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## 1. Compositional semantics of interrogative clauses

### 1.1 Hagstrom (2003)

<u>constituent questions</u>

e.g. *Which of them called?* (matrix, "root", or "direct" version)
*which of them called* (embedded or "indirect" version[2])

assuming that *them* refers to {John, Mary, Bill}:

ANSPOSS: a set of three propositions, i.e.:
{ that John called, that Mary called, that Bill called }

ANSTRUE in the world @ (see below): a set containing two propositions, i.e.:
{ that John called, that Bill called }

ANSEXH in the world @: a proposition, i.e.:
that John and Bill called and Mary didn't call
(formally: $\lambda w.[j \text{ called in } w \;\&\; b \text{ called in } w \;\&\; \neg [m \text{ called in } w]]$ )

specification of the world @:
John called in @, Bill called in @, Mary did not call in @.

- Observe that ANSPOSS and ANSTRUE are sets of propositions, whereas ANSEXH is just a single proposition.
- Note also that ANSTRUE and ANSEXH depend on the choice of a particular evaluation world, whereas ANSPOSS does not.

Heim extends Hagstrom's ideas to polar questions and alternative questions.[1]

<u>polar questions</u> (aka "YN questions")

e.g. *Did John call?* (matrix version)
*whetherJohn called* (embedded version)

ANSPOSS: a set of two propositions, namely:
{ that John called, that John didn't call }
(more formally: $\{ [\lambda w.\ j \text{ called in } w], [\lambda w.\ \neg [j \text{ called in } w]] \}$ )

ANSTRUE in the world @: a singleton set containing one proposition, i.e.:
{ that John called }

ANSEXH in the world @: a proposition, i.e.:
that John called

[1] ANSPOSS is better known in the literature as the "Hamblin set" or "Hamblin denotation" of a question.

alternative questions

e.g. *Did John↗ call or did Mary↘ call?* (matrix version)[4]
*whetherJohn↗ called or Mary↘ called* (embedded version)

ANSPOSS: a set of two propositions, i.e.:
{ that John called, that Mary called }

ANSTRUE in the world @: a singleton set containing one proposition, i.e.:
{ that John called }

ANSEXH in the world @: a proposition, i.e.:
that John called and Mary didn't call

**1.2 An updated version of Karttunen (1977)**

In the following, The meaning of **who** is exactly the same as the meaning of **somebody** (i.e., generalized quantifiers, <et,t>).

(1) Karttunen's "proto-question" operator, syntactically a C-head:
$[\![?]\!] = \lambda p_{st}.\ \lambda q_{st}.\ p = q$ [7]

(2) lexical entries for interrogative words, e.g.:
$[\![\textbf{who}^{[WH]}]\!]^{w} = \lambda f_{et}.\ \exists x\ [x \text{ is human in } w\ \&\ f(x) = 1]$

For the example *Who did John see?* or *who John saw*, it leads to a structure like (3):

(3) **who 7[ ? John see $t_7$ ]**

- **Problem**: (3) has a problem of type mismatch preventing us from interpreting the top-most node (i.e., the semantic computation of *who* and its sister).

- **Solution**: We base-generate **?** together with another covert operator as its sister. In the course of the derivation of LF, this sister moves away and leaves behind a trace of type <s,t>. For the moment, take this moving operator to be semantically vacuous.

(4) Who did John see?
DS: **[$_C$? OP] John see who**
wh-movement:
**who 7[ [? OP] John see $t_{7_e}$ ]**
operator-movement:
LF: **OP 1[ who 7[ [? $t_{1_{st}}$] John see $t_{7_e}$ ] ]**

Accordingly the topmost application of Predicate Abstraction will yield a function from propositions (to truth-values).

