Complete and True Attitudes held of questions

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Introduction: Exhaustivity

(1) Jenny knows who came.

- **Weakly exhaustive (WE)**
  $\forall x$ [x came $\rightarrow$ J knows x came]
- **Strongly exhaustive (SE)**
  $\forall x$ [x came $\rightarrow$ J knows x came] & $\forall x$ [x didn't come $\rightarrow$ J knows x did**n't** come]

The most prominent reading is stronger than WE and weaker than SE (Cremers & Chemla 2016). Compared with WE, it is **sensitive to false answers** (FAs).

Did ... come?	*a*	*b*	*c*	
Facts	✓	✓	✗	
Jenny's belief	✓	✓	?	☺
Mary's belief	✓	✓	✓	☹

- **Intermediately exhaustive (IE)** (Klinedinst & Rothschild 2011, a.o.)
  $\forall x$ [x came $\rightarrow$ J knows x came] & $\forall x$ [x didn't come $\rightarrow$ **not** [J bels x came]]

But, exhaustiveness doesn't apply to mention-some questions;
the IE reading is too weak in characterizing FA-sensitivity.

Introduction: Mention-all versus mention-some

Mention-all (MA) questions

Most questions admit only **exhaustive** answers. Non-exhaustive answers must be **ignorance-marked**, yielding undesired exclusive inferences otherwise.

(2) Who went to the party?
(*w: Only John and Mary went to the party.*)

a. John and Mary.\

b. John did .../ **Partial answer**
L H* L-H%

b′.#John did.\ ⇝ *Only John went to the party.*
H* L-L%

Mention-some (MS) questions: questions that admit MS answers

Basic ◇-questions admit MS answers. Crucially, while being non-exhaustive, MS answers **do not need to be ignorance-marked**.

(3) Where can we get coffee?
(*w: There are only two accessible coffee stores: A and B.*)

a. Store A.\ ⇝̸ *We can get coffee only from store A.* **MS-answer**

b. Store A and Store B.\ **Conj MA-answer**

c. Store A or Store B.\ **Disj MA-answer**

Introduction: FA-sensitivity in MS

Indirect **MS-questions** also have readings sensitive to false answers. (George 2013)

Italian newspapers are available at ...	*Newstopia?*	*PaperWorld?*
Facts	✓	✗
John's belief	✓	?
Mary's belief	✓	✓

(4) a. **John** knows where we can buy an Italian newspaper. TRUE

b. **Mary** knows where we can buy an Italian newspaper. FALSE

☞ **FA-sensitivity is independent from exhaustivity.**

Overview

Truth conditions of "Jenny knows Q"

1. Jenny knows an answer that completely addresses Q. **Completeness**
2. Jenny doesn't believe any false answers relevant to Q. **FA-sensitivity**

Goal: Provide a **uniform** analysis for indirect MS- and MA-questions.

Slogan: The mapping-relation from structure to meaning is highly principled.
For the same type of structures, the derivation of meaning is uniform.

Completeness

Core issue: Are MS-answers partial or complete?

- If they are **partial**, why MS-questions are tolerated of incomplete answers?
- If they are **complete**, how can we define Completeness and derive MS? ✓

Plan

- Lines of approaches to MS: pragmatic, post-structural, structural
- Arguments for structural approaches
- Two structural approaches: Fox (2013) and Xiang (2016)

Approaches to mention-some

Pragmatic approaches (Gr&S 1984, Ginzburg 1995, van Rooij & Schulz 2004, a.o.)

Complete answers must be exhaustive. MS answers are partial answers that are sufficient for the conversational goal behind the question.

(5) Where can we get coffee?

a. to find a place to get some coffee. MS

b. to investigate the local coffee market. MA

Post-structural approaches (Beck & Rullmann 1999, George 2011: ch 2, a.o.)

MS and MA are two independent readings, derived via different operations on question roots. However, MS/MA ambiguity can only be explained by pragmatics.

E.g. B&R (1999): A question **unambiguously** denotes the Hamblin-Karttunen intension; it takes MS iff the employed **Ans-operator** is **existential**.

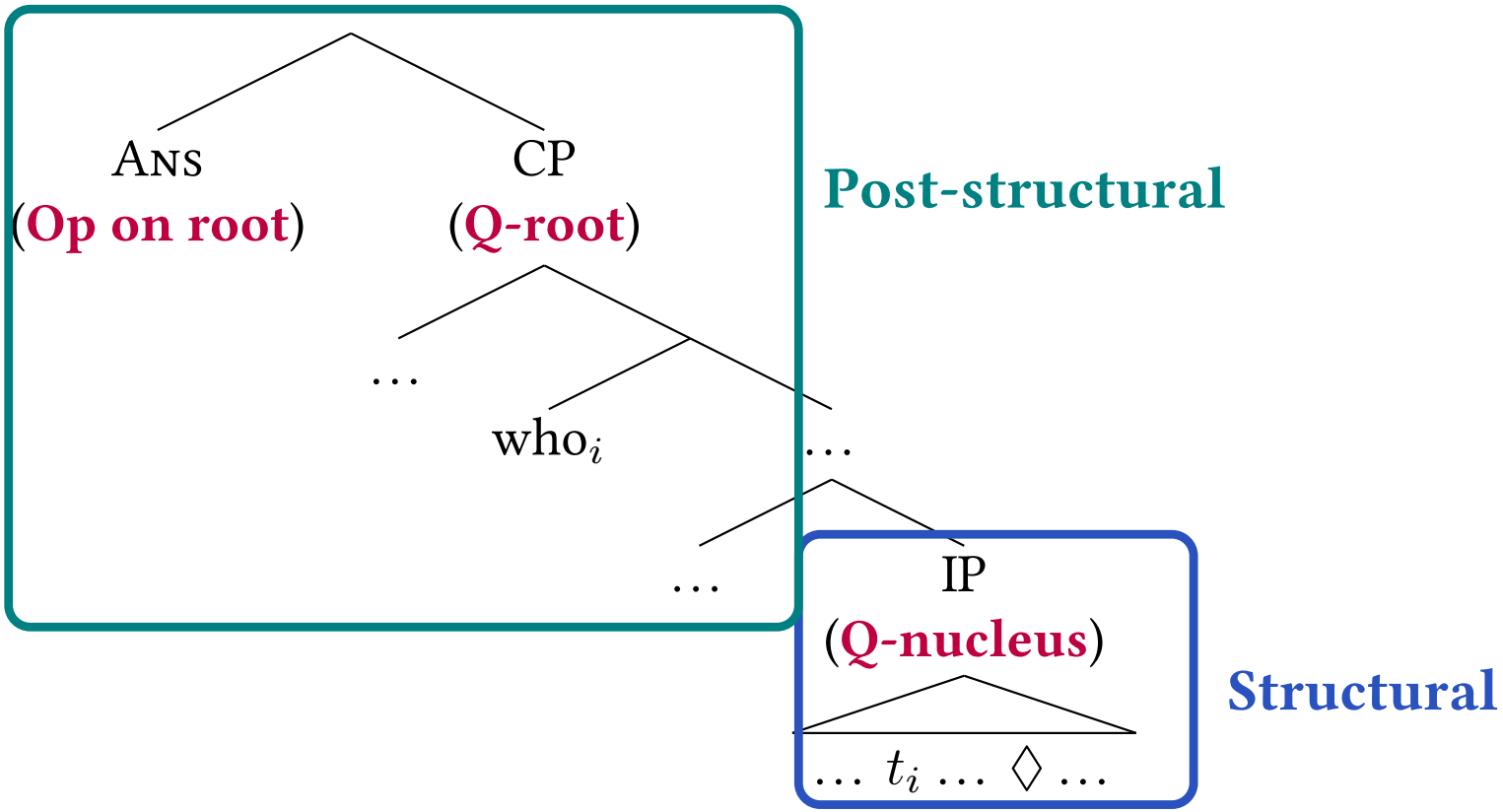
(6) a. $\textsc{Ans}_1(Q)(w) = \bigcap\{p : Q(w)(p) \wedge p(w)\}$ (for MA)

b. $\textsc{Ans}_3(Q)(w) = \lambda P_{\langle s,stt\rangle}.\exists p[P(w)(p) \wedge Q(w)(p) \wedge p(w)]$ (for MS)

Approaches to mention-some

Structural approaches (George 2011: ch. 6; Fox 2013, 2015; Xiang 2015, 2016bc)

MS/MA-answers are uniformly possible complete answers. The MS/MA ambiguity comes from minimal **structural variations** within the **question nucleus**.



Only structural approaches predict a grammatical relation between MS and ◊-modal.

