PLIN0056 Semantics Research Seminar

Lecture 3: Exhaustivity

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1 Question intensions

(1) Which cat did Chomsky see?

1.1 Hamblin-Karttunen-Heim-style approach

- Hamblin-Karttunen-style analysis (Hamblin 1973, Karttunen 1977)

  (2) $\lambda w_s.\lambda p_{\langle s,t\rangle}$. for some cat x in w, $p = \lambda w'_s$. Chomsky saw x in w'

  (3) λw_s. $\{\, \lambda w'_s$. Chomsky saw x in $w' \mid x$ is a cat in $w \,\}$

  – Karttunen 1977 only considers those propositions that are true in w.
  – Karttunen 1977 can only derive the *de re* reading for the restrictor of *cat*.
  – Hamblin 1973 can derive *de dicto*:

    (4) $\{\, \lambda w'_s$. x is a cat in w' and Chomsky saw x in $w' \mid x \in D_e \,\}$

    But this runs into independent issues (see Rullmann & Beck 1998).

- Heim-style analysis with presuppositions (Rullmann & Beck 1998, Heim 2012)

  (5) *De dicto*
  $\lambda w_s.\lambda p_{\langle s,t\rangle}$. for some $x \in D_e$, $p = \lambda w'_s:\ x$ is a cat in w'. Chomsky saw x in w'

  For any w, (5) applied to w characterises:

  $$\{\, \lambda w'_s:\ x \text{ is a cat in } w'. \text{ Chomsky saw } x \text{ in } w' \mid x \in D_e \,\}$$

  (6) *De re*
  $\lambda w_s.\lambda p_{\langle s,t\rangle}$. for some $x \in D_e$, $p = \lambda w'_s:\ x$ is a cat in w. Chomsky saw x in w'

  For any w, (6) applied to w characterises:

  $$\begin{aligned} &\{\, \lambda w'_s:\ x \text{ is a cat in } w. \text{ Chomsky saw } x \text{ in } w' \mid x \in D_e \,\} \\ = &\{\, \lambda w'_s. \text{ Chomsky saw } x \text{ in } w' \mid x \text{ is a cat in } w \,\} \cup \{\, \bot \,\} \end{aligned}$$

  Here, $\bot$ is a pathological proposition that is undefined for any $w \in \mathcal{W}$.

1.2 Partition semantics

(7) $\mathcal{S} \subseteq \wp(A)$ is a *partition* of A iff all of the following are true.
a. $\varnothing \notin \mathcal{S}$
b. $\bigcup \mathcal{S} = A$
c. For each $X, Y \in S$, if $X \neq Y$, then $X \cap Y = \varnothing$

- Hamblin-style partition semantics (Hamblin 1958)

(8) *De re*

$$\lambda w_s. \left\{ \left\{ w'_s \;\middle|\; \begin{array}{l} \text{for each } x \in S, x \text{ is a cat in } w \text{ and Chomsky saw } x \text{ in } w' \text{ and} \\ \text{for each } x \in D_e \backslash S, x \text{ is a cat in } w \text{ and Chomsky didn't see } x \text{ in } w' \end{array} \right\} \;\middle|\; S \subseteq D_e \right\}$$

(9) *De dicto*

$$\lambda w_s. \left\{ \left\{ w'_s \;\middle|\; \begin{array}{l} \text{for each } x \in S, x \text{ is a cat in } w' \text{ and Chomsky saw } x \text{ in } w' \text{ and} \\ \text{for each } x \in D_e \backslash S, x \text{ is a cat in } w' \text{ and Chomsky didn't see } x \text{ in } w' \end{array} \right\} \;\middle|\; S \subseteq D_e \right\}$$

For any w, each set of propositions represents a possible complete answer to the question in w.

- Groenendijk-&-Stokhof-style partition semantics (Groenendijk & Stokhof 1984)

  For Groenendijk & Stokhof 1984, the question extension with respect to $w \in \mathcal{W}$ is the complete answer to the question that is true in w in (8).