(8) computation for LF (4):

$[\![1 . \textbf{who } 7 . [\textbf{? t}_1] \textbf{ John see t}_7]\!]^{w, \varnothing\, 11}$

= (by Predicate Abstraction)

$\lambda p . [\![\textbf{who } 7 . [\textbf{? t}_1] \textbf{ John see t}_7]\!]^{w, [1\to p]}$

= (by entry for **who** and lambda reduction)

$\lambda p . \exists x [ \text{ x is human in w } \& [\![7 . [\textbf{? t}_1] \textbf{ John see t}_7]\!]^{w, [1\to p]}(x) = 1 ]$

= (by Predicate Abstraction and lambda reduction)

$\lambda p . \exists x [ \text{ x is human in w } \& [\![[\textbf{? t}_1] \textbf{ John see t}_7]\!]^{w, [1\to p, 7\to x]} = 1 ]$

= (by IFA)

$\lambda p . \exists x [ \text{ x is human in w } \& [\![\textbf{? t}_1]\!]^{w, [1\to p, 7\to x]} (\lambda w' . [\![\textbf{John see t}_7]\!]^{w', [1\to p, 7\to x]}) = 1 ]$

= (by FA and dropping irrelevant superscripts)

$\lambda p . \exists x [ \text{ x is human in w } \& [\![\textbf{?}]\!] ([\![\textbf{t}_1]\!]^{[1\to p, 7\to x]}) (\lambda w' . [\![\textbf{John see t}_7]\!]^{w', [1\to p, 7\to x]}) = 1 ]$

= (by Traces rule)

$\lambda p . \exists x [ \text{ x is human in w } \& [\![\textbf{?}]\!] (p) (\lambda w' . [\![\textbf{John see t}_7]\!]^{w', [1\to p, 7\to x]}) = 1 ]$

= (by entry for ?)

$\lambda p . \exists x [ \text{ x is human in w } \& \; p = \lambda w' . [\![\textbf{John see t}_7]\!]^{w', [1\to p, 7\to x]} ]$

= (by FA, entries for **John, see**, Traces Rule)

$\lambda p . \exists x [\text{x is human in w } \& \; p = \lambda w' . \text{ John sees x in w'}]$

This characterizes a set of propositions that contains one proposition per human-in-w: the proposition that that human was seen by John. It is basically the ANSPOSS in Hagstrom's terminology.[2]

## 2. *How-many* questions

Hackl proposes that *many* is not by itself a quantificational determiner of type <et,<et,t>>. Rather it is looking for an argument which is a natural number, and only after it has been saturated with such an argument, the resulting phrase is a quantificational determiner. So the type of *many* is type <e,<et,<et,t>>> – assuming that numbers are abstract individuals of some kind, hence members of De – and its entry is as in (4).

(3) $\#(x) := \text{ the cardinality of the set } \{y: \text{y is an atomic part of x}\}$

(4) $[\![\textbf{many}]\!] = \lambda n\text{: n is a number} . \lambda f_{<e,t>} . \lambda g_{<e,t>} . \exists x [\#(x) = n \;\&\; f(x) = 1 \;\&\; g(x) = 1]$

In a *how-many* question, the argument slot that was saturated by *that* or *three* is instead occupied by the wh-word *how*. In Karttunen's theory, this will be an existential quantifier, basically equivalent to *some number*.

[2] Heim also spells out the computation of polar questions and alternative questions. Given the limited space, those interested readers are referred to Heim's lecture notes for more details.

(8) $[\![\textbf{how}]\!] = \lambda f_{<e,t>}.\ \exists n\ [n \text{ is a number } \& \ f(n) = 1]$
(type <et,t>, i.e., a generalized quantifier[25])

A syntactic derivation for the question *How many cats meowed?* is illustrated below:

(9) base-generate: (a) $[_C$ **? OP**] [**how many cats meowed**]
operator movement: (b) **OP 5**[ [**?** $\mathbf{t_5}$] [**how many cats meowed**] ]
overt movement to Spec of C: (c) **OP 5**[**how many cats 1**[[**?** $\mathbf{t_5}$] $\mathbf{t_1}$ **meowed**] ]
covert movement of **how**: (d) **OP 5**[**how 2**[$\mathbf{t_2}$ **many cats 1**[[**?** $\mathbf{t_5}$] $\mathbf{t_1}$ **meowed**] ] ]