Evidence for structural approaches (I)

◊-modal licenses MS-readings in various *wh*-constructions.

(7) **Free relatives** (Chierchia & Caponigro 2013)

a. Mary ate what Jenny bought.
b. John went to where he **could** get coffee.

(8) ***Wh*-conditionals in Mandarin** (Liu 2016)

a. Ni qu-guo nar, wo jiu qu nar.
you go-EXP where, I JIU go where
Intended: 'I will go to **every** place where you have been to.'
b. Nar **neng** mai-dao kafei, wo jiu qu nar.
where can buy-reach coffee, I JIU go where
Intended: 'I will go to **one** of the places where I can buy coffee.'

Evidence for structural approaches (II)

Mention-some = mention-one: Each MS answer specifies only one option.

1. In answering a **matrix** MS-question, **mention-few answers** are interpreted exhaustively if not ignorance-marked.

(9) Where can we get coffee in the food court?

a.	Starbucks.\	$\not\rightsquigarrow$ *Only at Starbucks.*	MS
b.	Starbucks and Peet's.\	$\rightsquigarrow$ *Only at Starbucks and Peet's.*	MF
c.	Starbucks or Peet's.\	$\rightsquigarrow$ *Only at Starbucks and Peet's.*	MF

Compare: partial answers of matrix MA-questions can be mention-few.

(10) Who is in your committee, for example?

a.	Andy.	$\not\rightsquigarrow$ *Only Andy is in my committee.*
b.	Andy and Billy.	$\not\rightsquigarrow$ *Only Andy and Billy are in my committee.*

Evidence for structural approaches (II)

2. **Indirect** MS-questions cannot take non-exhaustive mention-few readings, even if mention-few answers suffice for the conversational goal.

(11) (Context: *The dean wants to meet with 3 eligible committee chair candidates.*)

Jenny knows who can chair the committee.

✓ $\exists x$ [x can chair $\wedge$ J knows that x can chair] MS

✓ $\forall x$ [x can chair $\rightarrow$ J knows that x can chair] MA

✗ $\exists xyz$ [xyz each can chair $\wedge$ J knows that xyz each can chair] MF

A sample truth value judgment task (p.c. with Seth Cable):

Scenario

Norvin says to us, "On my exam, you'll have to name ... multiple *wh*-fronting."

1. ... **one** language that has ... [TRUE]
2. ... **all** the languages that have ... [?TRUE]
3. ... **three** languages that have ... [FALSE]

Test sentence

Norvin said that we'll have to know where we can find multiple *wh*-fronting.

Evidence for structural approaches (III)

Experimental evidence With the same conversational goal, presence of ◊-modal significantly increases the acceptance of MS. (Xiang & Cremers 2017)

Scenario: Mary is in charge of choosing two children to lead the dance. The only rule is that the children leading the dance should have an accessory in common.

How children are dressed:

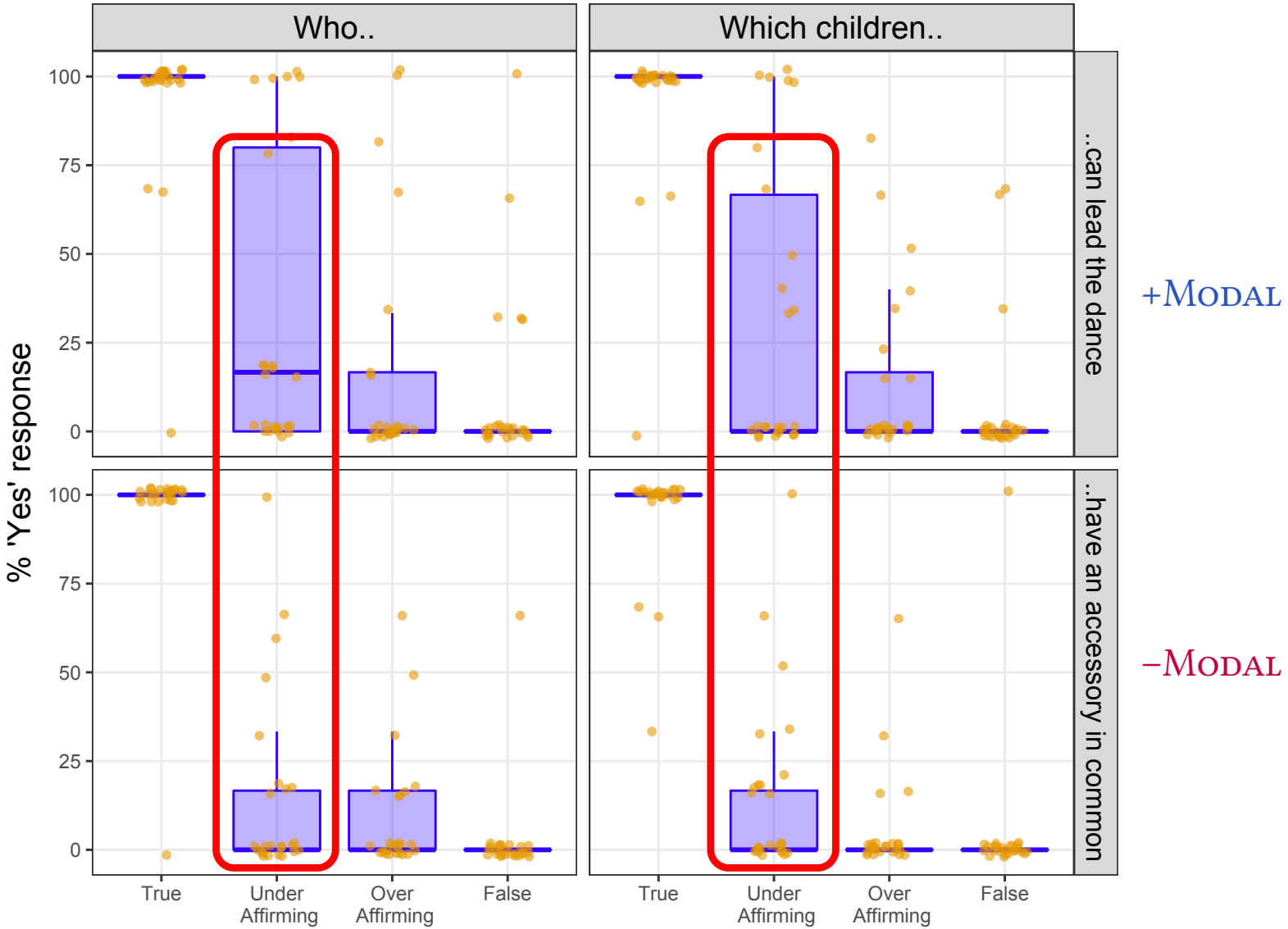
Ann Bill Chloe Diana

Mary's memory:
Bill and Chloe wear the same bow tie, Chloe wears a hat.
Therefore, Bill and Chloe can lead the dance.

Sentences: ±D-LINKED ±MODAL

Mary remembers { who / which children } { can lead the dance / have accessaries in common }

Evidence for structural approaches (III)



Mixed effects logit model on UA(=MS) targets reported a significant effect of Modal.

☞ MS is more readily available with the presence of ◊-modal.

Summarizing the evidence

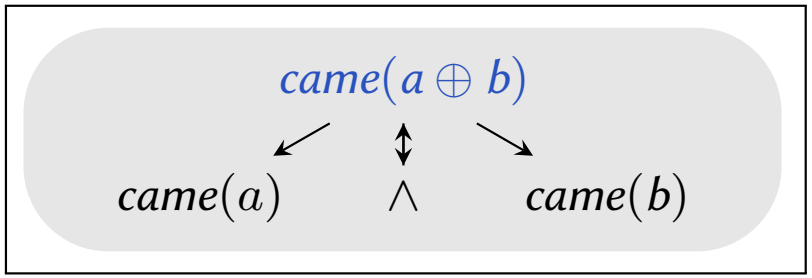
1. $\Diamond$-modal licenses MS in various *wh*-constructions.
2. Mention-some = mention-one
3. Significant effect of $\Diamond$-modal in licensing MS

☞ There must be some grammatical relation between MS and $\Diamond$-modal.

☞ Structural approaches ✓

Fox (2013): Weakening completeness

(12) Who came?
(w: *Only Andy and Billy came.*)



Completeness = Strongestness

Dayal (1996): Only the **strongest** true answer (i.e., the unique true answer that entails all the true answers) completely answers a question.

(13) $\textsc{Ans}_{Dayal}(Q)(w) = \iota p[w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow p \subseteq q]]$

This view is advantageous in several respects but leaves no space for MS.

