniform approach to interpreting copies resulting from *wh*-movement, and those resulting from Quantifier Raising.

Dayal's answerhood operator now accurately predicts that *Harry* should be infelicitous as a *complete* answer to (34), as Sauerland & Heck (2005) point out.

Note that Sauerland's principle explicitly gets the single pair reading only.

I need to elaborate on exactly how this works. Does applying Dayal's answerhood operator pointwise get the right results for the Pl reading? I'm actually not quite sure.

4.3 Restrictions on the pair-list interpretation

I need to talk here about whether or not its possible to derive the putative trapped list reading.

4.3.1 Islands

Dayal (1996) uses the term *wh-triangle* to refer to cases where a PL reading obtains across a *wh*-island.

(40) a. Which store assistant knows who bought which item of clothing.

b. JOHN knows who bought THE DRESS, BILL knows who bought THE GLOVES, etc.

Dayal (2002) in fact claims that PL readings are generally unavailable when the *in-situ wh*-expression is contained inside of an island, giving the following datapoint as an example (from Dayal 2002: p. 512).

(41) a. Which linguist will be offended if we invited which philosopher?

b. Professor Smith will be offended if we invite Professor Brown.

c. # Professor Smith will be offended if we invite Professor Brown, and Professor King will be offended if we invite Professor Matthews.

Discuss Mitcho and Hadas' work here showing that PL readings are available across islands.

Kotek & Erlewine (2016)

4.3.2 Nested *which*-phrases

So far so good. So far we have only considered the putative single-pair reading of nested *which*-questions. Strikingly, nested *which*-questions lack a Pair-List reading.[12] In order to probe the availability of the PL reading, I shall use embeddability under *list verbs* as a diagnostic, following Kitagawa, Roehrs & Tomioka (2003) (see also Schwarz 1994).

(42) a. Tell me which relative of which child attended the pot luck.

b. *List which relative of which child attended the pot luck.

4.3.3 Trapped list readings

Cheng & Demirdache (2010) recognize the existence of so-called 'trapped' PL readings.

(43) a. Which parent thanked Mary for giving which child which toy?

b. John thanked Mary for giving Sybren a plane and Amina a train, and Terry thanked Mary for giving Zara a ball and Ilea a teddy bear.

The solution here clearly has something to do with how we fold in answerhood operators.

5 A comparison to bi-dimensional approaches

Kotek (2016), citing Elliott (2015), agrees that multiple questions involving nested *which*-phrases lack a PL reading. Kotek (2016) claims that their system outlined for interpreting interrogatives derives this restriction. We show here that this is not in fact the case, and in fact nested *which*-phrases bring to light a general compositional problem for bi-dimensional approaches to the semantics of *wh*-expressions.

Kotek (2016), building on Beck 2006, proposes that interrogatives involve three core components: (i) a *wh*-expression, (ii) the interrogative complementizer C, and (iii) a question operator ALTSHIFT. Kotek assumes a two-dimensional semantics (Rooth 1985), according to which expressions of the language have an *ordinary semantic value* and a *focus semantic value*. *Wh*-expressions are defined in the focus-

[12] This was first observed in Elliott 2015.

semantic dimension, but not the ordinary-semantic dimension. The assumptions concerning the semantics of *wh*-expressions are outlined below:[13]

(44) a. $[\![\text{who}]\!]^o$ = undefined

b. $[\![\text{who}]\!]^f = \lambda x.\text{human}_@(x)$

c. $[\![\text{which student}]\!]^o$ = undefined

d. $[\![\text{which student}]\!]^f = \lambda x.\text{student}_@(x)$

Kotek (2016) assumes that the interrogative complementizer is semantically vacuous, and serves only to drive movement of a *wh*-expression to its specifier, so we ignore it for the remainder of the discussion. The ALTSHIFT operator is the source of interrogative semantics. It is defined as a type-flexible operator that returns the focus-semantic value of its sister as its output in the ordinary semantic dimension.[14]

(45) a. $[\![\textsc{AltShift}\ \alpha_\sigma]\!]^o = [\![\alpha]\!]^f$

b. $[\![\textsc{AltShift}\ \alpha_\sigma]\!]^f = \lambda a.a = [\![\textsc{AltShift}\ \alpha_\sigma]\!]^a$

In the focus-semantic dimension, composition is assumed to proceed via Pointwise Functional Application (PFA), as defined in (46):

(46) **Pointwise Functional Application (PFA)**
If $[\![\alpha]\!]^f \in D_{\langle\langle\sigma,\tau\rangle,t\rangle}$ and $[\![\beta]\!]^f \in D_{\langle\sigma,t\rangle}$, then $[\![\alpha\beta]\!]^f \in D_{\langle\tau,t\rangle}$, and
$[\![\alpha\beta]\!]^f = \lambda K \in D_\tau.\exists P, x[[\![\alpha]\!]^f(P) \wedge [\![\beta]\!]^f(x) \wedge K = P(x)]$

The LF Kotek assumes for a nested *which*-question. Kotek's system gets the composition of the nested *which*-phrase wrong.