According to Heim, (9d) has the denotation in (11). However, since the underlined part is a tautology, we finally get the denotation in (12):[3]

(11) $\{p: \exists x\ [\ \underline{\exists n[n \text{ is a number } \& \ \#(x) = n]}\ \&\ [\![\textbf{cats}]\!]^{@}(x) = 1\ \&\ p = \lambda w.[\![\textbf{meow}]\!]^{w}(x)]\ \}$

(12) $\{p: \exists x\ [\ [\![\textbf{cats}]\!]^{@}(x) = 1\ \&\ p = \lambda w.[\![\textbf{meow}]\!]^{w}(x)]\ \}$

- **Problem**: This is precisely the meaning we would have derived for the question *Which cats meowed?*

- Solution: In (9d), we had two phrases that are scoped above **?**, namely **how** and $\mathbf{t_2}$ **many cats**. According to the WH-licensing Principle, (9d) is filtered out by the Wh-Licensing principle as syntactically ill-formed. In order to satisfy the Wh-Licensing Principle, ***reconstruction*** must apply to the phrase [$\mathbf{t_2}$ **many cats**] (though not, of course, to **how**).

(13) At LF, a phrase α occupies a specifier position of ? if and only if α has the feature [WH].

The well-formed LF is in (14) and the interpretation of (14) is in (15).[4]

(14) **OP 5**[**how 2**[ $[_C$ **?** $\mathbf{t_5}$] $\mathbf{t_2}$ **many cats meowed** ] ]

(15) $\{p: \exists n\ [n \text{ is a number } \&\ p = \lambda w.\ \exists x\ [\#(x) = n\ \&\ [\![\textbf{cats}]\!]^{w}(x) = 1\ \&\ [\![\textbf{meow}]\!]^{w}(x) = 1]\ ]\}$

**Interim summary**

In Karttunen semantics, in order to interpret the semantics of interrogative clauses (i.e., to avoid the problem of type mismatch), wh-movement is obligatory (overt or covert), as evidenced by the semantically vacuous operator (OP) and the *wh*-word *how* in *how-many* question.

## 3. Hamblin semantics

- **Heim's point**: In Hamblin semantics, it remains neutral to the *wh*-movement.

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[3] The underlined part says that x has some number or other of atomic parts, which cannot fail to be true.

[4] Heim leaves the computation of (14) as an exercise to readers.

(2) (a) $[\![\textbf{John}]\!] = \{ \text{John} \}$
(b) $[\![\textbf{leave}]\!] = \{ [\lambda x.\ \lambda w.\ x \text{ leaves in } w] \}$
(c) $[\![\textbf{see}]\!] = \{ [\lambda x.\ \lambda y.\ \lambda w.\ y \text{ sees } x \text{ in } w] \}$
(d) $[\![\textbf{remember}]\!] =$
$\{ [\lambda p_{st}.\ \lambda x.\ \lambda w.\ \forall w'[w' \text{ is compatible with } x\text{'s memories in } w \rightarrow p(w') = 1] \}$
etc.

(4) (a) $[\![\textbf{who}]\!]^w = \{x \in D_e : x \text{ is human in } w\}$
(b) $[\![\textbf{which boy}]\!]^w = \{x \in D_e : x \text{ is a boy in } w\}$[34]

(5) (a) **who left**
$[\![\textbf{who left}]\!]^@ = \{p \in D_{st} : \exists y\ [y \text{ is human in } @\ \&\ p = [\lambda w.\ y \text{ leaves in } w]\}$
(b) **Mary saw which boy**
$[\![\textbf{Mary saw which boy}]\!]^@ =$
$\{p \in D_{st} : \exists y\ [y \text{ is a boy in } @\ \&\ p = [\lambda w.\ \text{Mary sees } y \text{ in } w]\}$

Here in the Hamblin theory, these denotations are obtained from different, in fact, simpler LFs. There is no **?**-operator in Comp, and all the *wh*-phrases are *in situ* – either never moved in the first place, or reconstructed back to their base positions.