Completeness = Max-informativity

Fox (2013): Any true answer that is **max-informative** (i.e., not asymmetrically entailed by any true answers) is complete.

(14) $\textsc{Ans}_{Fox}(Q)(w) = \{p : w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow q \not\subset p]\}$

- ☞ A question takes MS iff it can have **multiple** max-inf true answers.
- ☞ A question takes MA if its answer space is **closed under conjunction**.

Fox (2013): Predicting MS/MA ambiguity

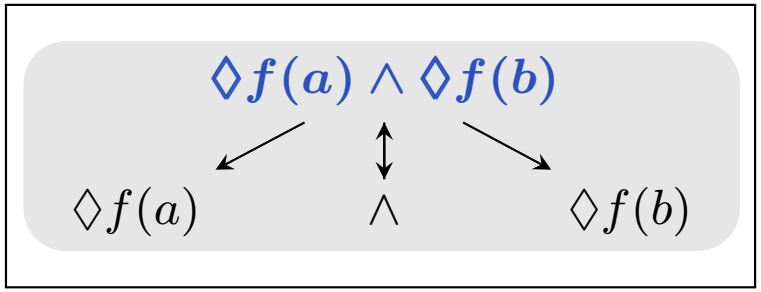
The *wh*-trace has a covert phrase mate EACH. In $\Diamond$-questions, the MS/MA ambiguity is from the **scope ambiguity of distributivity** relative to the $\Diamond$-modal.

- **Global** distributivity: Q is closed under conjunction, yielding **MA**.
- **Local** distributivity: Q can have multiple max-inf true answers, yielding **MS**.

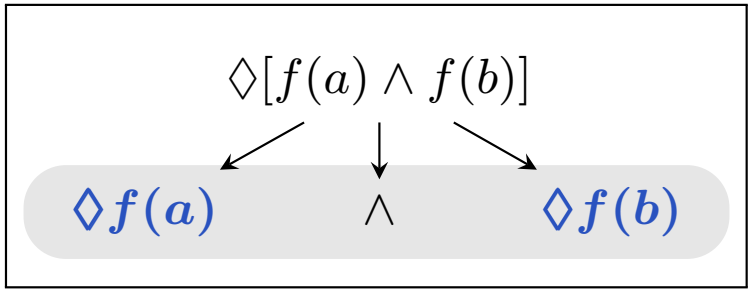
(15) Who can chair the committee?
(*w: Only Andy and Billy can chair the committee; single-chair only.*)

a. $Q = \{\textsc{Each}(X)(\lambda x.\Diamond \mathit{chair}(x)) : X \in \mathit{hmn}_{@}\}$

b. $Q = \{\Diamond\textsc{Each}(X)(\lambda x.\mathit{chair}(x)) : X \in \mathit{hmn}_{@}\}$



$[X$ EACH$] \gg \Diamond$: MA



$\Diamond \gg [X$ EACH$]$: MS

Problems with Fox (2013)

Problem 1: It under-generates MS answers.

(16) Who can serve on the committee?
(w: *The committee can be made up of g+j or g+j+d.*)

a. Gennaro and Jim.\ $\Diamond[serve(g) \wedge serve(j)]$

$\Uparrow$

b. Gennaro, Jim, and Danny.\ $\Diamond[serve(g) \wedge serve(j) \wedge serve(d)]$

Solution to P1: local exhaustification

The $\Diamond$-modal embeds an **exhaustifier** ($\approx$ *only*) associated with the *wh*-trace.

(17) $\boldsymbol{O}(p) = \lambda w[p(w) = 1 \wedge \forall q \in \mathcal{A}lt(p)[p \not\subseteq q \rightarrow q(w) = 0]]$
(p is true, any alternative of p that is not entailed by p is false.)

This exhaustifier provides a **non-monotonic** environment w.r.t. the *wh*-trace, preventing (16a) from being entailed by (16b):

$$\Diamond\boldsymbol{O}[serve(g) \wedge serve(j)] \not\Leftarrow \Diamond\boldsymbol{O}[serve(g) \wedge serve(j) \wedge serve(d)]$$

Problems with Fox (2013)

Problem 2: Each cannot be used in questions with a collective predicate.

Who can form a team? exhibits MS/MA ambiguity, although *form a team* licenses only a collective reading.

A **B** **C** **D**

(18) a. ✓ The kids **formed teams**. [covered: True]
b. # The kids **formed a team**. [collective: False]

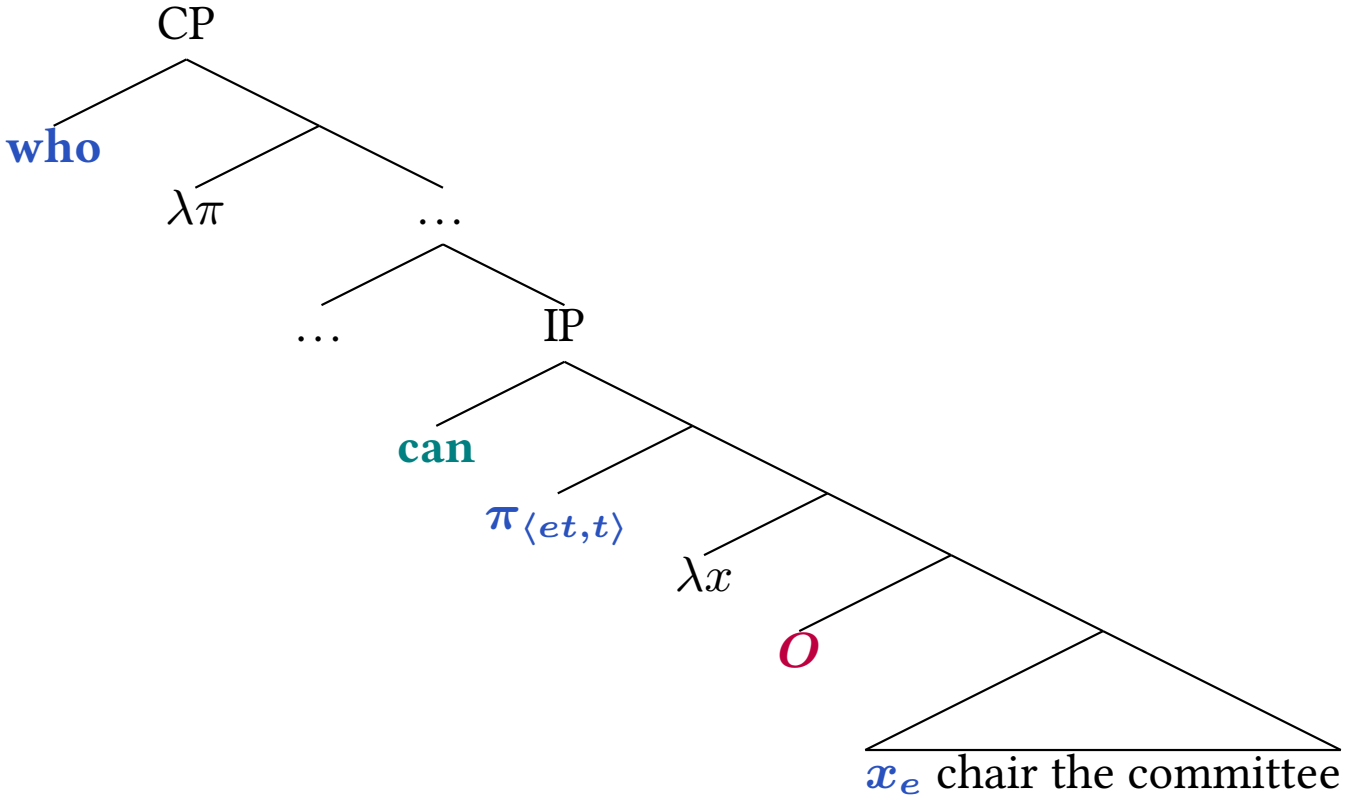
☞ MS/MA ambiguity is not from the scope ambiguity of distributivity.

MS/MA ambiguity is from the scope ambiguity of a higher-order *wh*-trace.

The *wh*-item takes a short IP-internal QR and then moves to [Spec, CP].

- The **individual** trace x_e is associated with a local O**-operator**.
- The **higher-order** trace $\pi_{\langle et,t\rangle}$ can scope below or above the $\Diamond$**-modal**.

