Questions are higher-order:  
Solving the dilemma between uniqueness and mention-some

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1. Introduction

• Mention-some (MS) versus mention-all (MA):
  
  – MA-questions:
    
    A complete answer to (1) has to specify all the attendants in the considered domain: “MA answers” like (Ia). If an answer is not MA, it has to be accompanied by an ignorance inference (Ib-c).

    (1) Who came to the party yesterday?  
        (w: only John and Mary came to the party.)
        a. John and Mary did. Complete (MA)
        b. John did. But I’m not sure if anyone else did. Partial
        c. JOHN did ... Partial
        L H* L-H%

  – MS-questions:
    
    The ◇-Q (2) admits “MS answers”; (2a) specifies only some gas station, but it has no ignorance mark.

    (2) Where can we get gas?  
        (w: there are only two accessible stations, A and B.)
        a. You can go to station A. MS
        b. You can go to station A or B. Disjunctive MA
        c. You can go to station A, and you can go to station B. Conjunctive MA

• Uniqueness requirement of singular-marked questions:
  
  A wh-Q expects a unique true answer once if the NP within the wh-phrase is marked as singular.

    (3) a. Which professor went to the reception? # I heard that several profs did. Singular
    b. Which professors went to the reception? I heard that several profs did. Plural
    c. Who went to the reception? I heard that many people did. Neutral

Roadmap

Section 2: The dilemma: uniqueness vs. mention-some (Dayal 1996 vs. Fox 2013)
Section 3: Deriving uniqueness via the Supremum Requirement
Section 4: Questions with a collective predicate

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2. The dilemma: uniqueness vs. mention-some

2.1. Dayal (1996)

- **Ans-D** returns the strongest true answer of \( Q \) in \( w \), which entails all the true answers of \( Q \) in \( w \).
  
  \[ \text{Ans-D}(Q)(w) = \exists p \in Q \land \forall p' \in Q \rightarrow (w \in p' \rightarrow p \subseteq p'). \]

- The presupposition of \( \text{Ans-D} \) captures the uniqueness requirement of singular-marked \( w \)-questions. Plural-terms denote atomic and sum individuals; singular-terms only range over atomic domains. (Link 1983)

- **Problem**: \( \text{Ans-D} \) cannot capture the MS readings of \( \Diamond \)-Qs grammatically.

2.2. Fox (2013: V1)

- **Ans-F** returns the set of maximally informative (MaxI) true answers of \( Q \) in \( w \). A true answer of \( Q \) is MaxI iff it isn’t asymmetrically entailed by any true propositions in \( Q \).
  
  \[ \text{Ans-F}(Q)(w) = \{ p : w \in p \land \forall p' \in Q \rightarrow (w \in p' \rightarrow p \not\subseteq p') \}. \]

- This analysis allows (i) non-exhaustive answers to be good answers;
  (ii) a question to have multiple good answers.

- **Problem**: \( \text{Ans-F} \) cannot capture the uniqueness requirement of singular-marked questions.

2.2. Fox (2013: V2)

2.2. Fox (2013: V2) uses innocently exclusive exhaustifications and higher-order disjunctive answers to predict uniqueness (details are omitted). This theory predicts that “which \( P \) fit?” has a unique true answer as long as \( P \) is not closed under join in the sense of Spector’ (2007) diagnose. While my analysis predicts that “which \( P \) fit?” requires uniqueness iff \( P \) is not closed under sum.
3. Solving the dilemma: A higher-order semantics of questions

3.1. The source of uniqueness: Supremum Requirement

- Dayal (1996) checks uniqueness based on the entailment relations among the true answers.

- I argue that uniqueness can be checked by looking at the relation between (i) the individuals named by the true answers (i.e. the short answers) and (ii) the NP within the wh-item.

(14) Let \( Q = \text{Which } P \text{ f?} \), then for any two distinct individuals \( a \) s.t. \( a \in P \) and \( b \in P \), \( f(a) \) and \( f(b) \) cannot be simultaneously true if \( a \oplus b \notin P \).

