Composing Questions

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1 Summary

Throughout the past four decades: Extensive literature on[1]

- The syntax of *wh*-questions (Ross, 1967; Perlmutter, 1971; Kuno and Robinson, 1972; Chomsky, 1977; Huang, 1982; Lasnik and Saito, 1984; É Kiss, 1986; Nishigauchi, 1986; Pesetsky, 1987; Cheng, 1991; Lasnik and Saito, 1992; Hornstein, 1995; Chomsky, 1995; Pesetsky, 2000; Richards, 2001; Cable, 2007, 2010, among many others)
- The semantics of *wh*-questions (Pope,1972; Hamblin,1973; Karttunen,1977; Groenendijk and Stokhof, 1984; Engdahl, 1986; Comorovski, 1989; Dayal, 1996; Hagstrom, 1998; Reinhart, 1998; Kratzer and Shimoyama, 2002; Dayal, 2002; Shimoyama, 2006; Cheng and Demirdache, 2010; Fox, 2012; Nicolae, 2013, among many others)
- Intervention effects in *wh*-questions (Beck, 1996; Kim, 2002; Beck, 2006; Beck and Kim, 2006; Grohmann, 2006; Haida, 2007; Tomioka, 2007; Mayr, 2010, to appear; Li and Law, 2014, a.o.)

My goal: a theory of that draws on insights from all three bodies of literature.

Today:

① Background on interrogative syntax and pied-piping.

② A new semantics for questions, based on Cable's (2007) syntax for pied-piping.

- Superiority effects
- Readings of multiple questions
- Presuppositions of multiple questions
- Intervention effects

☞ Wider empirical coverage than other current theories (e.g. Cable, 2007, 2010; Cheng and Demirdache, 2010; Fox, 2012; Nicolae, 2013).

☞ Simpler than current theories.

③ A new description of *focus intervention effects* (Beck, 2006) (time permitting).

[1] These lists are non-exhaustive!

2 Background

2.1 The readings of multiple questions

- Multiple questions have *single-pair* and *pair-list* readings.

(1) *Which* student read *which* book?
  a. Single pair: *John read Moby Dick*.
  b. Pair-list: *John read Moby Dick, Mary read War & Peace, Bill read Oliver Twist*.

- The pair-list reading involves answering a set of questions. For each individual in the domain of *student*, we ask: which book did that individual read?

(2) **A set of questions based on the denotation of the higher *wh* in (1):**

$$\left\{\begin{array}{l}\text{Which book did John read?}\\ \text{Which book did Mary read?}\\ \text{Which book did Bill read?}\end{array}\right\}$$

- The meaning of a question is the set of possible answers to the question (Hamblin, 1973; Karttunen, 1977).
- We get a family of questions "sorted" by *students* (Roberts, 1996; Hagstrom, 1998; Krifka, 2001; Büring, 2003; Willis, 2008; Fox, 2012; Nicolae, 2013, a.o.) :

(3) **A family of questions denotation based on (2):**

$$\left\{\left\{\begin{array}{c}\text{John read MD}\\ \text{John read WP}\\ \text{John read OT}\end{array}\right\},\left\{\begin{array}{c}\text{Mary read MD}\\ \text{Mary read WP}\\ \text{Mary read OT}\end{array}\right\},\left\{\begin{array}{c}\text{Bill read MD}\\ \text{Bill read WP}\\ \text{Bill read OT}\end{array}\right\}\right\}$$

- For the superiority-violating question, we construct a set of questions about on the books in the domain:

(4) **A set of questions for the superiority-violating question:**
Which book did *which* student read?

$$\left\{\begin{array}{l}\text{Which student read Moby Dick?}\\ \text{Which student read War and Peace?}\\ \text{Which student read Oliver Twist?}\end{array}\right\}$$

- Now we get a family of questions sorted by *books*:

(5) **A family of questions denotation for a superiority-violating question:**

$$\left\{\left\{\begin{array}{c}\text{John read MD}\\ \text{Mary read MD}\\ \text{Bill read MD}\end{array}\right\},\left\{\begin{array}{c}\text{John read WP}\\ \text{Mary read WP}\\ \text{Bill read WP}\end{array}\right\},\left\{\begin{array}{c}\text{John read OT}\\ \text{Mary read OT}\\ \text{Bill read OT}\end{array}\right\}\right\}$$

- Note the denotations of obeying and violating questions are different in terms of the structure of the sets. This is well motivated in the literature (see in particular Dayal, 2002; Fox et al., 2010).

☞ My goal: model pair-list reading of multiple questions as nested set structures.