(19) Who can chair the committee? (MS reading)



Xiang (2016): Deriving mention-some

(20) Who can chair the committee?
$Q = \{\Diamond\pi(\lambda x.O[\mathit{chair}(x)]) : \pi$ is a generalized quantifier over *hmn*$\}$

(*w: Only Andy and Billy can chair the committee; single-chair only.*)

$$\Diamond[Of(a) \wedge Of(b) \wedge Of(a \oplus b)]$$

$$\Diamond[Of(a) \wedge Of(b)] \quad \Diamond[Of(a) \wedge Of(a \oplus b)] \quad \Diamond[Of(b) \wedge Of(a \oplus b)]$$

$$\begin{tikzcd}
\boldsymbol{\Diamond Of(a)} \arrow[d] \arrow[dr] & \boldsymbol{\Diamond Of(b)} \arrow[dl] \arrow[dr] & \Diamond Of(a \oplus b) \arrow[dl] \arrow[d] \\
\Diamond[Of(a) \vee Of(b)] \arrow[dr] & \Diamond[Of(a) \vee Of(a \oplus b)] \arrow[d] & \Diamond[Of(b) \vee Of(a \oplus b)] \arrow[dl] \\
& \Diamond[Of(a) \vee Of(b) \vee Of(a \oplus b)] &
\end{tikzcd}$$

Conjunctive
(contradictory)

Individual
(independent)

Disjunctive
(partial)

Xiang (2016): Deriving mention-some

(21) Who can chair the committee?
(*w: Only Andy and Billy can chair the committee; single-chair only.*)

$$\Diamond[Of(a) \wedge Of(b)]$$

$$\boldsymbol{\Diamond Of(a)} \quad \vee \quad \boldsymbol{\Diamond Of(b)}$$

$$\Diamond[Of(a) \vee Of(b)]$$

Conjunctive (contradictory)

Individual (independent)

Disjunctive (partial)

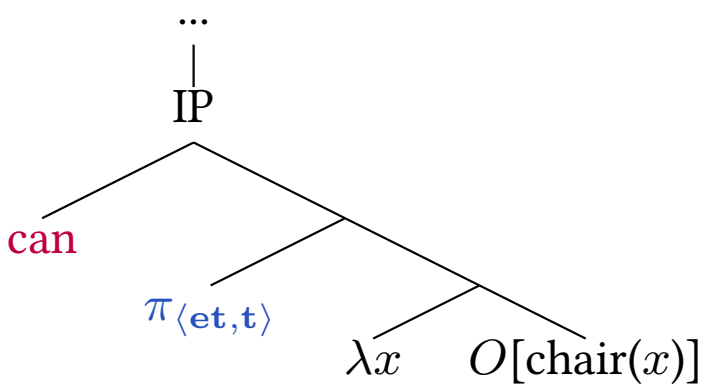
Predictions

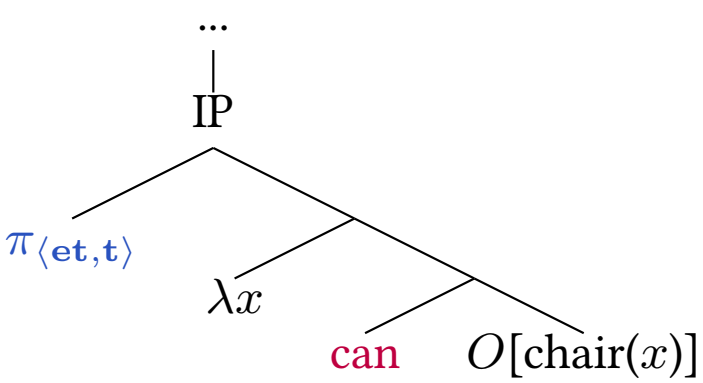
- **Mention-some = mention-one:**
  Conjunctive and disjunctive answers cannot be max-inf.
- **$\Diamond$-modal licenses MS:**
  The O-operator makes the individual answers logically independent; the presence of the $\Diamond$-modal makes them not mutually exclusive.

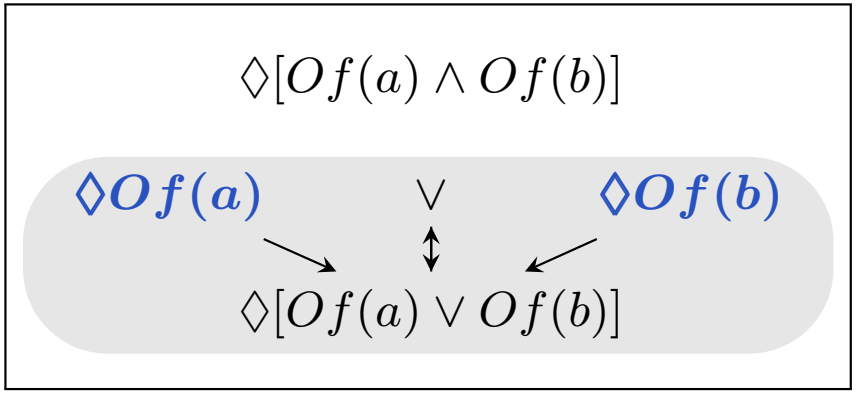
Xiang (2016): Deriving conjunctive mention-all

(22) 'Who can chair the committee?' 'Andy and Billy.'

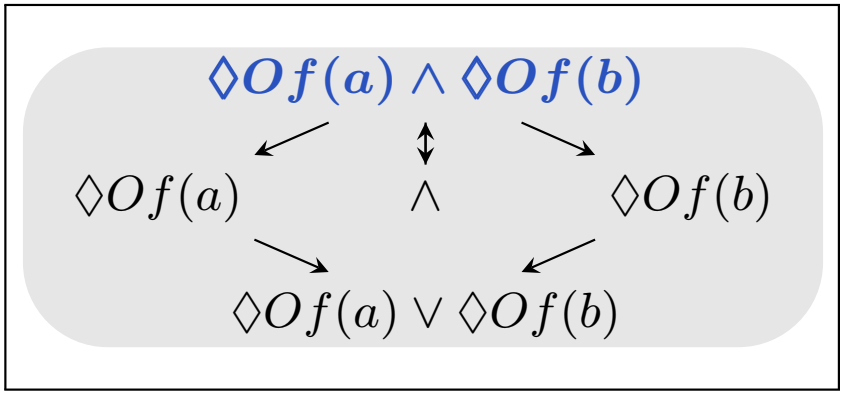
When $\pi \gg \Diamond$: conjunctions take wide scope, yielding conjunctive MA.







$\Diamond \gg \pi$: MS



$\pi \gg \Diamond$: Conjunctive MA

Summarizing Completeness

Mention-some

- The MS/MA ambiguity stems from minimal structural variations within the question nucleus (such as the scope ambiguity of a higher-order *wh*-trace).
- MS- and MA-answers are derived uniformly as possible complete answers.
- Other issues: (see appendix)
  - Dilemma between uniqueness and MS
  - Disjunctive MA-answers

Completeness of "Jenny knows Q"

(23) Jenny knows a max-informative true answer of Q.

$\lambda w.\exists \phi \in \textsc{Ans}([\![\text{Q}]\!])(w)[\mathit{know}_w(j, \phi)]$

where $\textsc{Ans}([\![\text{Q}]\!])(w) = \{p : w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow q \not\subset p]\}$

Sensitivity to false answers

FA-sensitivity on partial answers

Accounts of IE readings consider only answers that are **potentially complete**:

(1′) Jenny knows who came.
$\forall x$ [x came $\rightarrow$ J knows x came] & $\forall x$ **[x didn't come $\rightarrow$ not [J bels x came]]**
(... & J doesn't believe any false MA-answers of "who came")

But, FA-sensitivity is also concerned with answers that are **always partial**. (This fact challenges Klinedinst & Rothschild's exhaustification-based account of IE.)

(24) Who came?

a.	Andy or Billy.	$\phi_a \vee \phi_b$	**Disjunctive partial**
b.	Andy didn't.	$\neg\phi_a$	**Negative partial**

FA-sensitivity on partial answers

FA-sensitivity is concerned with false disjunctives: $\phi_b \vee \phi_c$

(25) Jenny knows [who came]. [Judgment: FALSE]

Fact: *a* came, but *bc* didn't.
J's belief: *a* and someone else came, **who might be *b* or *c***.

(26) Jenny knows [where we can get gas]. [Judgment: FALSE]

Fact: *a* sells gas, but *bc* do not.
J's belief: *a* and somewhere else sell gas, **which might be *b* or *c***.

FA-sensitivity is concerned with false denials

Italian papers are available at ...	*A?*	*B?*	*C?*	
Facts	✓	✗	✓	
Mary's belief	✓	✓	?	**over-affirming (OA)**
Sue's belief	✓	?	✗	**over-denying (OD)**

(27) **Sue** knows where we can buy an Italian newspaper. TRUE/FALSE?