(15) a. Which boys \( d \)?
   \( \sqrt{w} : \{f(a), f(b)\} \) \( a \oplus b \in \text{*boy} \)

b. Which boy \( d \)?
   \( \times w : \{f(a), f(b)\} \) \( a \oplus b \notin \text{boy} \)

c. Which two boys \( d \)?
   \( \sim \) only two of the boys did \( f \).
   \( \times w : \{f(a \oplus b), f(b \oplus c)\} \) \( a \oplus b \oplus c \notin \text{two-boys} \)

The merits of Ans-D’s presupposition can be reached by the \( S(\text{upremum})-\text{Requirement} \) on the quantificational domain of the wh-phrase.\(^3\)

(16) **Supremum Requirement**

Let \( Q = \text{Which } P \text{ f?} \), \( D \) is a subset of \( P \) named by a set of true answers in \( w \) (i.e., all the answers in \( \{f(x) : x \in D\} \) are true in \( w \)). Then for \( Q \) being defined in \( w \), the supremum of \( D \) must be a member of \( P \) (viz. \( P(\oplus D) = 1 \)).

(17) **Supremum of D** (Link 1983)

The result of applying sum operations to the elements in \( D \):

a. If \( D = \{x\} \), then \( \oplus D = x \)

b. If \( D = \{x_1, x_2, x_3, \ldots x_n\} \), then \( \oplus D = x_1 \oplus x_2 \oplus x_3 \ldots \oplus x_n \)

3.2. Question denotation

- The H-K semantics of questions has no space to check the S-Requirement. E.g. in “Ans\{f(a), f(b)\}”, it is not obvious how Ans can retrieve the individuals \( a \) \( b \) and the extension of \( P \).

- I re-evaluate the semantics of questions:

In the LF of a question, there is a core constituent \( Q \) that denotes a family of possible answer sets. In each answer set, the value of the wh-phrase ranges over a subset \( D \) of \( P \) s.t. \( \oplus D \) is member of \( P \).

(18) **Which P d?**

\[ Q = \{\{f(x) : x \in D\} : D \subseteq P \land P(\oplus D) = 1\} \]

**H-K semantics:** \( Q = \{f(x) : x \in P\} \)

A question denotes a set of possible answers.
Each answer names a qualified individual.

**New semantics:**

A question denotes a family of possible answer sets.
Each answer set names a qualified individual set.

\(^3\)The S-Requirement is also reflected in syntax: in Italian, French, and German, the wh-determiner and its NP complement agree on numbers. (Thanks to Laurence B. Violette and Ziren Zhou for showing me the relevant data.)
3.3. The \( \mathbb{R} \)-operator.

- If \( P \) is plural or number-neutral, any of its subsets satisfies the S-Requirement. Thus \( Q \) includes all the (non-empty) subsets of the Hamblin denotation.

\[
(19) \text{ Which two boys came? (consider only two boys: } ab; \,*\text{boy} = \{a,b,a \oplus b\})
\]

\[
Q = \{(f(x) : x \in D) : D \subseteq ^*\text{boy} \land ^*\text{boy}(\oplus D) = 1\}
\]

\[
= \begin{cases} 
(f(x) : x \in \{a\}), & (f(x) : x \in \{a,b\}), \\
(f(x) : x \in \{b\}), & (f(x) : x \in \{a,a \oplus b\}), \\
(f(x) : x \in \{a \oplus b\}), & (f(x) : x \in \{b,a \oplus b\}), \\
(f(x) : x \in \{a,b,a \oplus b\}) & (f(x) : x \in \{b,a,a \oplus b\})
\end{cases}
\]

\[
= \{\alpha : \alpha \subseteq \{f(a), f(b), f(a \oplus b)\}, \alpha \neq \emptyset\}
\]

- If \( P \) is singular or numeral-modified, only singleton subsets of \( P \) satisfy the S-Requirement. Thus \( Q \) is a family of singleton sets.

\[
(20) \text{ Which boy came? (consider only two boys: } ab; \,*\text{boy} = \{a,b\})
\]

\[
Q = \{(f(x) : x \in D) : D \subseteq \text{boy} \land \text{boy}(\oplus D) = 1\}
\]

\[
= \begin{cases} 
(f(x) : x \in \{a\})
\end{cases}
\]

\[
(21) \text{ Which two boys came? (consider only three boys: } abc; \,*\text{2-boys} = \{a \oplus b, b \oplus c, a \oplus c\})
\]

\[
Q = \{(f(x) : x \in D) : D \subseteq ^*\text{2-boys} \land ^*\text{2-boys}(\oplus D) = 1\}
\]

\[
= \begin{cases} 
(f(x) : x \in \{a \oplus b\}), & (f(x) : x \in \{b \oplus c\}), \\
(f(x) : x \in \{a \oplus c\}) & (f(x) : x \in \{a \oplus c\})
\end{cases}
\]