(10) *De re*

$$\lambda w_s.\lambda w'_s.\, \{\, x \mid x \text{ is a cat in } w \text{ that Chomsky saw in } w \,\} = \{\, x \mid x \text{ is a cat in } w \text{ that Chomsky saw in } w' \,\}$$

(11) *De dicto*

$$\lambda w_s.\lambda w'_s.\, \{\, x \mid x \text{ is a cat in } w \text{ that Chomsky saw in } w \,\} = \{\, x \mid x \text{ is a cat in } w' \text{ that Chomsky saw in } w' \,\}$$

The question intension Q is an equivalence relation between possible worlds, inducing a partition over the set of possible worlds, ($\mathcal{W}/Q = \{\, [w]_Q \mid w \in \mathcal{W} \,\} = \{\, \{\, w' \mid Q(w)(w') = 1 \,\} \mid w \in \mathcal{W} \,\}$).

- We could devise a partition semantics with presuppositions (but there's no need for it, as we will see).

1.3 Choosing between the two

Some arguments for the partition approach.

1. Complete vs. partial answers
2. Embedded questions

- Heim 1994 points out that 1. is not a sound argument.
- Heim 1994 also argues that 2. actually favours the HK-style approach (see also Klinedinst & Rothschild 2011).
- Implicatures are better explained by the HK-style approach.
- The literature on Inquisitive Semantics observes that certain complex questions don't denote partitions (see Ciardelli, Groenendijk & Roelofsen 2013, 2018).

2 Complete and partial answers

(12) What languages does he speak?
  a. He speaks French and English.
  b. He speaks French.
  c. He speaks French, English, and maybe German.
  d. He speaks two languages.
  e. It's raining.

2.1 Partition semantics

Complete vs. partial answers are defined with respect to a partition.

Let $Q_{\text{GS}} \in D_{\langle s,\langle s,t\rangle\rangle}$ be a G&S-style question intension—an equivalence relation between possible worlds, inducing a partition $\mathcal{W}/Q_{\text{GS}}$.

(13) A proposition $p \in D_{\langle s,t\rangle}$ is a *complete answer* to Q_{GS} iff
for some $X \in \mathcal{W}/Q_{\text{GS}}$, $\{\, w \in \mathcal{W} \mid p(w) = 1 \,\} \cap X \neq \varnothing$; and
for every $Y \in \mathcal{W}/Q_{\text{GS}} \backslash \{\, X \,\}$, $\{\, w \in \mathcal{W} \mid p(w) = 1 \,\} \cap Y = \varnothing$.

(14) A proposition $p \in D_{\langle s,t\rangle}$ is a *partial answer* to Q_{GS} iff
for some $X \in \mathcal{W}/Q_{\text{GS}}$, $\{\, w \in \mathcal{W} \mid p(w) = 1 \,\} \cap X \neq \varnothing$; and
for some $Y \in \mathcal{W}/Q_{\text{GS}}$, $\{\, w \in \mathcal{W} \mid p(w) = 1 \,\} \cap Y = \varnothing$

- A proposition $p \in D_{\langle s,t\rangle}$ that is not a partial answer to Q_{GS} (i.e., it's either a contradiction or overlaps with every cell) is not an answer to Q_{GS}. Note that an utterance expressing such a proposition might be a pragmatically felicitous response, e.g., "I don't know", "I don't want to answer that question".
- Normally, by a partial answer, we mean a partial answer that is not a complete answer.

(15) A proposition $p \in D_{\langle s,t\rangle}$ is an *exact (complete) answer* to Q_{GS} iff
for some $X \in \mathcal{W}/Q_{\text{GS}}$, $\{\, w \in \mathcal{W} \mid p(w) = 1 \,\} = X$

(16) A proposition $p \in D_{\langle s,t\rangle}$ is an *overinformative complete answer* to Q_{GS} iff
for some $X \in \mathcal{W}/Q_{\text{GS}}$, $\varnothing \subset \{\, w \in \mathcal{W} \mid p(w) = 1 \,\} \subset X$

2.2 Reconstructing partitions in the HK-style approach

Heim 1994 points out that HK-style denotations can be turned into G&S-style equivalence relations (but not *vice versa*).