2.2 Q-theory and pied-piping

- I adopt Cable's (2007) syntax for *wh*-movement and pied-piping.
- Tlingit (Na-Dene; Alaska, British Columbia, Yukon) questions:

(6) **Tlingit *wh*-movement and pied-piping (Cable, 2010):**

a. [[$_{NP}$ Daa] **sá**] i éesh al'óon?
what **Q** your father he.hunts.it
'What is your father hunting?'

b. [[$_{DP}$ Daakw keitl] **sá**] asháa?
which dog **Q** it.barks
'Which dog is barking?'

c. [[$_{PP}$ Goodéi] **sá**] kkwagóot?
where.to **Q** I.will.go
'Where will I go to?'

d. [[$_{CP}$ Goodéi wugootx] **sá**] has oowajée i shagóonich?
where.to he.went **Q** they.think your parents.ERG
'Where do your parents think that he went?'

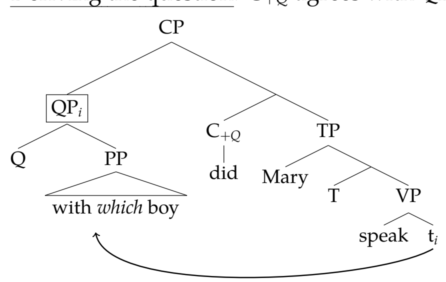
e. [[$_{NP}$ Aadóo] **sá**]$_1$ [[$_{NP}$ daa] **sá**]$_2$ [$_{TP}$ t_1 yéi oowajée [t_2 du jee yéi teeyí]]?
who **Q** what **Q** they.think their hand.at it.is.there
'Who thinks they have what?'

- *sá* is a Q(uestion)-particle. Interrogative movement in Tlingit is Q-driven.
- In all *wh*-fronting languages, *wh*-movement happens as the result of the presence of *Q-particles* in the derivation (cf. Hagstrom, 1998; Horvath, 2007, a.o.).

(7) **English:** With *which* boy did Mary speak?

a. Building a QP: Q is merged with the PP, projects QP.

b. Deriving the question: C_{+Q} agrees with QP attracts it to its specifier:



Excursion: Cable's semantics, which I am not adopting, assumes multiple C heads which are in charge of question interpretation. Some of these heads include:

(8) $[\![\text{C XP}]\!]^g = \lambda p\ [\ \exists f.\ p = [\![\text{XP}]\!]^{g(i/f)}\ ]$

(9) $[\![\text{C}_{2\ \text{i,j}}\ \text{XP}]\!]^g = \lambda p\ [\ \exists f.\ \exists h.\ p = [\![\text{XP}]\!]^{g(i/f)(j/h)}\ ]$

(10) $[\![\text{C+}_{\text{ i}}\ \text{XP}]\!]^g = \lambda p\ [\ \exists f.\ \exists h.\ p = h\ (\ [\![\text{XP}]\!]^{F\, g(i/f)}\ )\ ]$

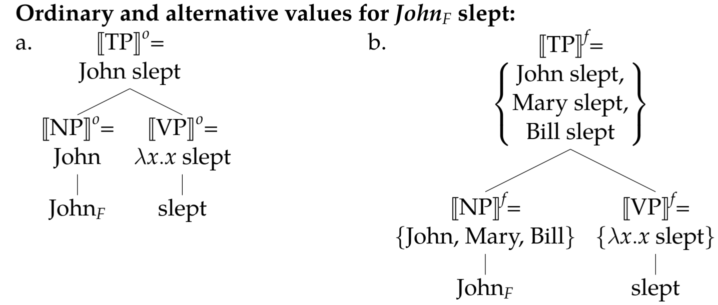
(11) $[\![\text{C}_{\text{ Q-Dlink i}}\ \text{XP}]\!]^g = \lambda p\ [\ \exists f.\ \exists h.\ p = h\ (\ [\![\text{XP}]\!]^{F\, g(i/f)}\ )\ ]$
if all the propositions in $\lambda p\ [\ \exists f.\ \exists h.\ p = h\ (\ [\![\text{XP}]\!]^{F\, g(i/f)}\ )\ ]$ are 'familiar', otherwise undefined.

2.3 Alternative semantics

(12) **Sentences are interpreted in a multi-dimentional system:**
$John_F$ slept

- Each node has an *ordinary value* $[\![\cdot]\!]^o$ and an *alternative value* $[\![\cdot]\!]^f$ (Rooth, 1985, a.o.).
- The alternative value is the set of *alternatives* for a node.
- Some *Ops* (e.g. *only*, Question operator) operate on alternative values.

(13) **Ordinary and alternative values for $John_F$ slept:**



3 Proposal

3.1 The ingredients

- Cable's syntax of Q-particles (with one modification), with a new semantics.
- The derivation of a question involves three components:
Wh-words, Q-particles, and the interrogative complementizer C_{+Q}.