Experiments: Design

Exp-MA Klinedinst & Rothschild (2011)

abcd trying out for the swimming team. Only *ad* made the team. Identify whether each prediction (A1-A4) correctly predicted who made the swimming team.

	A	*b*	*c*	*D*	SE	IE	WE	Ans-type
A1	✗	?	✗	✓	✗	✗	✗	**OD**
A2	?	✗	✗	✓	✗	✗	✗	MS
A3	✓	?	✗	✓	✗	✓	✓	MA
A4	✓	✓	?	✓	✗	✗	✓	**OA**

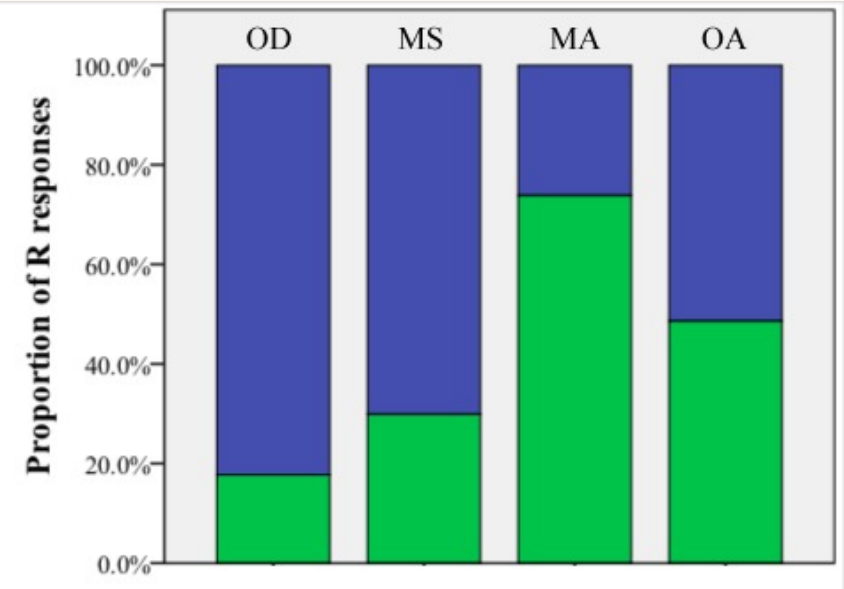
Exp-MS Xiang (2016a)

Four places *abcd* at Central Square selling alcohol. Only *ad* sold red wine. Susan asked her local friends where she could buy a bottle of red wine at Central Square. For each answer (A1-A4), identify whether it correctly answered Susan's question.

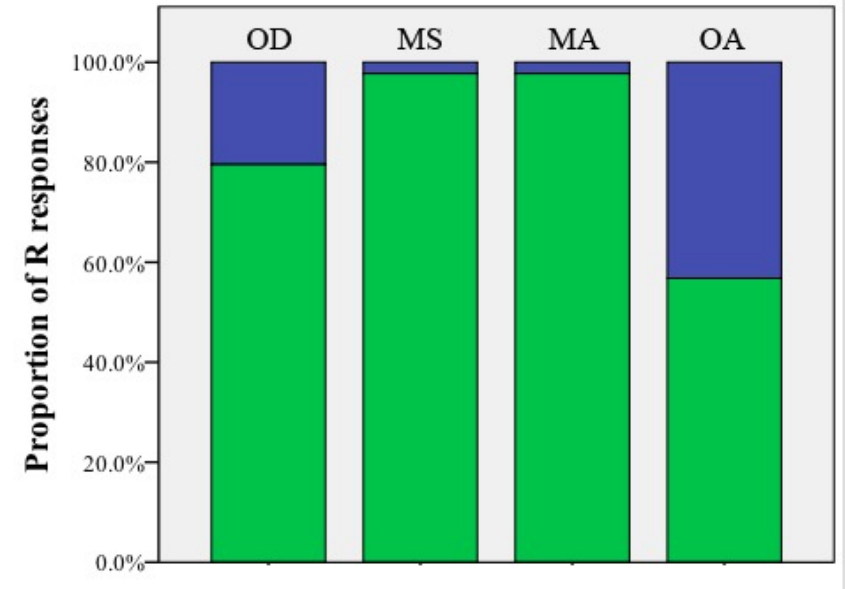
	A	*b*	*c*	*D*	Ans-type
A1	✗	?	✗	✓	**OD**
A2	?	✗	✗	✓	MS
A3	✓	?	✗	✓	MA
A4	✓	✓	?	✓	**OA**

Experiments: Results

By Answer: Exp-MA **N = 107**



By Answer: Exp-MS **N = 88**



In each experiment, each two answers were fit with a logistic mixed effect model. All the models, except the one for MS-MA in Exp-MS, reported a significant effect.

1. OD/OA < MS/MA in Exp-MS

☞ Both OA and OD are involved in FA-sensitivity.

2. OD < OA in Exp-MA; OD > OA in Exp-MS

☞ FA-sensitivity exhibits an **asymmetry** varying by Q-type. (Appendix)

Characterizing FA-sensitivity

Conditions of "Jenny knows Q"

- **Completeness**
  Jenny knows a max-informative true answer of Q.
  $\lambda w.\exists \phi \in \textsc{Ans}([\![\mathrm{Q}]\!])(w)[\mathit{know}_w(j, \phi)]$
  where $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{p : w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow q \not\subset p]\}$

- **FA-sensitivity**
  Jenny doesn't believe any **Q-relevant** false answers.
  $\lambda w.\forall \phi \in \textsc{Rel}([\![\mathrm{Q}]\!])[w \notin \phi \rightarrow \neg \mathit{believe}_w(j, \phi)]$, where $\textsc{Rel}([\![\mathrm{Q}]\!]) = ????$

Characterizing FA-sensitivity: Q-relevance

If Hamblin set $Q = \{p, q\}$, then $\textsc{Rel}([\![\text{Q}]\!]) = \{p, q, \neg p, p \vee q, p \wedge q, \ldots\}$.

Q-relevance:

(28) $\textsc{Rel}([\![\text{Q}]\!]) = \{\bigcup X : X \subseteq \textsc{Part}([\![\text{Q}]\!])\}$
(ϕ is Q-relevant iff ϕ is a union of some partition cells of Q.)

(29) Who came?

a. $\phi_a \vee \phi_b = c_1 \cup c_2 \cup c_3$
b. $\neg\phi_a = c_3 \cup c_4$

c_1	w: both of *ab* came in w
c_2	w: only *a* came in w
c_3	w: only *b* came in w
c_4	w: neither of *ab* came in w

Characterizing FA-sensitivity: Q-relevance

Various ways to define partition:

- Based on the **equivalence of true** answers:
  $\textsc{Part}([\![\mathrm{Q}]\!]) = \{\lambda w[Q_w = Q_{w'}] : w' \in W\}$
- Based on the **equivalence of complete true** answers:
  $\textsc{Part}([\![\mathrm{Q}]\!]) = \{\lambda w[\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \textsc{Ans}([\![\mathrm{Q}]\!])(w')] : w' \in W\}$

Who came?

w: $Q_w = \{\phi_a, \phi_b, \phi_{a\oplus b}\}$		w: both ab came$_w$		w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{\phi_{a\oplus b}\}$
w: $Q_w = \{\phi_a\}$	$=$	w: only a came$_w$	$=$	w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{\phi_a\}$
w: $Q_w = \{\phi_b\}$		w: only b came$_w$		w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{\phi_b\}$
w: $Q_w = \varnothing$		w: neither came$_w$		w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \varnothing$

Where can we get gas?

w: $Q_w = \{\Diamond\phi_a, \Diamond\phi_b, \Diamond\phi_{a\vee b}\}$		w: both ab sell$_w$ gas		w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{\Diamond\phi_a, \Diamond\phi_b\}$
w: $Q_w = \{\Diamond\phi_a, \Diamond\phi_{a\vee b}\}$	$=$	w: only a sells$_w$ gas	$=$	w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{\phi_a\}$
w: $Q_w = \{\Diamond\phi_b, \Diamond\phi_{a\vee b}\}$		w: only b sells$_w$ gas		w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \{\phi_b\}$
w: $Q_w = \varnothing$		w: neither sells$_w$ gas		w: $\textsc{Ans}([\![\mathrm{Q}]\!])(w) = \varnothing$

Characterizing FA-sensitivity: Q-relevance

To get the partition, **knowing Q** cannot be reduced to **knowing one answer of Q.**

(30) Jenny knows [$\textsc{Ans}_w$ who came] ✗

Feasible options to define the embedded question:

(31) Jenny knows [**Partition** who came] ✓
Jenny knows [**Hamblin set** who came] ✓
Jenny knows [**Property** who came] ✓
Jenny knows [λw $\textsc{Ans}_w$ [who came]] ✓

Summarizing FA-sensitivity

- **Content**
  FA-sensitivity is much stronger than what it has been thought to be. It is concerned with all the Q-relevant propositions, including those that are always partial.
- **Derivation**
  Q-relevant propositions are uniformly derived from the partition of Q. Hence, embedded questions must be able to supply partitions.

