Wh-items quantify over polymorphic sets

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What we know: *Wh*-words are existential quantifiers.

Cross-linguistically, *wh*-words behave like **∃-indefinites** in non-interrogatives.

Example

(1) Yuehan haoxiang jian-le **shenme-ren**.
John perhaps meet-PERF what-person
'Perhaps John met **someone**.'

What we don't know: What do *wh*-words quantify over?

Overview

The traditional view

A *wh*-phrase existentially quantifies over the set of **individuals** denoted by the *wh*-complement. (Karttunen 1977)

(2) a. $[\![\text{which NP}]\!] = \lambda P_{\langle e,t \rangle}.\exists x \in [\![\text{NP}]\!][P(x)] = [\![\text{some NP}]\!]$

b. $\textsc{Be}([\![\text{which NP}]\!]) = [\![\text{NP}]\!]$
(Be converts an $\exists$-quantifier to its quantification domain. (Partee 1987))

Example

(3) With only two considered kids a and b, we have:

a. $\textsc{Be}([\![\text{which kid}]\!]) = [\![\text{kid}]\!] = \{a, b\}$

b. $\textsc{Be}([\![\text{which kids}]\!]) = [\![\text{kids}]\!] = \{a, b, a \oplus b\}$

My view

Some *wh*-items have a **richer** quantification domain: it contains not only **individuals**, but also **generalized quantifiers** that are conjunctions or disjunctions over these individuals.

(4) a. $[\![\text{Andy and Billy}]\!] = a \oplus b$

b. $[\![\text{Andy and Billy}]\!] = a \bar{\wedge} b = \lambda P_{\langle e,t \rangle}[P(a) \wedge P(b)]$

Generalized conjunction

(5) a. For any two items a and b of type τ:

$a \bar{\wedge} b = \lambda P_{\langle \tau,t \rangle}[P(a) \wedge P(b)]$

b. For any non-empty set α of type $\langle \tau, t \rangle$:

$\bar{\bigwedge} \alpha = \lambda P_{\langle \tau,t \rangle}.\forall x \in \alpha[P(x)]$

Generalized disjunction

(6) a. For any two items a and b of type τ:

$a \bar{\vee} b = \lambda P_{\langle \tau,t \rangle}[P(a) \vee P(b)]$

b. For any non-empty set α of type $\langle \tau, t \rangle$:

$\bar{\bigvee} \alpha = \lambda P_{\langle \tau,t \rangle}.\exists x \in \alpha[P(x)]$

Roadmap

1. Setting up the relation between questions and answers
2. Defining the *wh*-determiner
3. Deriving the individual and higher-order readings of *wh*-questions

1. *Wh*-questions and their answers

full answers vs. short answers

(7) Which boy came?

a. John came. (full answer)
b. John. (short answer)

A categorial approach of question semantics

- I define questions as **topical properties**.
- Topical properties are λ-abstracts ranging over propositions. A topical property maps a short answer to a propositional answer.

(8) Which boy came?

a. $\mathbf{P} = \lambda x[boy_{@}(x) = 1.{}^{\wedge}came(x)]$
b. $\mathbf{P}(j) = {}^{\wedge}came(j)$

$\mathrm{Dom}(\mathbf{P})$	$boy_{@}$	the set of possible short answers
$\{\mathbf{P}(\alpha) : \alpha \in \mathrm{Dom}(\mathbf{P})\}$	$\{{}^{\wedge}came(x) : x \in boy_{@}\}$	the set of possible full answers

Why pursing a categorial approach?

- The individual specified by a short answer must be in the quantification domain of the *wh*-item (Jacobson 2016):

(9) Which linguist did Mary invite?

  a. Mary invited Andy, but I don't know if Andy is a linguist.
  b. Andy, # but I don't know if Andy is a linguist.

☞ **Short answers are real answers.** The relation between questions and short answers should be captured semantically.

Other reasons (Xiang 2017):

1. Caponigro's (2003) generalization on free relatives;
2. Quantificational variability effects of questions with collective predicate.

complete answers vs. partial answers

- Usually, a complete answer specifies all the true answers.

(10) Who did Mary invite?
(*w*: *Mary only invited Andy and Billy.*)
a. Andy and Billy.\ (complete answer)
b. Andy .../ (partial answer)

- Dayal (1996): The complete answer of a question is the **strongest true** answer.