☞ *Wh*-words are elements that introduce alternatives into the derivation.
They do not have an ordinary semantic value (Hamblin, 1973; Beck, 2006; Cable, 2010).

(14) **The meaning of *who* is a set of individuals:**
Ordinary value: $[\![who]\!]^o$ is undefined
Alternative value: $[\![who]\!]^f = \{x_e : x \in \text{human}\}$

(15) **The meaning of a *which*-NP phrase is the same as NP itself:**
$[\![\textit{which}\ \text{student}]\!]^f = [\![\text{student}]\!]^o = \{\ \text{Alex, Bobby, Chris, Dana...}\ \}$

☞ The interrogative complementizer, C triggers interrogative movement.

- In English, C_{+Q} has an EPP feature; one QP must be pronounced in Spec,CP.
- At LF, all Q-particles must be in Spec,CP.

(16) **The Complementizer plays no role in the semantics of the question:**
$[\![\text{C}]\!] = \lambda P_\tau.\ P$

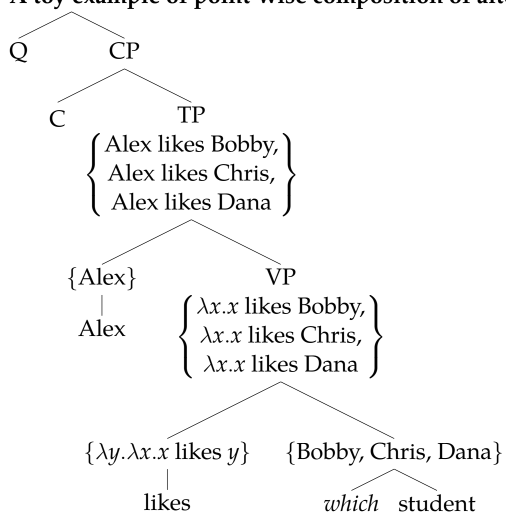
☞ Q-particles are cause pied-piping. They drive interrogative semantics.

- Q takes a set of propositions (or a set of such sets...) with an alternative value and returns it as the ordinary value of the question (cf. Shimoyama 2001; Beck and Kim 2006's semantics for C).

(17) **The semantics of the Q-particle:**
$[\![\mathrm{Q}\ \alpha_\sigma]\!]^o = [\![\alpha_\sigma]\!]^f$ $\qquad \sigma \in \{\langle st,t\rangle, \langle\langle st,t\rangle,t\rangle, ...\}$

☞ In-situ composition using alternatives: *Wh*-words that are not wrapped inside a QP will project alternatives without moving.

(18) **A toy example of point-wise composition of alternatives:**[2]



- If one element (e.g. *wh*) does not have an ordinary semantic value, this is inherited by the rest of the structure.

(19) **Principle of Interpretability (Beck, 2006; Beck and Kim, 2006):**
An LF must have an ordinary semantic interpretation.

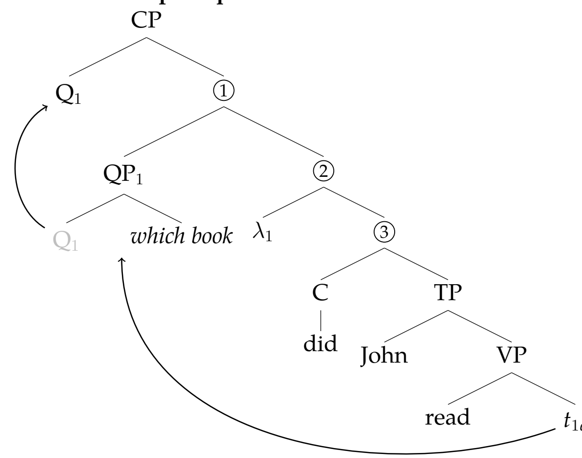
- In (18), Q takes a set of propositions that are the alternative value of CP and returns it as the ordinary value of the question.
- The question denotes a set of propositions that are the possible answers to the question (Hamblin, 1973; Karttunen, 1977).

[2]This is the kind of derivation we would want to give for a *wh*-in-situ language, e.g. Japanese.

3.2 The derivation of a simplex question

- Construct one QP, move it to Spec,CP.
- QP movement satisfies C's EPP feature.

(20) **The LF of a simplex question:**[3]



- Detailed derivations in an appendix!
- Important to note:
  a. After QP movement, Q must move out of QP to resolve a type-mismatch.
  b. $[\![③]\!]^f$ = { λw. John read x in w }.
  c. $[\![①]\!]^f$ = {λw. John read x in w : $x \in$ *book*}.
  d. Node ① does not have an ordinary semantic value.
  e. Q_1 takes $[\![①]\!]^f$ and returns it as the ordinary value of the question.