Let $Q_{\text{HK}} \subseteq D_{\langle s,t\rangle}$ be a set of propositions characterised by a HK-style question extension characterises.

(17) $R_{Q_{\text{HK}}} := \lambda w_s.\lambda w'_s.$ for each $p \in Q_{\text{HK}}$, $p(w) = p(w')$.

(18) What did Chomsky see?

$$Q_{\text{HK}} = \{\, \lambda w'_s. \text{ Chomsky saw } x \text{ in } w' \mid x \in D_e \,\} = \left\{ \begin{array}{c} \lambda w'_s. \text{ Chomsky saw } e_1 \text{ in } w', \\ \lambda w'_s. \text{ Chomsky saw } e_2 \text{ in } w', \\ \lambda w'_s. \text{ Chomsky saw } e_3 \text{ in } w', \\ \vdots \end{array} \right\}$$

$R_{Q_{\text{HK}}}$ is an equivalence relation, inducing the partition $\mathcal{W}/R_{Q_{\text{HK}}}$:

$$\left\{ \left\{ w_s \;\middle|\; \begin{array}{l} \text{for each } x \in S, \text{ Chomsky saw } x \text{ in } w \\ \text{for each } y \in D_e \backslash S, \text{ Chomsky didn't see } y \text{ in } w \end{array} \right\} \;\middle|\; S \subseteq D_e \right\}$$

(19) a. A proposition $p \in D_{\langle s,t\rangle}$ is a complete answer to Q_{HK} iff p is a complete answer to $R_{Q_{\text{HK}}}$.
b. A proposition $p \in D_{\langle s,t\rangle}$ is a partial answer to Q_{HK} iff p is a partial answer to $R_{Q_{\text{HK}}}$.

2.3 Partitions in the Heim-style presuppositional approach

(20) Which cat did Chomsky see?

a. *De re*

$\lambda w_s.\lambda p_{\langle s,t\rangle}.$ for some $x \in D_e$, $p = \lambda w'_s:\ x$ is a cat in w. Chomsky saw x in w'

b. *De dicto*

$\lambda w_s.\lambda p_{\langle s,t\rangle}.$ for some $x \in D_e$, $p = \lambda w'_s:\ x$ is a cat in w'. Chomsky saw x in w'

2.3.1 *De re*

Under the *de re* reading, the question extension characterises the set containing the HK-style total propositions + $\bot$. So we can use the same strategy as before, except that we'll factor out $\bot$.

Let $Q_{\mathrm{H}} \in D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$ is a Heim-style question intension under the *de re* reading. For any possible world $w \in D_s$, let's write:

(21) $\mathsf{set}(Q_{\mathrm{H}}(w)) \coloneqq \{\, p \in D_{\langle s,t\rangle} \mid Q_{\mathrm{H}}(w)(p) = 1$ and $p \neq \bot \,\}$

(22) $R_{\mathsf{set}(Q_{\mathrm{H}}(w))} \coloneqq \lambda w'_s.\lambda w''_s.$ for each $p \in \mathsf{set}(Q_{\mathrm{H}}(w))$, $p(w') = p(w'')$

(23) a. A proposition $p \in D_{\langle s,t\rangle}$ is a complete answer to Q_{H} with respect to w iff p is a complete answer to $R_{\mathsf{set}(Q_{\mathrm{H}}(w))}$.

b. A proposition $p \in D_{\langle s,t\rangle}$ is a partial answer to Q_{H} with respect to w iff p is a partial answer to $R_{\mathsf{set}(Q_{\mathrm{H}}(w))}$.

2.3.2 *De dicto*

In the *de dicto* denotation, we have to be careful with the presuppositions.