Conclusions

Attitudes held of questions are subject to Completeness and FA-sensitivity. This talk characterizes these conditions uniformly for MS- and MA-questions.

- For **Completeness**:
  MS- and MA-answers are uniformly derived as possible complete answers.
- For **FA-sensitivity**:
  In both MS- and MA-questions, FA-sensitivity is concerned with all the Q-relevant propositions, which are derived uniformly from the partition.

Slogan: The mapping-relation from structure to meaning is highly principled.
For the same type of structures, the derivation of meaning is uniform.

Thank You!

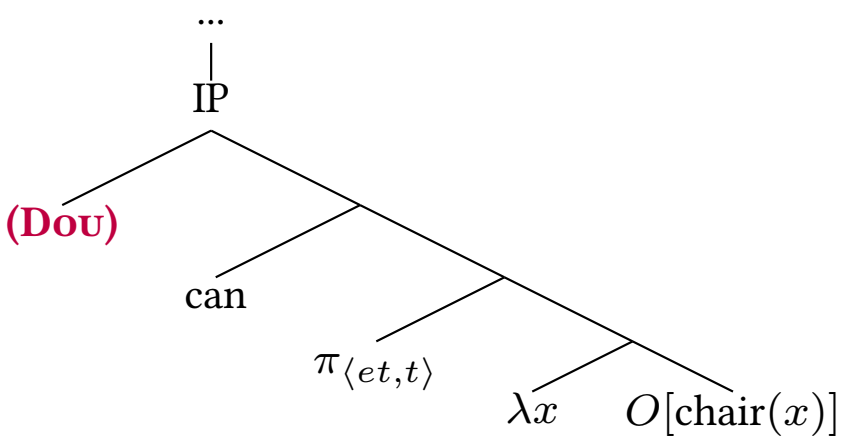
Appendix

1. Disjunctive mention-all
2. Dilemma between uniqueness and mention-some
3. Against the exhaustification-based approach
4. Factivity in FA-sensitivity
5. Asymmetry of FA-sensitivity

Q1: How can we derive disjunctive MA-answers of MS-questions?

(32) "Who can chair the committee?" "Andy or Billy.\"

Proposal: Disjunctive MA arises when a DOU-operator presents above the ◊-modal.



Mandarin *dou* in questions

In a ◊-question, presence of *dou* that c-commands the *wh*-item blocks MS.

(33) **Dou** shui keyi danren weiyuanhui zhuxi?
DOU who can act-as committee chair
'Who all can chair the committee?'

1. Disjunctive mention-all

Dou has multiple functions. In a $\Diamond$-declarative, associating *dou* with a pre-verbal disjunction yields a conjunctive/FC meaning.

(34) [John **or** Mary] **dou** can chair the committee.
$\approx$ 'Both John **and** Mary can chair the committee.'

Defining *dou* (Xiang 2015, 2016: ch. 7, 2017)

Dou is a pre-exhaustification exhaustifier on sub-alternatives. Sub-alternatives are roughly alternatives that are not innocently excludable.

(35) $[\![\text{dou}]\!](p) = \exists q \in \textsc{Sub}(p).\lambda w[p(w) = 1 \wedge \forall q \in \textsc{Sub}(p)[O(q)(w) = 0]]$

a. Affirms the prejacent, and negates the exhaustification of each sub-alt.
b. Presupposes the existence of a sub-alternative.

(36) a. $p = \Diamond f(j) \vee \Diamond f(m)$

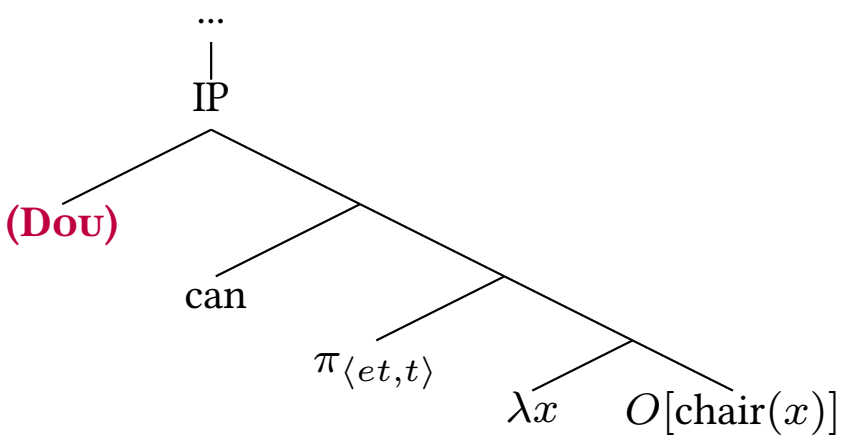
b. $\textsc{Sub}(p) = \{\Diamond f(j), \Diamond f(m)\}$

c. $[\![\text{dou}]\!](p) = [\Diamond f(j) \vee \Diamond f(m)] \wedge \neg O\Diamond f(j) \wedge \neg O\Diamond f(m)$
(j or m can chair $\wedge$ not only j can chair $\wedge$ not only m can chair)
$= \Diamond f(j) \wedge \Diamond f(m)$
(j can teach **and** m can chair)

(37) "Who can chair the committee?" "Andy or Billy.\"

Disjunctive MA arises when a covert **Dou-operator** appears above the $\Diamond$-modal: Dou strengthens disjunctive answers into free choice statements.

(38) $\textsc{Dou}(p) = \lambda w[p(w) = 1 \wedge \forall q \in \textsc{Sub}(p)[O(q)(w) = 0]]$



$\Diamond[Of(a) \wedge Of(b)]$

$\boldsymbol{\Diamond Of(a)}$ $\vee$ $\boldsymbol{\Diamond Of(b)}$

$\Diamond[Of(a) \vee Of(b)]$

Without O_{DOU}: MS

$\textsc{Dou}\Diamond[Of(a) \wedge Of(b)]$

$\textsc{Dou}\Diamond Of(a)$ $\wedge$ $\textsc{Dou}\Diamond Of(b)$

$\textsc{Dou}\Diamond[\boldsymbol{Of(a)} \vee \boldsymbol{Of(b)}]$

With O_{DOU}: disjunctive MA

2. The dilemma between uniqueness and MS

Questions with a singular-marked or number-modified *wh*-phrase are subject to a **uniqueness effect**.

(39) a. Which student came? $\rightsquigarrow$ 'Only one of the students came.'
b. Which two students came? $\rightsquigarrow$ 'Only two of the students came.'

Dayal's presupposition

$\textsc{Ans}_{Dayal}([\![\text{Q}]\!])(w)$ is defined only if Q has a strongest true answer in w.

In lacking of plural answers, a singular-marked question doesn't have a strongest true answer if it has multiple true answers.

(40) (w: *Among the considered students, only Andy and Billy came.*)
Which students came?
$Q_w = \{came(a), came(b)\}$ presupposition failure

Fox's generalization of MS

A question takes MS iff it can have multiple Max-informative true answers.

$\rightarrow$ Singular-marked questions are MS questions. ✗

Two independently motivated assumptions

1. The quantification domain of a *wh*-phrase is closed under boolean conjunction and disjunction iff the extension of the *wh*-complement is closed under sum.
2. The root denotation of a question is a topical property $\mathbf{P}$.