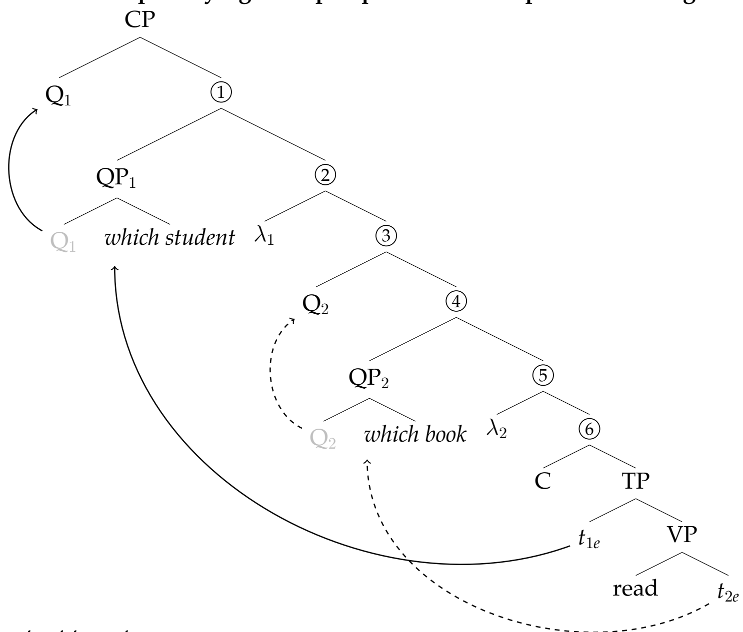
(21) **A set of possible answers to the question:**
{ John read MD, John read WP, John read OT }

[3]I assume, but do not show here and in other LFs, successive-cyclic of QP through phase edges, A-movement of the *v*P internal subject, head movement of the verb, etc.
[3]To simplify the notation, I represent assignment dependent elements in the denotation using unbound variables.

3.3 The pair-list reading of a superiority-obeying multiple question

- Construct two QPs.
- Attract closest (Rizzi, 1990; Chomsky, 1995, 2000): QP_1 moves first, QP_2 then attracted to lower Spec,CP, tucks in below QP_1 (Richards, 1997).[4]

(22) **The LF of a sup.-obeying multiple question with a pair-list reading:**



- Important to note:
  a. No ordinary value at node ④.
  b. $[\![③]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : y \in book\}$.
  c. Point-wise compose *student* with ②, to create a nested structure:
     $[\![①]\!]^f = \{\{\lambda w.\ x \text{ read } y \text{ in } w : y \in book\} :\ x \in student\}$
  d. Q_1 returns this into the ordinary meaning of the question.

☞ A family of questions denotation sorted by the higher *wh*—here, *student*.

(23) **A family of questions denotation yields a pair-list reading:**

$$\left\{ \begin{Bmatrix} \text{John read MD} \\ \text{John read WP} \\ \text{John read OT} \end{Bmatrix}, \begin{Bmatrix} \text{Mary read MD} \\ \text{Mary read WP} \\ \text{Mary read OT} \end{Bmatrix}, \begin{Bmatrix} \text{Bill read MD} \\ \text{Bill read WP} \\ \text{Bill read OT} \end{Bmatrix} \right\}$$

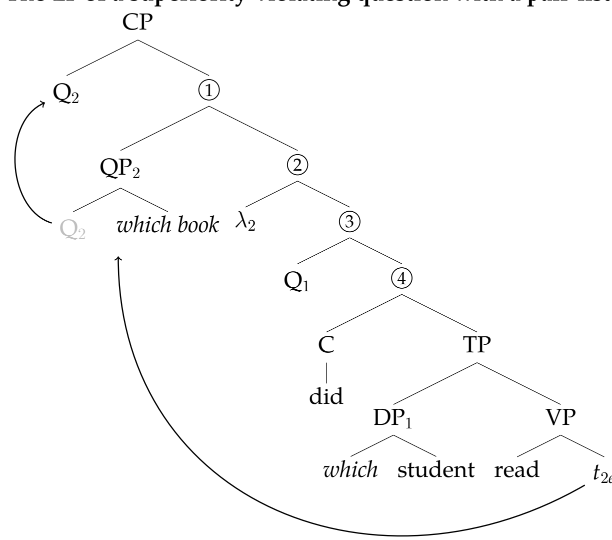
[4]Additional arguments for this architecture in Pesetsky (2000); Beck (2006); Cable (2007, 2010); Kotek (2014b).

3.4 The pair-list reading of a superiority-violating multiple question

- Construct only one QP, on lower wh_2. Move QP_2 to Spec,CP.
- Base-generate Q_1 below moved position of QP_2.

☞ This is different from Cable's original proposal.
For Cable, whether Q projects a QP or is merged onto the spine is a language-level parameter.
For me, it can happen within the same language.