(11) $\text{Ans}_{Dayal}(Q)(w) = \iota p[w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow p \subseteq q]]$
(presupposition ignored)

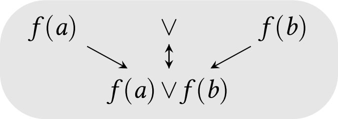
- Adapting to a categorial approach:

(12) For a question with a topical property P,
a. its complete true **short** answer:
$\iota\alpha[\alpha \in \text{Dom}(\text{P}) \wedge w \in \text{P}(\alpha) \wedge \forall\beta \in \text{Dom}(\text{P})[w \in \text{P}(\beta) \rightarrow \text{P}(\alpha) \subseteq \text{P}(\beta)]]$
b. its complete true **full** answer:
$P(\iota\alpha[\alpha \in \text{Dom}(\text{P}) \wedge w \in \text{P}(\alpha) \wedge \forall\beta \in \text{Dom}(\text{P})[w \in \text{P}(\beta) \rightarrow \text{P}(\alpha) \subseteq \text{P}(\beta)]])$

- In answering a non-modalized question, a disjunction is always incomplete.

(13) A: "Who did John invite?"
B: "Andy or Billy."

Whenever the disjunction is true, one of the disjuncts must be true, which is semantically stronger than this disjunction.



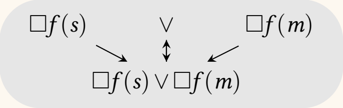
2. The meaning of the *wh*-determiner

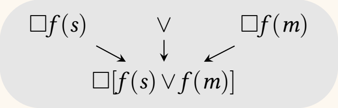
Evidence from $\Box$-questions

- Elided disjunctions can completely answer $\Box$-questions. (Spector 2007, 2008)

(14) A: "What does John have to read?"
B: "*Syntax* or *Morphology*."

or $>$ $\Box$: partial ✓
'John has to read *s* or has to read *m*. I don't know which exactly.'
$\Box$ $>$ *or*: complete ✓
'John has to read *s* or *m*. The choice is up to him.'





- Interpreting $s \bar{\vee} m$ below the $\Box$-modal yields the complete reading.

(15) a. $[\![s \text{ or } m]\!] = s \bar{\vee} m = \lambda f_{\langle e,t \rangle}[f(s) \vee f(m)]$
b. $(\lambda G_{\langle et,t \rangle}.\Box[G(\lambda x.read(j,x))])(s \bar{\vee} m) = \Box[read(j,s) \vee read(j,m)]$

☞ The quantification domain of *what* contains generalized disjunctions.

Evidence for the involvement of generalized disjunctions

Evidence from □-questions

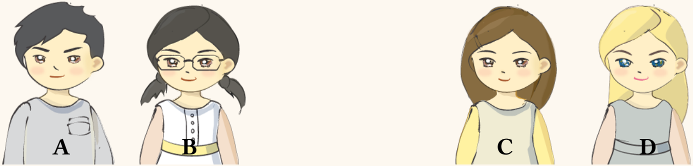
- Elided disjunctions cannot completely answer singular □-questions. (Fox 2013)

(16) A: "Which book does John have to read?"
B: "*Syntax* or *Morphology*."

or $>$ □: partial ✓
'John has to read *s* or has to read *m*. I don't know which exactly.'
□ $>$ *or*: complete ✗
'John has to read *s* or *m*. The choice is up to him.'

☞ The domain of *which book* doesn't contain generalized disjunctions.

Evidence from questions with collective predicates



- The predicate *formed a team* licenses only a collective reading.

(17) a. # The kids formed a team. collective: FALSE
b. ✓ The kids formed teams. covered: TRUE

- But (18-b) does not suffer presupposition failure.

(18) a. # John knows that the kids formed a team.
b. ✓ John knows which kids formed a team.
$\rightsquigarrow$ 'John knows $f.a.t.(a \oplus b) \wedge f.a.t.(c \oplus d)$'

☞ The domain of *which kids* contains generalized conjunctions.