[13] I depart from Kotek (2016) here in some minor notational respects. Focus-semantic values are given consistently as characteristic functions, rather than sets. The denotation of a nominal predicate is explicitly relativized to the actual world @.

[14] Note that this is non-compositional. Can we reformulate it using a compositional version of focus semantics.

(47)
- $[\![]\!]^o$ = undefined; $[\![]\!]^f$ = undefined
  - which
  - $[\![]\!]^o$ = undefined; $[\![]\!]^f = \lambda P.\exists x[\text{author}_@(x) \wedge P = \lambda y.\text{book}_@(y) \wedge \text{by}_@(x)(y)]$
    - $[\![]\!]^o = \lambda x.\text{book}_@(x)$; $[\![]\!]^f = \lambda P.P = \lambda x.\text{book}_@(x)$; book
    - $[\![]\!]^o$ = undefined; $[\![]\!]^f = \lambda P.\exists x[\text{author}_@(x) \wedge P = \lambda y.\text{by}_@(x)(y)]$
      - $[\![]\!]^o = \lambda y.\lambda x.\text{by}_@(x)(y)$; $[\![]\!]^f = \lambda R.R = \lambda y.\lambda x.\text{by}_@(x)(y)$; by
      - $[\![]\!]^o$ = undefined; $[\![]\!]^f = \lambda x.\text{author}_@(x)$; which author

Pointwise Functional Application (lambdified):

(48) **Pointwise Functional Application (PFA)**
If $[\![\alpha]\!]^f \in D_{\langle\langle\sigma,\tau\rangle,t\rangle}$ and $[\![\beta]\!]^f \in D_{\langle\sigma,t\rangle}$, then $[\![\alpha\beta]\!]^f \in D_{\langle\tau,t\rangle}$, and
$[\![\alpha\beta]\!]^f = \lambda K \in D_\tau.\exists P, x[[\![\alpha]\!]^f(P) \wedge [\![\beta]\!]^f(x) \wedge K = P(x)]$

There are a couple of potential responses to this, if one would like to maintain Kotek's system. One possibility is that the *in-situ wh*-expression undergoes covert movement to the edge of the nested *which*-phrase. Its trace is interpreted as a bound variable in the ordinary-semantic dimenion.

6 Uegaki

Uegaki's (2017) compositional analysis of constituent questions in Japanese is extremely similar to Kotek's (2016) analysis – the question particle *ka* is identified with Kotek's ALTSHIFT operator.

(49) a. $[\![\text{ka } \alpha_\sigma]\!]^o = [\![\alpha]\!]^f$

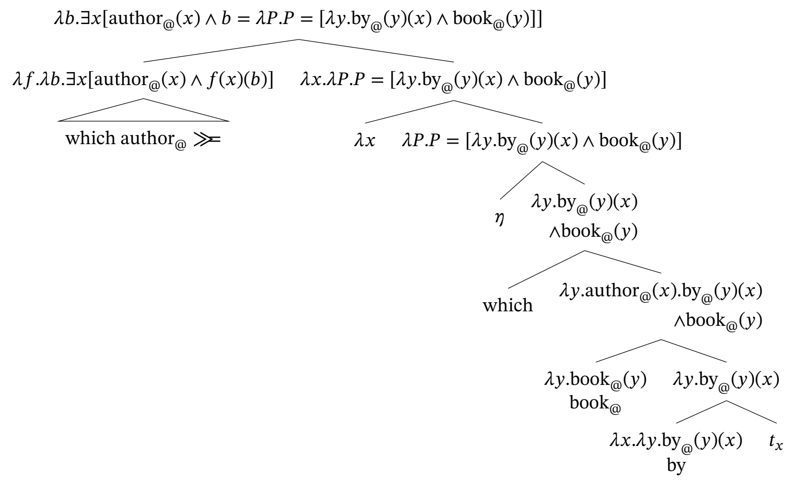
b. $[\![\text{ka } \alpha_\sigma]\!]^f = \lambda a.a = [\![\text{ka } \alpha_\sigma]\!]^a$