3.3. The \( \mathbb{R} \)-operator.

- For a question being defined in \( w \), there must be an answer set in \( Q \) that consists of exactly all the true answers in \( w \). I encode this requirement within the presupposition of the response \( \mathbb{R} \)-operator.\(^4\)

\[
(22) \text{ The response } \mathbb{R} \text{-operator:}
\]

- \( \mathbb{R}(Q)(w) \) presupposes that \( Q \) includes a set \( \alpha \) s.t.

  - \( (\alpha \text{ is the maximal true answer set in } w) \)
  
  \( (= \alpha \text{ is the true answer set that is a superset of any true answer set}) \)

  \( (= \alpha \text{ includes all the true answers but no false answer}) \)

  \( (\alpha \text{ has some MaxI members.}) \)

- When defined, \( \mathbb{R}(Q)(w) \) returns the set of MaxI members of \( \alpha \).

\[
(23) \mathbb{R}(Q)(w) = \exists \alpha \in Q[\alpha = \text{MAX}(Q_w) \land \text{MaxI}(\alpha) \neq \emptyset].\text{MaxI}(\alpha[\alpha \in Q] \land \alpha = \text{MAX}(Q_w))
\]

\[
\text{a. } Q_w = \{\alpha : \alpha \in Q \land \forall p \in \alpha[p(w)]\} \quad \text{true answer sets}
\]

\[
\text{b. } \text{MAX}(Q_w) = \alpha[\alpha \in Q_w \land \forall \beta \in Q_w[\beta \subseteq \alpha]] \quad \text{maximal true answer set}
\]

\[
\text{c. } \text{MaxI}(\alpha) = \{p : p \in \alpha \land \forall q \in \alpha[q \notin p]\} \quad \text{maximally informative members}
\]

\(^4\)The condition (ii) in the presupposition of \( \mathbb{R} \) is to capture the negative island effects of degree questions (cf. Fox & Hackl 2006).
– Without ◊:

(24) Let \( w \) : among the boys, only \( ab \) came.
   a. Which boys came?
      i. \( Q_w = \{\{f(a), f(b), \}, \{f(a), f(b), f(a \oplus b)\}, \ldots, \{f(a), f(b), f(a \ominus b)\}\} \)
      ii. \( R(Q)(w) = \{f(a \ominus b)\} \)
         MA \( \sqrt{\mathbb{V}} \)
   b. Which boy came?
      i. \( Q_w = \{\{f(a)\}, \{f(b)\}\} \)
      ii. \( R(Q)(w) \) is undefined
         Presupposition failure \( \sqrt{\mathbb{V}} \)

– With ◊:

(25) Let \( w \) : the committee can be chaired by \( a \) or by \( b \); co-chair is not allowed\(^5\)
   a. Who can chair the committee?
      i. \( Q_w = \{\{\Diamond f(a), \Diamond f(b), \Diamond f(a \ominus b)\}\} \)
      ii. \( R(Q)(w) = \{\Diamond f(a), \Diamond f(b)\} \)
         MS \( \sqrt{\mathbb{V}} \)
   b. Which professor can chair the committee?
      i. \( Q_w = \{\{\Diamond f(a)\}, \{\Diamond f(b)\}\} \)
      ii. \( R(Q)(w) \) is undefined
         Presupposition failure \( \sqrt{\mathbb{V}} \)

• Predictions:

<table>
<thead>
<tr>
<th>I. A question requires uniqueness iff its ( Q ) consists of only singleton sets.</th>
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<tbody>
<tr>
<td>iff the sum of any two distinct members of ( P ) is not a member of ( P ).</td>
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<tr>
<td>II. A question admits MS iff ( R(Q)(w) ) can be non-singleton.</td>
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4. Questions with a collective predicate

4.1. The problem

• The distributional pattern of MS holds in questions with a collective predicate:

(26) requires to specify the component members of all the teams; (27) only requires to specify the component members of some possible team.