## Karttunen theory for Japanese

### 5.1 Karttunen theory applied to Japanese interrogatives

(1) "Indeterminate" pronouns in Japanese
$[[\textbf{dare}]]^w = [[\textbf{who}]]^w = \lambda g_{<e,t>}.\ \exists x[\ x \text{ is human in } w\ \&\ g(x) = 1]$
$[[\textbf{dono}]]^w = [[\textbf{which}]]^w = \lambda f_{<e,t>}.\lambda g_{<e,t>}.\exists x[\ f(x) = 1\ \&\ g(x) = 1]$
$[[\textbf{nani}]]^w = [[\textbf{what}]]^w$
etc.

- What is the Q-morpheme *ka* doing? Note that in Shimoyama's paper, the role of *ka* is left open.

- Two possibilities

(2) (a) $[[\textbf{ka}]] = [[\textbf{?}]] = \lambda p_{<s,t>}.\ \lambda q_{<s,t>}.\ p = q$
(b) $[[\textbf{ka}]] = [[\textbf{ANSEXH}]] = \lambda Q_{<st,t>}.\lambda w'.\forall p[Q(p) = 1 \rightarrow p(w) = p(w')]$

- Also, let's assume WH-Licensing principle is cross-linguistically universal

(3) At LF, a phrase α occupies a specifier position of ? if and only if α has the feature [WH]

### 5.2 Karttunen theory extended to universal *mo*-constructions

(i) dare –mo-ga odotta
who MO NOM danced
"Everyone danced."

(ii) [*dono* gakusei-no hahaoya]-**mo** odotta
which student-GEN mother MO danced.
"Every student's mother danced."

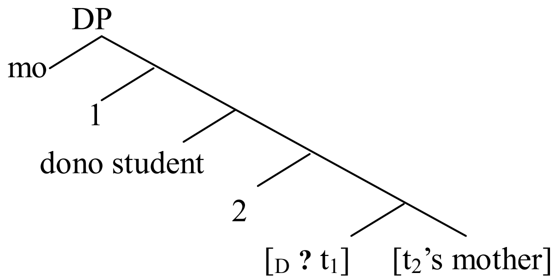
(iii) [[*dono* gakusei-ga syootaisita] sensei]-**mo** odotta
which student-NOM invited teacher MO came
"For every student x, the teacher(s) that x invited danced." (Shimoyama 2006)

- A Kartunnenean analysis of *mo*

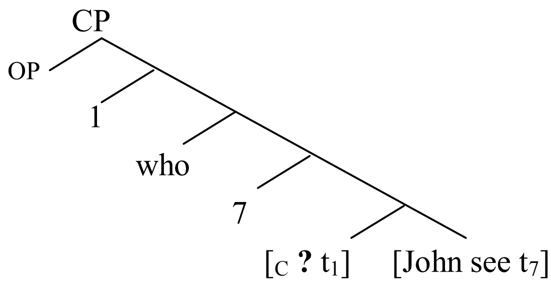
(4) **[[?]]** = $\lambda x_e.\lambda y_e.x = y$ (c.f. 2a)

(5) **[[mo]]** = **[[every]]** = $\lambda f_{<e,t>}.\lambda g_{<e,t>}.\forall x[f(x) = 1 \rightarrow g(x) = 1]$

(6) Derivation of the subject of (ii) = "dono-student' mother"




- Compare (6) to the derivation of "Who did John see?" (see (4) on page 2)




### 5.3 Descriptive summary of island facts according to Shimoyama

- "every wh-phrase must be in the spec of <u>the lowest</u> **?** or **?** that c-commands its trace. A wh-phrase cannot bind its trace across any intervening **?** or **?** head..."

(8) *…wh-phrase$_i$ [**?**/**?** … [**?**/**?**...t$_i$…]…]… = wh-island, intervention

(9) $^{OK}$...wh-phrasei [**?**/**?** … [island...t$_i$…]…]… = Complex NP/Adjunct-island