7 Charlow's system

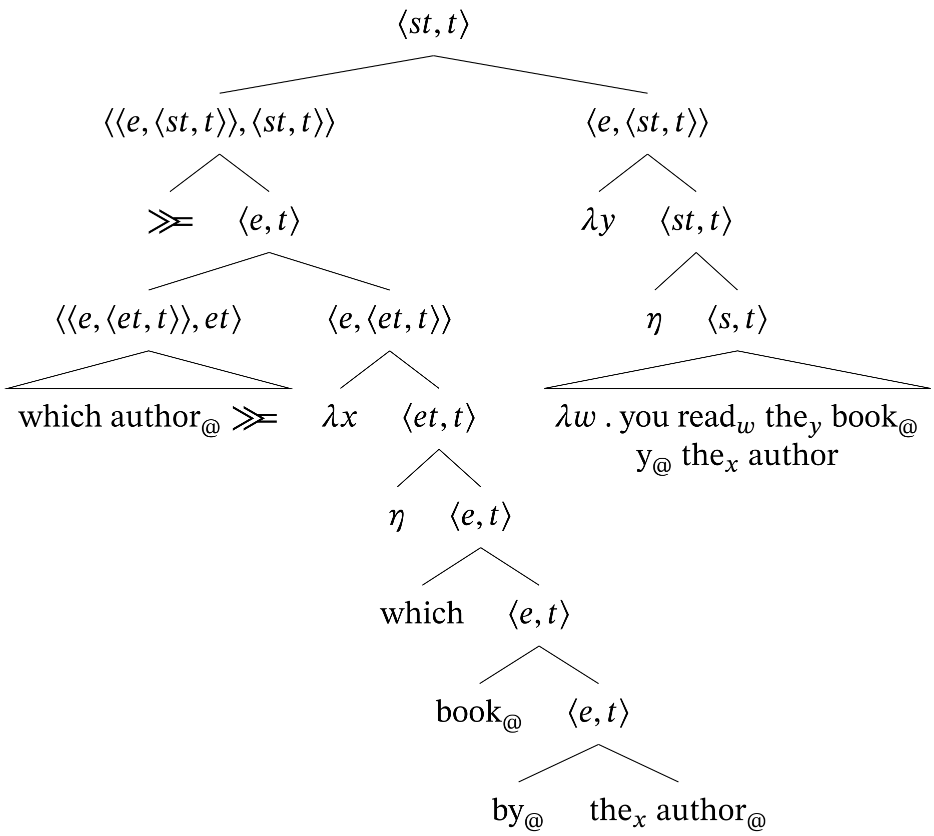
7.1 Composition of the *wh*-expression

Make sure I've projected the presuppositions properly here.

(50)


$\lambda b.\exists x[\text{author}_@(x) \wedge b = \lambda P.P = [\lambda y.\text{by}_@(y)(x) \wedge \text{book}_@(y)]]$
$\lambda f.\lambda b.\exists x[\text{author}_@(x) \wedge f(x)(b)]$
$\lambda x.\lambda P.P = [\lambda y.\text{by}_@(y)(x) \wedge \text{book}_@(y)]$
which author$_@$ $\gg=$
λx
$\lambda P.P = [\lambda y.\text{by}_@(y)(x) \wedge \text{book}_@(y)]$
η
$\lambda y.\text{by}_@(y)(x) \wedge \text{book}_@(y)$
which
$\lambda y.\text{author}_@(x).\text{by}_@(y)(x) \wedge \text{book}_@(y)$
$\lambda y.\text{book}_@(y)$
book$_@$
$\lambda y.\text{by}_@(y)(x)$
$\lambda x.\lambda y.\text{by}_@(y)(x)$
by
t_x

(51)


$\langle st, t\rangle$
$\langle\langle e, \langle st, t\rangle\rangle, \langle st, t\rangle\rangle$
$\langle e, \langle st, t\rangle\rangle$
$\gg=$
$\langle e, t\rangle$
λy
$\langle st, t\rangle$
$\langle\langle e, \langle et, t\rangle\rangle, et\rangle$
$\langle e, \langle et, t\rangle\rangle$
η
$\langle s, t\rangle$
which author$_@$ $\gg=$
λx
$\langle et, t\rangle$
λw . you read$_w$ the$_y$ book$_@$ y$_@$ the$_x$ author
η
$\langle e, t\rangle$
which
$\langle e, t\rangle$
book$_@$
$\langle e, t\rangle$
by$_@$
the$_x$ author$_@$

7.2 Charlow's system with trace conversion

This is the computation of the SP reading using Charlow's system, with the role of presuppositions and partiality made explicit.