(24) $\lambda w_s.\lambda p_{\langle s,t\rangle}.$ for some $x \in D_e$, $p = \lambda w'_s:\ x$ is a cat in w'. Chomsky saw x in w'

This function happens to be intensionally rigid, so for any possible world w, we'll be working with the same set of propositions with non-trivial presuppositions.

$$\left\{\begin{array}{c} \lambda w'_s:\ e_1 \text{ is a cat in } w'.\ \text{Chomsky saw } x \text{ in } w', \\ \lambda w'_s:\ e_2 \text{ is a cat in } w'.\ \text{Chomsky saw } x \text{ in } w', \\ \lambda w'_s:\ e_3 \text{ is a cat in } w'.\ \text{Chomsky saw } x \text{ in } w', \\ \vdots \end{array}\right\}$$

- (24) itself is a total function from possible worlds to total functions from propositions to truth-values.
- Usually, all the presuppositions of the propositions in the set cannot be satisfied with respect to a given context set.
- To talk about the relation version of (24), we need to decide what to do with cases where $w \notin \mathrm{dom}(p)$.

First attempt The most straightforward extension is:

(25) $R'_{\mathsf{set}(Q_{\mathrm{H}}(w))} \coloneqq \lambda w'_s.\lambda w''_s.$ for each $p \in \mathsf{set}(Q_{\mathrm{H}}(w))$,
$[w \notin \mathrm{dom}(p)$ and $w' \notin \mathrm{dom}(p)]$ or $[p(w') = p(w'')]$

(26) a. A proposition $p \in D_{\langle s,t\rangle}$ is a complete answer to Q_{H} with respect to w iff p is a complete answer to $R'_{\mathsf{set}(Q_{\mathrm{H}}(w))}$.
b. A proposition $p \in D_{\langle s,t\rangle}$ is a partial answer to Q_{H} with respect to w iff p is a partial answer to $R'_{\mathsf{set}(Q_{\mathrm{H}}(w))}$.

But this will render both (27a) and (27b) as partial answers to (27).

(27) Which cat did Chomsky see?
a. Chomsky didn't see this cat.
b. The creature over there is not a cat.

Second attempt Let's take the maximal subset of (27) whose presuppositions are all satisfied with respect to the current context set c. For any set $S \subseteq D_{\langle s,t\rangle}$ of (potentially partial) propositions:

(28) $S\restriction_c := \{\, p \in S \mid \text{for each } w \in c,\ w \in \mathrm{dom}(p) \,\}$

Let c be a Stalnakerian context and $Q_{\mathrm{H}} \in D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$ be a Heim-style question intension.

(29) *Bridging principle for question intensions*
Asking (a question denoting) Q_{H} with respect to c is felicitous, only if for each $w \in c$, $R_{\mathsf{set}(Q_{\mathrm{H}}(w))\restriction_c}$ induces a non-trivial partition on c.

For the example at hand, there needs to be at least two entities that are commonly known to be cats in c, in order for it to give rise to a non-trivial partition.

But in the general case, this projects presuppositions too weakly. Consider:

(30) Gennaro didn't manage to quit smoking.

This presupposes (at least) that Gennaro has been a smoker.

(31) Which professor in this department didn't manage to quit smoking?

This seems to presuppose that every professor in this department was once a smoker (and that one of them didn't manage to quit, while the others did quit).

This won't be predicted.

(32) $$\lambda w_s.\lambda p_{\langle s,t\rangle}.\ \text{for some } x \in D_e,\ p = \lambda w'_s\colon \left[\begin{array}{l} x \text{ is a professor in this department in } w' \\ \text{and was a smoker in } w' \text{ and} \ldots \end{array}\right].\ x \text{ didn't manage to quit smoking in } w'$$

If there is a professor who is not commonly known to have smoked (either they are known to have never smoked or it is not commonly agreed that they smoked or that they did not), the question will simply ignore them.

Third attempt Heim 2012 assumes that *which* is a unary quantifier. Instead, let's postulate a covert domain variable $\mathbf{X}_{\hat{e}}$ and make *which* a binary quantifier that projects a universal presupposition.[1]

(33) $[\![\textbf{which}]\!]^g = \lambda X_{\hat{e}}.\lambda P_{\langle e,t\rangle}\colon\ \text{for each } x \in X,\ x \in \mathrm{dom}(P).\ \text{for some } x \in X,\ P(x) = 1$

[1]We exclusively focus on distributive predicates here, but to take care of non-distributive predication, we can use (i).