(19) $[\![ab \text{ and } cd]\!] = a \oplus b \bar{\wedge} c \oplus d = \lambda f_{\langle e,t \rangle}[f(a \oplus b) \wedge f(c \oplus d)]$

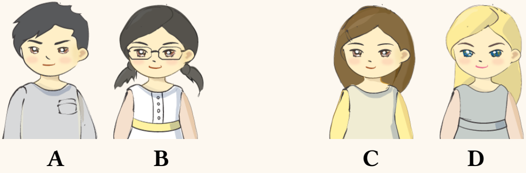
Against an alternative explanation

- Why not ascribing the conjunctive closure to something outside the question, such as a $\bigcap$-closure within the ANS-operator?

(20) $\textsc{Ans}_{\text{Heim}}(Q)(w) = \bigcap\{p : w \in p \in Q\}$ Heim (1994)

- This approach cannot capture the following contrast:

(21) a. ✓ John knows which kids formed a team.
$\rightsquigarrow$ 'John knows $f.a.t.(a \oplus b) \wedge f.a.t.(c \oplus d)$'
b. # John knows which two kids formed a team.
$\rightsquigarrow$ 'Only two of the kids formed a team.'



Evidence for the involvement of generalized conjunctions

Explaining the infelicity and uniqueness effect

A question is defined only if it has a **strongest** true answer. (Dayal 1996)

- Assuming that *which kids* quantifies over also **generalized quantifiers**:

(22) Which kids formed a team?

a. $\mathbf{P} = \lambda G_{\langle et,t\rangle}[G \text{ is a conj/disj over } {}^{*}kid.\hat{}G(\lambda x_e.f.a.t.(x))]$

b. Short: $\{\textsc{lift}(a \oplus b), \textsc{lift}(c \oplus d), a \oplus b \bar{\wedge} c \oplus d\}$

Full: $\{f.a.t.(a \oplus b), f.a.t.(c \oplus d), f.a.t.(a \oplus b) \wedge f.a.t.(c \oplus d)\}$

c. Strongest true answer: $f.a.t.(a \oplus b) \wedge f.a.t.(c \oplus d)$ ✓

- Assuming that *which two kids* quantifies over only **individuals**:

(23) Which two kids formed a team?

a. $\mathbf{P} = \lambda x_e[two\text{-}kids(x) = 1.\hat{}f.a.t.(x)]$

b. Short: $\{a \oplus b, c \oplus d\}$

Full: $\{f.a.t.(a \oplus b), f.a.t.(c \oplus d)\}$

c. Strongest true answer: not exist ✗

Generalization

1. If a *wh*-item is singular or numeral-modified, its quantification domain contains only **individuals**.
2. If a *wh*-item is plural or number-neutral, its quantification domain is **polymorphic**, it consists of not only **individuals** but also **generalized conjunctions and disjunctions** over these individuals.

My proposal

- The lexical entry of the *wh*-determiner contains a **†-operator**.

(24) a. $[\![\text{wh-}]\!] = \lambda A_{\langle e,t\rangle}\lambda P_{\langle \tau,t\rangle}.\exists \alpha_\tau \in \dagger A[P(\alpha)]$

b. $\textsc{Be}([\![\text{which NP}]\!]) = \dagger[\![\text{NP}]\!]$

- This †-operator closes a set A under conjunction and disjunction iff A itself is closed under sum:

$$\dagger A = \begin{cases} \textsc{min}\{\alpha : A \subseteq \alpha \wedge \forall \beta \neq \varnothing[\beta \subseteq \alpha \rightarrow \bar{\bigvee}\beta \in \alpha \wedge \bar{\bigwedge}\beta \in \alpha]\} & \text{if } {}^*A = A \\ A & \text{otherwise} \end{cases}$$

Example

(25) Consider only three kids *abc*, we have:

a. $\textsc{Be}([\![\text{which kid}]\!]) = \dagger[\![\text{kid}]\!] = [\![\text{kid}]\!] = \{a, b, c\}$

b. $\textsc{Be}([\![\text{which two kids}]\!]) = \dagger[\![\text{two kids}]\!] = [\![\text{two kids}]\!] = \{a \oplus b, b \oplus c, a \oplus c\}$

c. $\textsc{Be}([\![\text{which kids}]\!]) = \dagger[\![\text{kids}]\!] = \left\{ \begin{array}{l} a,\ b,\ c,\ a \oplus b,\ ...,\ a \oplus b \oplus c \\ a \bar{\wedge} b,\ a \bar{\wedge} a \oplus b,\ ... \\ a \bar{\vee} b,\ a \bar{\vee} a \oplus b,\ ... \\ (a \bar{\wedge} b) \bar{\vee} (b \bar{\wedge} c),\ ... \end{array} \right\}$