(52) a. $[\![\text{the}_1 \text{ author}_@]\!] = g(1)$ iff $\text{author}_@(g(1))$; otherwise undefined.

b. $[\![\text{by}_@]\!] = \lambda x\,.\,\lambda y\,.\,y \text{ by}_@\ x$

c. $= \lambda y\,.\,y \text{ by}_@\ g(1)$ iff $\text{author}_@(g(1))$; otherwise undefined.

d. $[\![\ \text{book}_@]\!] = \lambda y\,.\,\text{book}_@(y)$

e. $= \lambda y\,.\,\text{book}_@(y) \wedge y \text{ by}_@\ g(1)$ iff $\text{author}_@(g(1))$; otherwise undefined.

f. $=\ g(2)$ iff $\text{book}_@(g(2)) \wedge g(2) \text{ by}_@\ g(1) \wedge \text{author}_@(g(1))$; otherwise undefined

g. $[\![\text{read}]\!] = \lambda y\,.\,\lambda z\,.\,z \text{ read}_w\ y$

h. $= \lambda z\,.\,z \text{ read}_w$ y iff $\text{book}_@(g(2)) \wedge g(2) \text{ by}_@\ g(1) \wedge \text{author}_@(g(1))$; otherwise undefined

i. $= \lambda p\ :\ \text{book}_@(g(2)) \wedge g(2) \text{ by}_@\ g(1) \wedge \text{author}_@(g(1))\,.\,p = \lambda w\ :\ \text{book}_@(g(2)) \wedge g(2) \text{ by}_@\ g(1) \wedge \text{author}_@(g(1))\ .\ \text{you read}_w\ g(2)$

j. $= \lambda y\ :\ \text{book}_@(y) \wedge y \text{ by}_@\ g(1) \wedge \text{author}_@(g(1))\,.\,\lambda p\,.\,p = \lambda w\ :\ \text{book}_@(y) \wedge y \text{ by}_@\ g(1) \wedge \text{author}_@(g(1))\ .\ \text{you read}_w\ y$

(53) a. $[\![\text{the}_3 \text{ author}_@]\!] = g(3)$ iff $\text{author}_@(g(3))$; otherwise undefined.

b. $= \lambda y\,.\,\text{book}_@(y) \wedge y \text{ by}_@\ g(3)$ iff $\text{author}_@(g(3))$; otherwise undefined.

c. $= \lambda P\ :\ \text{author}_@(g(3))\,.\,P = \lambda y\ :\ \text{author}_@(g(3))\text{book}_@(y) \wedge y \text{ by}_@\ g(3)$

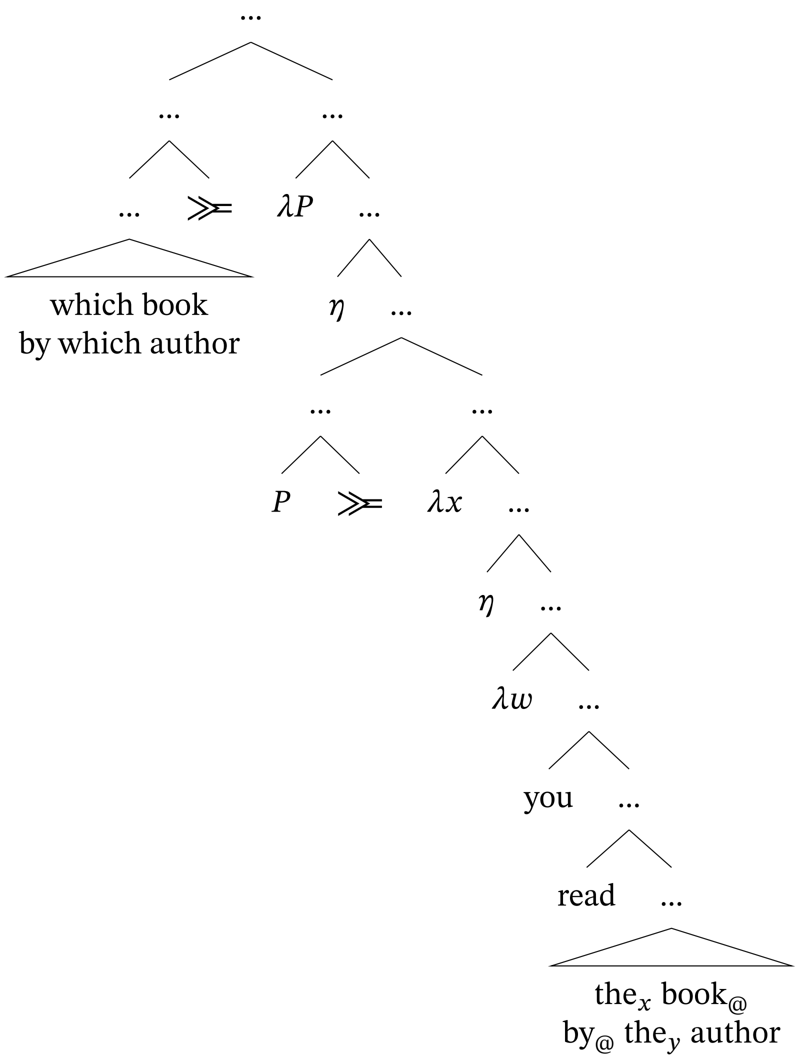
d. $= \lambda x\ :\ \text{author}_@(x)\,.\,\lambda P\,.\,P = \lambda y\ :\ \text{author}_@(x)\text{book}_@(y) \wedge y \text{ by}_@\ x$