☞ Short answers of a question can be GQs iff this question is plural or un-marked. Adapted to a categorial approach, $\textsc{Ans}_{Dayal}$ can interact with short answers:

(41) $\textsc{Ans}_{Dayal}(\mathbf{P})(w)$ is defined only if
$\exists \boldsymbol{\alpha} \in \mathrm{Dom}(\mathbf{P})[w \in \mathbf{P}(\alpha) \wedge \forall \beta \in \mathrm{Dom}(\mathbf{P})[w \in \mathbf{P}(\beta) \rightarrow \mathbf{P}(\alpha) \subseteq \mathbf{P}(\beta)]]$

Solving the dilemma

In search of the strongest true answer, short answers that are GQs can be interpreted with a **wide scope**. This wide scope reading is obtained by internal lift:

(42) **Internal lift:** $\uparrow\uparrow$ (Shan & Barker 2006, Barker & Shan 2014, Charlow 2014)
$\alpha^{\uparrow\uparrow} = \lambda\theta_{\langle\tau tt,t\rangle}.\alpha(\lambda x_{\tau}.\theta(\lambda f_{\langle\tau,t\rangle}.f(x)))$ $\qquad \langle\langle\tau tt, t\rangle, t\rangle$

$\textsc{Ans}(\mathbf{P})(w)$ is defined only if
$\exists\alpha \in \mathrm{Dom}(\mathbf{P})\exists\boldsymbol{\alpha'} \in \{\boldsymbol{\alpha}, \boldsymbol{\alpha}^{\uparrow\uparrow}\}[w \in \mathbf{P}(\alpha') \wedge \forall\beta \in \mathrm{Dom}(\mathbf{P})[w \in \mathbf{P}(\beta) \rightarrow \mathbf{P}(\alpha') \subseteq \mathbf{P}(\beta)]]$

- **Preserving MS:**

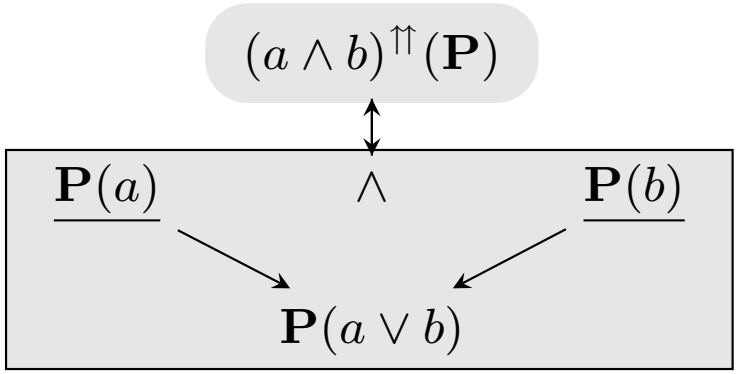
(43) Who can chair the committee?
(*w: Only Andy and Billy can chair; only single-chair is allowed.*)

a. $\mathbf{P} = \lambda\pi_{\langle et,t\rangle}[\mathit{hmn}_{@}(\pi) = 1.\Diamond\pi(\lambda x.Of(x))]$

b. $\mathbf{P}(a \wedge b) = \Diamond[Of(a) \wedge Of(b)]$ $\quad (\Diamond \gg \wedge)$

c. $(a \wedge b)^{\uparrow\uparrow}(\mathbf{P}) = \Diamond Of(a) \wedge \Diamond Of(b)$ $\quad (\wedge \gg \Diamond)$

Although the actual answer space (squared) does not have a strongest true answer, a true proposition based on $(a \wedge b)^{\uparrow\uparrow}$ entails all the true answers.



- **Getting uniqueness:**
The topical property of a singular question is only defined for non-scopal elements (viz. atomic individuals). Hence type-lifting makes no difference.

The EXH-based approach (Klinedinst & Rothschild 2011, Uegaki 2015)

1. The ordinary value of an indirect question is its **Completeness** Condition.
2. **FA-sensitivity** is derived by **exhaustifying** Completeness.

(44) O [$_S$ Jenny knows [$_Q$ who came]] (w: *ab came, but c didn't.*)

a. $[\![S]\!] = \lambda w.\exists\phi \in \textsc{Ans}([\![Q]\!])(w)[know_w(j,\phi)] = know(j, \phi_{a\oplus b})$
(J knows a **true** complete answer of Q.)

b. $\mathcal{A}lt(S) = \{\lambda w.\exists\phi \in \textsc{Ans}([\![Q]\!])(\boldsymbol{w'})[bel_w(j,\phi)] \mid w' \in W\}$

$$= \left\{ \begin{array}{lll} bel(j,\phi_a) & bel(j,\phi_{a\oplus b}) & bel(j,\phi_{a\oplus b\oplus c}) \\ bel(j,\phi_b) & bel(j,\phi_{b\oplus c}) & \\ bel(j,\phi_c) & bel(j,\phi_{a\oplus c}) & \end{array} \right\}$$

({J believes ϕ: ϕ is a **possible** complete answer of Q})

c. $[\![O(S)]\!] = know(j,\phi_{a\oplus b}) \wedge \neg bel(j,\phi_c)$
(J **only** believes the **TRUE** complete answer of Q.)

☞ FA-sensitivity is a **scalar implicature** of Completeness.

Extending to MS-questions

Using **innocent exclusion**, global exhaustification yields an inference close to FA-sensitivity. (D. Fox and A. Cremers p.c. independently)

(45) O_{IE} [$_{\text{S}}$ Jenny knows [$_{\text{Q}}$ where we can get gas]] (*w: ab sell gas, but c doesn't.*)

a. $[\![\text{S}]\!] = \lambda w.\exists\phi \in \textsc{Ans}([\![\text{Q}]\!])(w)[\mathit{know}_w(j,\phi)]$
$= \mathit{know}(j,\phi_a) \vee \mathit{know}(j,\phi_b)$

b. $\mathcal{A}lt(\text{S}) = \{\lambda w.\exists\phi \in \textsc{Ans}([\![\text{Q}]\!])(\boldsymbol{w'})[\mathit{bel}_w(j,\phi)] \mid w' \in W\}$

$$= \left\{ \begin{array}{lll} \mathit{bel}(j,\phi_a), & \mathit{bel}(j,\phi_a) \vee \mathit{bel}(j,\phi_b), & \ldots \\ \mathit{bel}(j,\phi_b), & \mathit{bel}(j,\phi_a) \vee \mathit{bel}(j,\phi_c), & \\ \mathit{bel}(j,\phi_c), & \mathit{bel}(j,\phi_b) \vee \mathit{bel}(j,\phi_c), & \end{array} \right\}$$

c. $[\![O_{\text{IE}}(\text{S})]\!] = [\mathit{know}(j,\phi_a) \vee \mathit{know}(j,\phi_b)] \wedge \neg\mathit{bel}(j,\phi_c)$

Innocent exclusion negates only innocently excludable alternatives. (Fox 2007)

(46) $O_{\text{IE}}(p) = \lambda w[p(w) = 1 \wedge \forall q \in \text{IExcl}(p)[q(w) = 0]]$
where $\text{IExcl}(p) = \bigcap\{A : A$ is a maximal subset of $\mathcal{A}lt(p)$ such that $\{\neg q : q \in A\} \cup \{p\}$ is consistent$\}$

First, FA-sensitivity is concerned with all types of false answers, not just those that can be complete.

To obtain the desired FA-sensitivity inference, exhaustification needs to operate on a special alternative set:

(47) $\boldsymbol{O}_{\text{IE}}$ [$_{\text{S}}$ Jenny knows where we can get gas]
(w: *ab sell gas, but cd do not.*)

a. $[\![\text{S}]\!] = \mathit{know}(j, \phi_a) \vee \mathit{know}(j, \phi_b)$

b. $$\mathcal{A}lt(\text{S}) = \left\{ \begin{array}{ll} \mathit{bel}(j, \phi_c), \mathit{bel}(j, \phi_d), \ldots & \text{Over-affirming} \\ \mathit{bel}(j, \neg\phi_a), \mathit{bel}(j, \neg\phi_b), \ldots & \text{Over-denying} \\ \mathit{bel}(j, \phi_c \vee \phi_d), \ldots & \text{Disjunctive} \\ \ldots & \\ \cancel{\mathit{bel}(j, \phi_a \wedge \phi_b)}\ldots & \cancel{\text{Mention-all/few}} \end{array} \right\}$$

3. Problems with the exhaustification-based approach

Second, FA-sensitivity inferences do not behave like scalar implicatures.

1. FA-sensitivity inferences are **not cancelable**.

   (48) a. Did Mary invite some of the speakers to the dinner?
   b. Yes. **Actually she invited all of them.**

   (49) (w: *Andy and Billy presented this morning, Cindy didn't.*)
   a. Does Mary know which speakers presented this morning?
   b. Yes. **#Actually she believes that *abc* all did.**

2. FA-sensitivity inferences are easily generated in **downward-entailing** environments.

   (50) If Mary invited some of the speakers to the dinner, I will buy her a coffee.
   $\not\leadsto$ If M invited some **but not all** speakers to the dinner, I will...

   (51) If Mary knows which speakers presented this morning, I will ...
   $\leadsto$ If [M knows *ab* presented] $\wedge$ **not [M believes *c* presented]**, I will...

3. Problems with the exhaustification-based approach

3. FA-sensitivity inferences are not "mandatory" scalar implicatures: (52b) evokes an **indirect** scalar implicature, while (53b) doesn't.