(24) **The LF of a superiority-violating question with a pair-list reading:**



- Important to note:
  a. No ordinary value at node ④, TP.
  b. $[\![③]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\}$.
  c. Point-wise compose *book* with ②, to create a nested structure:
     $[\![①]\!]^f = \{\{\lambda w.\ x \text{ read } y \text{ in } w : x \in student\} :\ y \in book\}$
  d. Q_2 returns this into the ordinary meaning of the question.

☞ A family of questions denotation sorter by the higher *wh*—here, *book*.

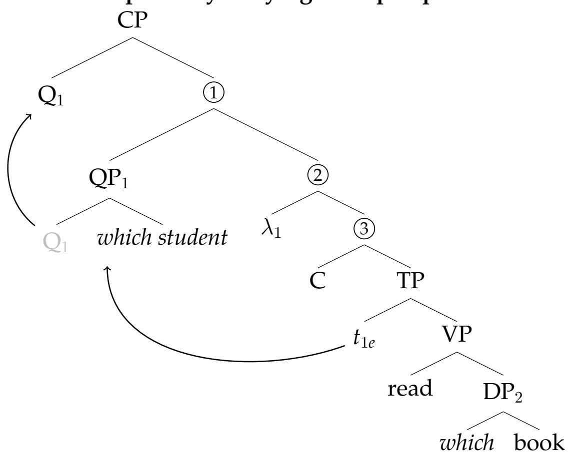
(25) **A family of questions denotation yields a pair-list reading:**

$$\left\{ \begin{Bmatrix} \text{John read MD} \\ \text{Mary read MD} \\ \text{Bill read MD} \end{Bmatrix}, \begin{Bmatrix} \text{John read WP} \\ \text{Mary read WP} \\ \text{Bill read WP} \end{Bmatrix}, \begin{Bmatrix} \text{John read OT} \\ \text{Mary read OT} \\ \text{Bill read OT} \end{Bmatrix} \right\}$$

3.5 The single-pair reading of a multiple question

- Single-pair readings arise whenever all Q-particles occur above all *wh*-phrases.
- **Option 1:** Build just one QP; move QP to C. Use Q to interpret the question.[5]

(26) **The LF of a superiority-obeying multiple question with one QP:**



- Important to note:
  a. $[\![③]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : y \in book\}$.
  b. This set composes with the set of students:
  $[\![①]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : y \in book, x \in student\}$.

- The resulting meaning is a 'flat' set of propositions, corresponding to the possible answers to the question.

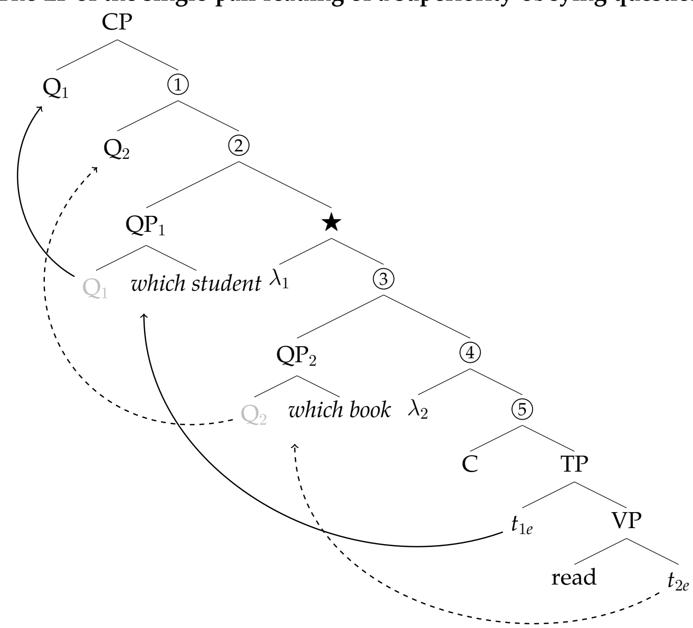
(27) **A single-pair reading is modeled as a 'flat' set of propositions:**

$$\left\{ \begin{array}{l} \text{John read MD, John read WP, John read OT, Mary read MD,} \\ \text{Mary read WP, Mary read OT, Bill read MD, Bill read WP, Bill read OT} \end{array} \right\}$$

- **Option 2:** Minimally alter the LF in (22) so that Q_2 moves above QP_1.[6]
- This derivation begins as (22) did, up to node ③.

[5]This is also how we'll derive the single-pair reading of a superiority-violating question.
[6]This option is only possible for a superiority-obeying question.