(26) Who formed a team?

(\( w \): there are only two teams, made up of two girls \( ab \) and two boys \( cd \), respectively.)
   a. The two girls \( ab \) AND the two boys \( cd \) formed a team. Complete (MA)
   b. The two girls \( ab \) formed a team. Partial

(27) Who can form a team?

(\( w \): only the two girls \( ab \) and the two boys \( cd \) can form a team, respectively.)
   a. The two girls \( ab \) AND the two boys \( cd \) can form a team. Complete (MA)
   b. The two girls \( ab \) can form a team. Complete (MS)

• The answers of (26) must be closed under conjunction. Otherwise with \( w : \{f(a \oplus b), f(c \ominus d)\} \), Dayal (1996) predicts a presupposition failure, and Fox (2013)/the present analysis predict an MS reading.

• Puzzle: how can we close the answer space of (26) under conjunction?

\(^5\)See Appendix II for counterexamples and their solutions.
4.2. Solution

- Let the nominal part be the source of the conjunctive closure. For instance, we can assume that the wh-item denotes a set of individuals and is universally quantified.

\[ [\text{ALL}] (X) = \lambda P_{<e,\mathcal{A}>} . \lambda w . \forall x \in X [P_w (x)] \]

(28) Which \( P f \)?
\[ Q = \{ [\text{ALL} (X) (f) : X \subseteq D] : D \subseteq P \wedge P^{(\oplus)} D = 1 \} \]

- When \( P \) is plural or number-neutral, \( Q \) includes a family of answer sets that are closed under conjunction.

(29) Who formed a team?

a. \( Q = \{ [\text{ALL} (X) (f) : X \subseteq D] : D \subseteq \text{person} \wedge \text{person}^{(\oplus)} D = 1 \} \)

b. \( Q_w = \left\{ \begin{array}{l}
[\text{ALL} (X) (f) : X \subseteq \{a \oplus b\}], \\
[\text{ALL} (X) (f) : X \subseteq \{c \oplus d\}], \\
[\text{ALL} (X) (f) : X \subseteq \{a \oplus b, c \oplus d\}] 
\end{array} \right\} = \left\{ \begin{array}{l}
[f(a \oplus b)] \\
[f(c \oplus d)] \\
[f(a \oplus b), f(c \oplus d), f(a \oplus b) \wedge f(c \oplus d)] 
\end{array} \right\} \]

c. \( \mathcal{R} (Q) (w) = \{ f(a \oplus b) \wedge f(c \oplus d) \} \) \quad \text{MA} \checkmark

- For a num-modified \( P \), only singleton subsets of \( P \) satisfy the S-requirement. \( Q \) denotes a family of singleton sets, simplified into \( [30] \). \( [30] \) is undefined in \( w_2 \) since no possible answer set has \( f(a \oplus b) \wedge f(c \oplus d) \).

(30) Which four students formed a team?

\[ \sqrt{w_1} : \{ \text{team 1, a} \oplus b \oplus c \oplus d \} \]
\[ \times w_2 : \{ \text{team 1, a} \oplus b, \text{team 2, c} \oplus d \} \]

a. \( Q = \{ [\text{ALL} (X) (f) : X \subseteq D] : D \subseteq 4\text{-students} \wedge 4\text{-students}^{(\oplus)} D = 1 \} \)
\[ = \{ [\text{ALL} (X) (f) : X \subseteq \{ x \} : x \in 4\text{-students}] \} \]

b. \( = \{ [f(x) : x \in 4\text{-students}] \} \)

- In the case of \( \Diamond \)-questions, the MS/MA ambiguity can be explained by the scope ambiguity of \( [\text{ALL} X] \) relative to the weak modal (à la Fox 2013 on the scope ambiguity of \( [\text{EACH} X] \), see Appendix III).

5. Conclusions

- I proposed a higher-order semantics of questions to explain two facts: (i) MS readings of \( \Diamond \)-questions and (ii) uniqueness requirements of singular-marked questions.

- A core constituent \( Q \) in the LF of a question denotes a family of possible answer sets. Each possible answer set names an individual set that satisfies Supremum Requirement. A question requires uniqueness iff its \( Q \) consists of only singleton sets.