(i) $[\![\textbf{which}]\!]^g = \lambda X_{\hat{e}}.\lambda P_{\langle e,t\rangle}\colon\ \bigsqcup X \leqslant \bigsqcup \mathrm{dom}(P).\ \text{for some } x \in X,\ P(x) = 1$

We will also need to project the presupposition through the wh-question operator '$\mathrm{C_{wh}}$'.

(34) $[\![\mathbf{C_{wh}}]\!]^g = \lambda w_s.\ \lambda p_{\langle s,t\rangle}.\lambda q_{\langle s,t\rangle}:\ w \in \mathrm{dom}(q).\ q = p$

(35) $[\![\lambda \mathbf{x}_e\ \mathbf{C_{wh}}\mathbf{w}\ \mathbf{p}\ \lambda \mathbf{w}'_s\ \textbf{Chomsky saw}_{\mathbf{w}'}\ \textsc{the}\ \textbf{cat}_{\mathbf{w}'}\ \textsc{ident}\ \mathbf{x}]\!]^g$
$= \lambda x_e:\ x$ is a cat in $g(\mathbf{w})$. $g(\mathbf{p}) = \lambda w'_s:\ x$ is a cat in w'. Chomsky saw x in w'

(36) $\left[\!\!\left[\lambda \mathbf{w}_s\ \lambda \mathbf{p}_{\langle s,t\rangle}\ \textbf{which}\ \mathbf{X}_{\hat{e}}\ \lambda \mathbf{x}_e\ \mathbf{C_{wh}}\mathbf{w}\ \mathbf{p}\ \lambda \mathbf{w}'_s\ \textbf{Chomsky saw}_{\mathbf{w}'}\ \textsc{the}\ \textbf{cat}_{\mathbf{w}'}\ \textsc{ident}\ \mathbf{x}\right]\!\!\right]^g$
$= \lambda w_s.\lambda p_{\langle s,t\rangle}:$ each $x \in g(\mathbf{X}_{\hat{e}})$ is a cat in w.
for some $x \in g(\mathbf{X}_{\hat{e}})$, $p = \lambda w'_s:\ x$ is a cat in w'. Chomsky saw x in w'

(37) *Bridging principle for questions*
Asking (a question denoting) $Q_{\mathrm{H}} \in D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$ is felicitous with respect to context set c, only if for each $w \in c$, $\mathrm{dom}(Q_{\mathrm{H}}(w)) \neq \varnothing$.

Then whenever asking (36) is felicitous in c, $g(\mathbf{X}_{\hat{e}})$ only contains individuals that are commonly known to be cats. This will guarantee that '*de dicto* presuppositions' of the propositions will be satisfied with respect to c, so we'll be able to just partition c in the same way as before.

(38) Suppose that asking $Q \in D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$ is felicitous with respect to c.
a. A proposition $p \in D_{\langle s,t\rangle}$ is a complete answer to Q_{H} with respect to c iff for each $w \in c$, p is a complete answer to $R_{Q_{\mathrm{H}(w)}}$.
b. A proposition $p \in D_{\langle s,t\rangle}$ is a partial answer to Q_{H} with respect to c iff for each $w \in c$, p is a partial answer to $R_{Q_{\mathrm{H}(w)}}$.

This will work for *de re* as well.

2.4 Remarks on 'D-linking'

That there's a covert domain variable for *which* might look like a good idea in light of the discourse property of *which*-phrases (Pesetsky 1987, Dayal 2016, 2017).

> When a speaker asks a question like *Which book did you read?*, the range of felicitous answers is limited by a set of books both speaker and hearer have in mind. If the hearer is ignorant of the context assumed by the speaker, a *which*-question sounds odd.
> (Pesetsky 1987: p. 107f)

Pesetsky actually does not properly motivate this analysis with data.