(52) a. Mary **only** invited the JUNIOR$_F$ speakers to the dinner.
$\rightsquigarrow$ Mary did not invite the senior speakers to the dinner. $\neg\phi_{\text{senior}}$

b. Mary **only** did **not** invite the JUNIOR$_F$ speakers to the dinner.
$\rightsquigarrow$ Mary invited the senior speakers to the dinner. ϕ_{senior}

b′. $\boldsymbol{O}\ \neg\phi_{\text{junior}} = \neg\phi_{\text{junior}} \wedge \neg\neg\phi_{\text{senior}} = \neg\phi_{\text{junior}} \wedge \phi_{\text{senior}}$

(53) (w: *Andy and Billy presented this morning, Cindy didn't.*)

a. Mary knows which speakers presented this morning.
$\rightsquigarrow$ not [Mary believes that Cindy presented this morning] $\neg bel(m, \phi_c)$

b. Mary does **not** know which speakers presented this morning.
$\not\rightsquigarrow$ Mary believes that Cindy presented this morning $bel(m, \phi_c)$

b′. $\boldsymbol{O}$ **not** [Mary knows which speakers presented this morning]

4. Factivity in FA-sensitivity

Puzzle 1: In FA-sensitivity, cognitive factive ***know*** is replaced with its non-factive counterpart ***believe***. (Spector & Egré 2015)

(54) (w: *ab came, but c didn't.*)
Jenny **knows** who came.
$\rightsquigarrow$ Jenny doesn't **believe**/#**know** that *c* came.

Explanation: Accommodating the factive presupposition of *know* makes the FA-sensitivity Condition contradictory or tautologous.

(55) a. Global accommodation
$\lambda w.\forall \phi \in \textsc{Rel}([\![\text{Q}]\!])[w \notin \phi \rightarrow \boldsymbol{w \in \phi} \wedge \neg \mathit{believe}_w(j, \phi)]$ **Contradiction**

b. Local accommodation
$\lambda w.\forall \phi \in \textsc{Rel}([\![\text{Q}]\!])[w \notin \phi \rightarrow \neg[\boldsymbol{w \in \phi} \wedge \mathit{believe}_w(j, \phi)]]$ **Tautology**

Hence in FA-sensitivity, the factive presupposition of *know* must be "**deactivated**".

Puzzle 2: Seemingly, **emotive factives** do not license FA-sensitive readings.

(56) (w: *ab came, but c didn't.*)
Jenny **is surprised at** who came.

a. $\rightsquigarrow$ Jenny is surprised that *ab* came.
b. $\not\rightsquigarrow$ Jenny isn't surprised that *c* came. $\phi_c.\neg \mathit{surprise}(j, \phi_c)$
b′. $\rightsquigarrow$ Not that Jenny is surprised that *c* came. $\neg[\phi_c \wedge \mathit{surprise}(j, \phi_c)]$

Explanation: FA-sensitivity collapses under factivity, due to local accommodation of the factive presupposition.

(57) Jenny **is surprised at** Q.
$\lambda w.\forall \phi \in \textsc{Rel}([\![\text{Q}]\!])[w \notin \phi \rightarrow \neg[\boldsymbol{w \in \phi} \wedge \mathit{surprise}_w(j, \phi)]]$ **Tautology**
(For any Q-relevant ϕ: if ϕ is false, then not that [J is surprised at ϕ and ϕ **is true**])

4. Factivity in FA-sensitivity

Puzzle 3: The factive presupposition of ***surprise*** isn't deactivated, (but instead locally accommodated).

Explanation: Factive presuppositions of emotive factives are strong and indefeasible, unlike those of cognitive factives. (Karttunen 1971, Stalnaker 1977)

(58) a. If someone **regrets** that I was mistaken, I will admit that I was wrong.
$\rightsquigarrow$ The speaker was mistaken.
b. If someone **discovers** that I was mistaken, I will admit that I was wrong.
$\not\rightsquigarrow$ The speaker was mistaken.

As weak factives, **communication verbs** pattern like cognitive factives.

(59) (w: *ab came, but c didn't.*)
Jenny **told**$_{[+\text{fac}]}$ Mary who came.
a. $\rightsquigarrow$ Jenny told$_{[+\text{fac}]}$ Mary that *ab* came. $\quad tell_{[+\text{fac}]}(j, m, \phi_{a \oplus b})$
b. $\rightsquigarrow$ Jenny didn't tell$_{[-\text{fac}]}$ Mary that *c* came. $\quad \neg tell_{[-\text{fac}]}(j, m, \phi_c)$

4. Factivity in FA-sensitivity

The unacceptability of false answers varies:

- In MA-Qs, OA is more tolerated than OD.
- In MS-Qs, OD is more tolerated than OA.

A false answer can be tolerated if it is "not misleading".

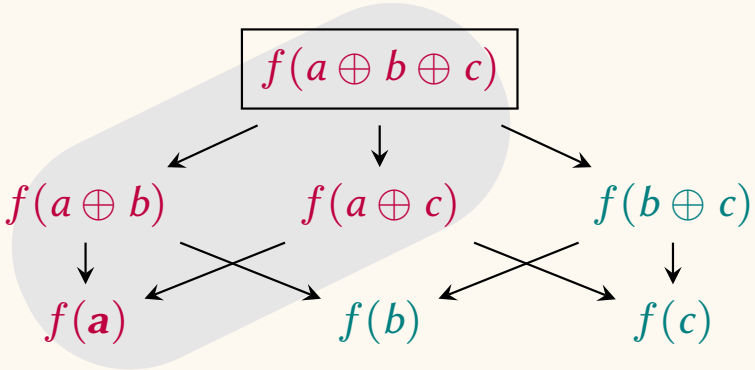
Could we get gas at ...?	A	B	C	
Fact	✓	✓	✗	
OA	✓	?	✓	Misleading
OD	✓	✗	?	Not misleading

Accepting a response ϕ, the questioner would update the answer space based on ϕ and take any **max-inf answer in the new answer space** as a resolution, making decisions accordingly. If none of these max-inf answers leads to an "improper decision", ϕ can be tolerated.

Principle of Tolerance

An answer ϕ is tolerated iff accepting ϕ yields an answer space s.t. every max-inf member of this answer space entails a complete true answer.

MA-Q: OA is more tolerated than OD



In MA-Qs, OA does not violate the Principle of Tolerance:

- Only let the unshaded answers be true. Complete true answer: $f(b \oplus c)$.
- Overly affirming $f(a)$ rules in all the shaded answers.
  The max-inf member in the updated answer space: $f(a \oplus b \oplus c)$.
- $f(a \oplus b \oplus c) \Rightarrow f(b \oplus c)$.

In MA-Qs, OD violates the Principle of Tolerance:

- Let all the answers be true. max-inf true answer: $f(a \oplus b \oplus c)$.
- Overly denying $f(a)$ rules out all the shaded answers.
  max-inf member in the updated answer space: $f(b \oplus c)$.
- $f(b \oplus c) \not\Rightarrow f(a \oplus b \oplus c)$

MS-Q: OA is less tolerated than OD

$\ldots$ $\boxed{\Diamond Of(b \oplus c)}$ $\ldots$

$\boxed{\Diamond Of(a)}$ $\boxed{\Diamond Of(b)}$ $\boxed{\Diamond Of(c)}$

In MS-Qs, OD does not violate the Principle of Tolerance:

- Let all the answers be true. All of them are complete.
- Overly denying $\Diamond Of(a)$ only rules out $\Diamond Of(a)$ itself.
  max-inf members in the updated space: all the unshaded answers.
- Each of the remaining answers entails a complete true answer (i.e., itself).

In MS-Qs, OA violates the Principle of Tolerance:

- Only let the unshaded answers be true. All of them are complete.
- Overly affirming $\Diamond Of(a)$ only rules in $\Diamond Of(a)$ itself.
  max-inf members in the updated answer space: all the answers.
- $\Diamond Of(a)$ does not entail any of the unshaded answers.

5. Asymmetry of FA-sensitivity

- **An appealing explanation**: OD is less tolerated than OA in MA-Qs because OD even doesn't satisfy Completeness.
- **Prediction**: This asymmetry would disappear if a participant was tolerant of incompleteness.
- **Assessment**: Subjects in Exp-MA tolerated of incompleteness (viz. who accepted MS&MA) also rejected OD significantly more than OA (binomial test: 89%, p <.05), contra prediction.

	OD	MS	MA	OA	N
	✗	✓	✓	✗	11
	✓	✓	✓	✗	1
	✗	✓	✓	✓	8
	✓	✓	✓	✓	8

⇒ **Regardless of whether Completeness was considered**, the subjects in Exp-MA consistently rejected **OD** more than **OA**.

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