(28) **The LF of the single-pair reading of a superiority-obeying question:**



- Crucial difference in node ★. Before: Q-particle resets meaning to ordinary value. Now: continue point-wise composing focus-alternatives.
  a. $[\![③]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : y \in book\}$.
  b. $[\![②]\!]^f = \{\lambda w.\ x \text{ read } y \text{ in } w : y \in book, x \in student\}$.

(29) **A single-pair reading is modeled as a 'flat' set of propositions:**[7]

$$\left\{ \left\{ \begin{array}{l} \text{John read MD, John read WP, John read OT, Mary read MD,} \\ \text{Mary read WP, Mary read OT, Bill read MD, Bill read WP, Bill read OT} \end{array} \right\} \right\}$$

3.6 Summary

- Cable's Q-based syntax for *wh*-movement and pied-piping.
- A simple semantics for *wh*-elements, Q-particles, and C.
- Single-pair and pair-list readings derived from minimally different structures.
- Presuppositions of the question correctly modeled, see Kotek (2014a).
- The theory combines with Beck's (2006) theory of intervention; below I show a new characterization of the phenomenon that my proposal makes possible.

[7]Despite the extra layer of brackets, this yields the exact same result as (27) above.

4 The intervention effects generalization

The common wisdom: Intervention effects happen when an *intervener* occurs between an in-situ *wh*-phrase and the interrogative complementizer.

- This is most easily seen in *wh*-in-situ languages.
  - (30a) shows an intervention effect with the quantifier 'no one.'
  - Intervention is avoided if *wh* is scrambled above the quantifier, (30b).

(30) **Japanese** (Data from Tomioka 2007)

a. ?* **Daremo** *nani-o* yom-ana-katta-no?
anyone what-acc read-neg-past-Q

b. ✓ *Nani-o* **daremo** ___ yom-ana-katta-no?
what-acc anyone read-neg-past-Q
'What did no one read?'

- We also see intervention effects in *wh*-movement languages.
  - Here we must look at multiple *wh*-questions.
  - Intervention avoided by scrambling in-situ *wh* above the intervener.[8]

(31) **German** (Data from Beck 1996)

a. ?? Wer hat **niemanden** *wo* angetroffen?
who has nobody where met

b. ✓ Wer hat *wo* **niemanden** ___ angetroffen?
who has where nobody met
'Who didn't meet anybody where'?

- Other interveners include: *(almost) every, at most n, never, no one, (very) few, always, often, only, even, also*.
- Beck (2006): In-situ *wh*-phrases are sensitive to intervention effects.

(32) **The intervention configuration:**

a. * [$_{CP}$ C ... **intervener** ... *wh*]

b. ✓ [$_{CP}$ C ... *wh* **intervener** ... t]

- Pesetsky (2000): Intervention effects affect English superiority-violating questions but not superiority-obeying questions.[9]

(33) **Intervention effects in English questions (Pesetsky, 2000):**

a. ✓ *Which* student **didn't** ___ read *which* book? — obeying

b. * *Which* book **didn't** *which* student read ___? — violating

(34) a. ✓ *Which* book did **only Mary** give ___ to *which* student? — obeying

b. * *Which* student did **only Mary** give *which* book to ___? — violating

(35) **In a Q-based system:**

a. ✓ [$_{QP}$ *Which* student] **didn't** ___ read [$_{QP}$ *which* book]? — obeying

b. * [$_{QP}$ *Which* book] Q **didn't** *which* student read ___? — violating

- Sauerland and Heck (2003); Cable (2007, 2010); Kotek and Erlewine (to appear): intervention effects also happen inside (overt and covert) QPs:

(36) **Intervention effect in English overt pied-piping (Cable, 2007):**

a. ? [$_{QP}$ A picture of *which* president] does Jim own ___?

b. * [$_{QP}$ **No** pictures of *which* president] does Jim own ___?

(37) **Intervention effect in English covert pied-piping (Kotek&Erlewine, t.a):**

a. ✓ [$_{QP}$ *Which* student] **didn't** read [$_{QP}$ a book from *which* library]?

b. * [$_{QP}$ *Which* student] read [$_{QP}$ **no** book from *which* library]?

- Previously: Intervention happens between C and *wh* AND between Q and *wh* (Cable, 2007, 2010).

☞ Kotek (2014a): A unified description of intervention-effect configurations.

(38) **Configuration of an intervention effect:**
* [Q ... **intervener** ... *wh* ...]

- Intervention happens in the region between Q and *wh*.
  - Inside QPs.
  - Above in-situ *wh* in superiority-violating question.
  - QP can normally move above an intervener and escape intervention.
  - But intervention re-emerges if we restrict QP movement in some way.[10]

[8] Pesetsky (2000); Cable (2007, 2010); Kotek (2014a) model all German questions as being derived from structures that were assigned to superiority-violating questions in English. This can be achieved by assuming that (a) there can only be one Q per derivation in German (Cable, 2007, 2010), or (b) C can only host one QP in German (Pesetsky, 2000).