(31) Which \( P f \)?

a. \( Q = \{ [f(x) : x \in D] : D \subseteq P \wedge P^{(\oplus)} D = 1 \} \) \quad \text{first-order form}

b. \( Q = \{ [\text{ALL} (X) (f) : X \subseteq D] : D \subseteq P \wedge P^{(\oplus)} D = 1 \} \) \quad \text{higher-order form}

- A response \( \mathcal{R} \)-operator selects out the MaxI members of the maximal true answer set in \( Q \). Each selected answer counts as a good answer. A question admits MS iff \( \mathcal{R} (Q) (w) \) can be non-singleton.
The following two denotations are semantically equivalent:

\[ Q = \{ (f(x) : x \in D \land D \subseteq P \land P(\wedge D) = 1) : D \subseteq D_c \} \]  

\( (D_c : \text{a contextually determined domain}) \)

\[ Q = \{ (f(x) : x \in D) : D \subseteq P \land P(\wedge D) = 1 \} \]

(33) Which boy came? \( (f = \text{came}) \)

**Method 1:**

(i) \( A \) is an existential generalized quantifier over individuals (of type \(<et, t>\))

(ii) \( Q \) is derived via a wh-movement to \([\text{spec, CP1}]\) and a D-movement to \([\text{spec, CP2}]\):

\[ \lambda \alpha \text{CP2} \exists D \subseteq D_c [\alpha = \{ (f(x) : x \in D \land D \subseteq \text{boy} \land \text{boy}(\wedge D) = 1) \}] \]

\[ \lambda D \text{CP1} \text{boy}(\wedge D) = 1 \land D \subseteq \text{boy} \land \exists x \in D[p = f(x)] \]

**Method 2:**

(i) A \( wh \) is an existential generalized quantifier over sets of individuals (of type \(<ett, t>\))

(ii) \( Q \) is derived via a D-movement to \([\text{Spec, CP1}]\) and a wh-movement to \([\text{Spec, CP2}]\):

\[ \lambda \alpha \text{CP2} \exists D \subseteq \text{boy}[\text{boy}(\wedge D) = 1 \land D \subseteq \text{boy} \land \alpha = \{ (f(x) : x \in D) \}] \]

\[ \lambda D \text{CP1} \exists x \in D[p = f(x)] \]
Appendix II: Local Exhaustifications

- Problem: in a $\Diamond$-Q where $\Diamond f(x)$ is monotonic w.r.t. $x$, some MS answers can be weaker than the others.

(34) Who can serve on the committee?
(w: the committee can consist of G+D or G+D+J)

a. G and D can serve. $\Diamond f(g \oplus d) \iff$ b. G, D, and J can serve. $\Diamond f(g \oplus d \oplus j)$

- Intuitively, “G and D can serve” means that the group consisting of only G+D can make up the committee. I propose that the weak modal in a $\Diamond$-question embeds an exhaustivity $O$-operator ($\approx$ only/alone) that is associated with the wh-trace.

(35) $O(p) = p \land \forall q \in Alt(p)[p \not\subseteq q \rightarrow \neg q]$

(Chierchia et al. 2013; a.o.)

The prejacent $p$ is true, and any alternative of $p$ not entailed by $p$ is false.

Local exhaustification creates a non-monotonic environment to the wh-trace, making both true MS answers MaxI.

Appendix III: Deriving the MS/MA ambiguity

- Method I: Scope ambiguity of distributivity. A $\Diamond$-question can take MS when $\Diamond > [\text{ALL } X]$.

\[\Diamond Of(a \oplus b) \land \Diamond Of(c \oplus d) \iff \Diamond Of[(a \oplus b) \land (c \oplus d)]\]

Fig. 1: MA (global distributivity)  Fig. 2: MS (local distributivity)

- Method II: Absence/Presence of the pre-exhaustification exhaustifier $O_{\text{dou}}$ (Xiang 2016). A disjunctive answer can be strengthened into an MA answer with the presence of $O_{\text{dou}}$.

(36) a. $O_{\text{dou}}(p) = p \land \forall q \in Sub(p)[\neg O(q)]$

(The prejacent is true, the exhaustification of each sub-alternative is false.)

b. $\text{Sub}(p) = Alt(p) - \text{IE-Excl}(p) - \{p\}$

(the set of alternatives excluding the IE-excludable alternatives and the prejacent itself)

References