3. Deriving the readings

Composing a *wh*-question

1. The property domain can be extracted by the Be-operator:

(26) Which boy came?

a. $\mathbf{P} = \lambda x[boy_@(x) = 1.\hat{}came(x)]$

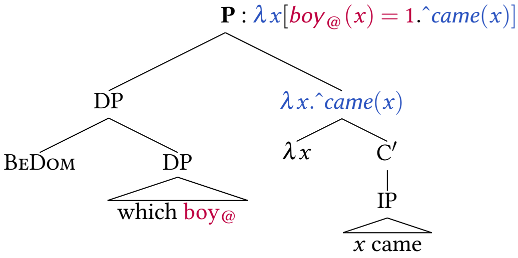
b. $\text{Be}(\llbracket \text{which boy}_@ \rrbracket) = boy_@$

2. Incorporate the property domain into **P**:

BeDom converts a *wh*-item (an ∃-quantifier) into a domain restrictor

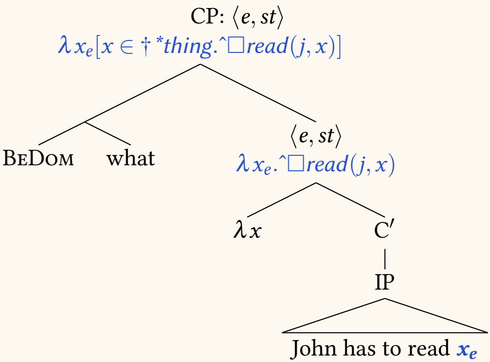
$\text{BeDom}(\mathscr{P}) = \lambda\theta_\tau.\iota P_\tau[[\text{Dom}(P) = \text{Dom}(\theta) \cap \text{Be}(\mathscr{P})] \wedge \forall\alpha \in \text{Dom}(P)[P(\alpha) = \theta(\alpha)]]$

(For any function θ, restrict the domain of θ with $\text{Be}(\mathscr{P})$.)



The semantic type of P is determined by the type of the highest *wh*-trace

(27) What does John have to read?
≈ 'What **individual item** x is s.t. John has to read x?'



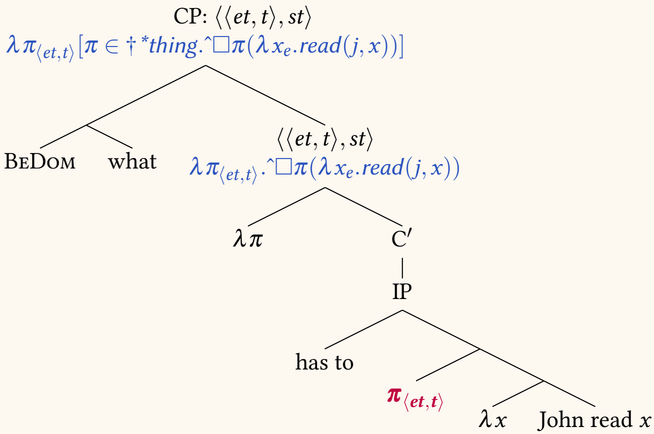
If the question takes an individual reading, a disjunctive answer has to be partial.

(28) $(s \bar{\vee} m)(\lambda x.\Box read(j,x)) = \Box read(j,s) \vee \Box read(j,m)$

Composing the higher-order readings

The semantic type of P is determined by the type of the highest *wh*-trace

(29) What does John have to read?
$\approx$ 'What **generalized quantifier π** is s.t. John has to read π?'



(30) $(\lambda\pi_{\langle et,t\rangle}[\pi \in \dagger{}^{*}thing.\hat{}\Box[\pi(\lambda x.read(j,x))]])(s \bar{\vee} m) = \Box[read(j,s) \vee read(j,m)]$

- The quantification domain of a *wh*-item:
  - If a *wh*-item is singular or numeral-modified, its quantification domain contains only **individuals**.
  - If a *wh*-item is plural or number-neutral, its quantification domain consists of not only **individuals** but also **generalized conj and disj**.
- If the quantification domain of the *wh*-item is polymorphic, the type of the topical property is determined by the semantic type of the highest *wh*-trace.

Thank you!

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