[9] I argue at length in my dissertation that this characterization is too simplistic, and in fact intervention arises whenever covert movement is restricted, and is avoided whenever it is possible. This can be teased apart from superiority.

[10] This could be the topic of a whole new presentation. Ask me about it if you're curious.

5 Conclusions

① A new proposal for interrogative syntax-semantics.
Achieves better empirical coverage than existing theories.

- Adopts **Cable's (2007, 2010) Q-theory syntax** with one modification.
- **A well-motivated syntax** for simplex and multiple questions.
- **A simple semantics** for *wh*-elements, Q-particles, and C.
- **Single-pair and pair-list readings** derived from minimally different LFs.
- Superiority, presuppositions of the question are modeled.
- Combines with existing theory of intervention effects.

② A new description of *focus intervention effects* (Beck, 2006).

- **Intervention effects occur between the Q particle and *wh*.**
- **Unified account** of intervention in matrix questions and inside pied-piping constituents.

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Appendix: Derivations of question meanings

The derivation of a simplex question, (20):

(39) a. $[\![\mathrm{TP}]\!]^o = \lambda w.$ John read x in w

b. $[\![\textcircled{3}]\!]^o = [\![\mathrm{TP}]\!] = \lambda w.$ John read x in w

c. $[\![\textcircled{2}]\!]^o =$

d. $[\![\mathrm{DP}_1]\!]^o$ is undefined
$[\![\mathrm{DP}_1]\!]^f = \{x_e : x \in \text{book}\}$

e. $[\![\textcircled{1}]\!]^o$ is undefined
$[\![\textcircled{1}]\!]^f = \{\lambda w.$ John read x in $w : x \in book\}$

f. $[\![\mathrm{CP}]\!]^o = [\![\textcircled{1}]\!]^f = \{\lambda w.$ John read x in $w : x \in book\}$
$= \lambda q_{\langle s,t\rangle} . \exists x \notin human\ [q = \lambda w.$ you read x in $w]$

(40) **A set of possible answers to the question:**
{ John read MD, John read WP, John read OT }

The derivation of the pair-list reading of a superiority-obeying question, (22):

(41) a. $[\![v\mathrm{P}]\!]^o = \lambda w.\ x$ read y in w

b. $[\![\textcircled{6}]\!]^o = \lambda y.\ \lambda w.\ x$ read y in w

c. $[\![\mathrm{DP}_2]\!]^o$ is undefined
$[\![\mathrm{DP}_2]\!]^f = \{y_e : y \in book\}$

d. $[\![\textcircled{5}]\!]^o$ is undefined
$[\![\textcircled{5}]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book\}$

e. $[\![\mathrm{TP}]\!]^o$ is undefined
$[\![\mathrm{TP}]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book\}$

f. $[\![\textcircled{4}]\!]^o = [\![\mathrm{TP}]\!]^o = \{\lambda w.\ x$ read y in $w : y \in book\}$

g. $[\![\textcircled{3}]\!]^o = [\![\textcircled{4}]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book\}$
$= \lambda q_{\langle s,t\rangle}.\ \exists y \in book\ [q = (\lambda w.\ x$ read y in $w)]$

h. $[\![\textcircled{2}]\!]^o = \lambda x.\ \lambda q_{\langle s,t\rangle}.\ \exists y \in book\ [q = (\lambda w.\ x$ read y in $w)]$

i. $[\![\mathrm{DP}_1]\!]^o$ is undefined
$[\![\mathrm{DP}_1]\!]^f = \{x_e : x \in student\}$

j. $[\![\textcircled{1}]\!]^o$ is undefined
$[\![\textcircled{1}]\!]^f = \{\{\lambda w.\ x$ read y in $w : y \in book\} :\ x \in student\}$

k. $[\![\mathrm{CP}]\!]^o = [\![\textcircled{1}]\!]^f = \{\{\lambda w.\ x$ read y in $w : y \in book\} :\ x \in student\}$
$= \lambda Q_{\langle st,t\rangle}.\exists x \in student\ [Q = \lambda q_{\langle s,t\rangle}.\exists y \in book\ [q = (\lambda w.x$ read y in $w)]]$

(42) **A family of questions denotation yields a pair-list reading:**

$$\left\{ \left\{ \begin{array}{c}\text{John read MD}\\ \text{John read WP}\\ \text{John read OT}\end{array} \right\}, \left\{ \begin{array}{c}\text{Mary read MD}\\ \text{Mary read WP}\\ \text{Mary read OT}\end{array} \right\}, \left\{ \begin{array}{c}\text{Bill read MD}\\ \text{Bill read WP}\\ \text{Bill read OT}\end{array} \right\} \right\}$$