(54) $[\![\text{which author}_@ \ggg\!=]\!] = \lambda f\,.\,\lambda b\,.\,\exists x[\text{author}_@(x) \wedge f(x)(b)]$

OK!!! This seems to get exactly the right result.

7.3 Charlow's system PL

(55)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read
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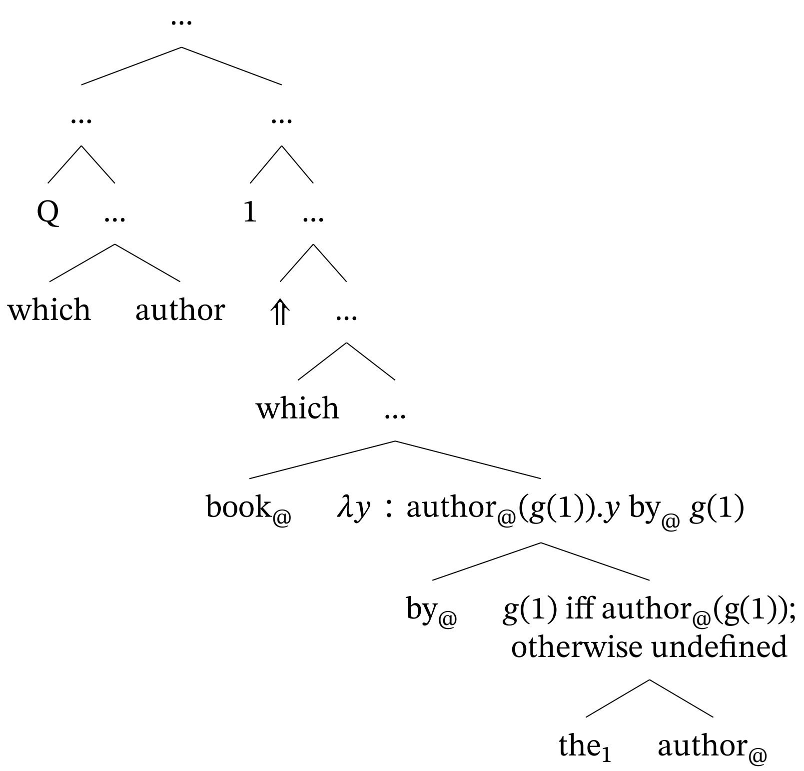
the$_x$ book$_@$
by$_@$ the$_y$ author

(56)



Sort out Sauerland and Heck bib entry.

Note that Sauerland & Heck's pragmatic principles an answer to a question must uniquely identify one element of the question denotation follows directly from Dayal's answerhood operator and Dayal's maximal informativity presupposition.

Address Yasu's point about restrictions on de re and de dicto readings in this particular configuration.

8 Fox 2017

8.1 Bulgarian

Fox (2017), citing judgements due to Snejana Iovtcheva, reports that (57) has a SP but no PL reading, whereas (58) has both a SP and a PL reading.

(57) *Koya kniga ot koy avtor e na masa-ta*
which book by which author is on table

‘Which book by which author is on the table?’

(58) *Ot koy avtor koya kniga e na masa-ta*
by which author which book is on table

‘Which book by which author is on the table?’

9 Conclusion

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