The derivation of the pair-list reading of a superiority-violating question, (24):

(43) a. $[\![\mathrm{DP}_1]\!]^o$ is undefined
$[\![\mathrm{DP}_1]\!]^f = \{x_e : x \in student\}$

b. $[\![\mathrm{TP}]\!]^o$ is undefined
$[\![\mathrm{TP}]\!]^f = \{\lambda w.\ x$ read y in $w : x \in student\}$

c. $[\![\textcircled{4}]\!]^o = [\![\mathrm{TP}]\!]^o$ is undefined
$[\![\textcircled{4}]\!]^f = [\![\mathrm{TP}]\!]^f = \{\lambda w.\ x$ read y in $w : x \in student\}$

d. $[\![\textcircled{3}]\!]^o = [\![\textcircled{3}]\!]^f = \{\lambda w.\ x$ read y in $w : x \in student\}$
$= \lambda q_{\langle s,t\rangle}.\ \exists x \in student\ [q = (\lambda w.\ x$ read y in $w)]$

e. $[\![\textcircled{2}]\!]^o = \lambda y.\ \lambda q_{\langle s,t\rangle}.\ \exists x \in student\ [q = (\lambda w.\ x$ read y in $w)]$

f. $[\![\mathrm{DP}_2]\!]^o$ is undefined
$[\![\mathrm{DP}_2]\!]^f = \{y_e : y \in book\}$

g. $[\![\textcircled{1}]\!]^o$ is undefined
$[\![\textcircled{1}]\!]^f = \{\{\lambda w.\ x$ read y in $w : x \in student\} :\ y \in book\}$

h. $[\![\mathrm{CP}]\!]^o = [\![\textcircled{1}]\!]^f = \{\{\lambda w.\ x$ read y in $w : x \in student\} :\ y \in book\}$
$= \lambda Q_{\langle st,t\rangle} .\ \exists y \in book\ [Q = \lambda q_{\langle s,t\rangle}.\ \exists x \in student\ [q = (\lambda w.\ x$ read y in $w)]]$

(44) **A family of questions denotation yields a pair-list reading:**

$$\left\{ \left\{ \begin{array}{c}\text{John read MD}\\ \text{Mary read MD}\\ \text{Bill read MD}\end{array} \right\}, \left\{ \begin{array}{c}\text{John read WP}\\ \text{Mary read WP}\\ \text{Bill read WP}\end{array} \right\}, \left\{ \begin{array}{c}\text{John read OT}\\ \text{Mary read OT}\\ \text{Bill read OT}\end{array} \right\} \right\}$$

The derivation of the single-pair reading of a superiority-obeying question, (28):

(45) a. $[\![\mathrm{TP}]\!]^o = \lambda w.\ x$ read y in w

b. $[\![\textcircled{5}]\!]^o = [\![\mathrm{TP}]\!] = \lambda w.\ x$ read y in w

c. $[\![\textcircled{4}]\!]^o = \lambda y.\ \lambda w.\ x$ read y in w

d. $[\![\mathrm{QP}_2]\!]^o$ is undefined
$[\![\mathrm{QP}_2]\!]^f = \{y_e : y \in book\}$

e. $[\![\textcircled{3}]\!]^o$ is undefined
$[\![\textcircled{3}]\!]^f = \{\lambda w.\ x$ read y in $w : y \in book\}$

f. $[\![\mathrm{QP}_1]\!]^o$ is undefined
$[\![\mathrm{QP}_1]\!]^f = \{x_e : x \in student\}$

g. $[\![\textcircled{2}]\!]^o$ is undefined
$[\![\textcircled{2}]\!]^f = \{\lambda w.\ x$ read y in $w : x \in student, y \in book\}$

h. $[\![\textcircled{1}]\!]^o = [\![\textcircled{2}]\!]^f = \{\lambda w.\ x$ read y in $w : x \in student, y \in book\}$
$= \lambda q_{\langle s,t\rangle}.\ \exists x \in student\ \exists y \in book\ [q = (\lambda w.\ x$ read y in $w]$

i. $[\![\mathrm{CP}]\!]^o = [\![\textcircled{1}]\!]^f = \{\{\lambda w.\ x$ read y in $w : x \in student,\ y \in book\}\}$
$= \{\ \lambda q_{\langle s,t\rangle}.\ \exists x \in student\ \exists y \in book\ [q = (\lambda w.\ x$ read y in $w]\ \}$

(46) **A 'flat' set of propositions yields a single-pair reading:**

$$\left\{ \left\{ \begin{array}{l}\text{John read MD, John read WP, John read OT, Mary read MD,}\\ \text{Mary read WP, Mary read OT, Bill read MD, Bill read WP, Bill read OT}\end{array} \right\} \right\}$$