Dayal 2017 claims, based on (39), that Pesetsky's D-linking condition is too strong.

(39) A: I bought a book to give to David on his birthday.
B: Which book did you buy? (adapted from Dayal 2017: (5))

Dayal suggests a weaker condition that the domain of quantification of a *which*-phrase to be 'potentially familiar'—the true answer to A's question in (39) might mention something that B is familiar with in some sense.

But this condition is arguably too weak.

(40) A: I met an Asian guy at David's birthday party last week.
B: #Which Asian guy did you meet?

It seems to me that the condition has to do with whether the answer could be properly phrased. (40)

sounds like B assumes that B can name most, possibly all, Asian guys. Similarly:

(41) A: I bought a Mongolian novel and a fountain pen to give to David on his birthday.
B: Which Mongolian novel did you buy?

The following examples where *which* quantifies over discourse-familiar individuals suggests that the condition is not about the discourse salience of the individuals.

(42) A: Last week I wrote two conference abstracts. One is about homogeneity and one is about free choice. I submitted one of them to *XPRAG* and the other one to *Sinn und Bedeutung*.
B: Which abstract did you submit to XPRAG?

(43) A: Last week I wrote two conference abstracts, both about homogeneity. I submitted one of them to *XPRAG* and the other one to *Sinn und Bedeutung*.
B: #Which abstract did you submit to XPRAG?

Logically A could answer (43B) by showing the abstract and saying "This one".

3 Embedded questions (sketch)

Groenendijk & Stokhof 1984 point out that (44) most naturally receives a *strongly exhaustive* reading.

(44) The philosopher knows what Chomsky saw.

(45) a. For everything x that Chomsky did see, the philosopher knows that Chomsky saw x; and
b. for everything y that Chomsky did not see, the philosopher knows that Chomsky did not see y.

The G&S-style approach accounts for this straightforwardly:

(46) $\lambda w_s.\lambda w'_s.\{\, x \in D_e \mid \text{Chomsky saw } x \text{ in } w \,\} = \{\, x \in D_e \mid \text{Chomsky saw } x \text{ in } w' \,\}$

- Being veridical, *know* passes the evaluation world to the question intension.
- Then the question extension at the evaluation world is the complete true answer to the question at the evaluation world.
- The entire sentence says that the philosopher knows the complete true answer.

But this is not an advantage of the partition approach, because we can reconstruct the partition under the HKH-style approach. Under the Heimian-approach, instead of the context set c, we will be working with the philosopher's doxastic alternatives.

Furthermore, Heim 1994 points out that some examples receive *weakly exhaustive* readings, and the partition approach undergenerates for them.

(47) The philosopher knows whose abstract was accepted, but does not know whose abstract was not.

(48) a. It surprised the organisers who showed up.
b. It surprised the organisers who didn't show up.

Klinedinst & Rothschild 2011 discuss *intermediate exhaustive* readings, which the partition approach also fails to account for.

(49) The philosopher (correctly) predicted who showed up.

(50) *Intermediate*
  a. For every person x who did show up, the philosopher predicted that x would show up; and
  b. for every person y who did not show up, the philosopher did <u>not</u> predict that y would show up.

(51) *Strong*
  a. For every person x who did show up, the philosopher predicted that x would show up; and
  b. for every person y who did not show up, the philosopher predicted that y would <u>not</u> show up.

The HKH-style approach is more flexible.

- We can always turn the HKH denotation to a partition via R.
- Weakly exhaustive readings are accounted for by conjoining just the true propositions in the set of propositions.
- Intermediate exhaustive readings via exhaustification (Klinedinst & Rothschild 2011).

4 Implicatures

(52) Who did Chomsky invite?
  a. He invited Jakobson.
  b. He didn't invite Jakobson.

- A positive answer is normally exhaustified, e.g., (52a) suggests that Chomsky only invited Jakobson.
- A negative answer is normally understood as a partial answer, e.g., (52b) does not suggest that Chomsky invited everyone else.

This is not due to negation in the answer.

(53) Who did Chomsky not invite?
  a. He didn't invite Jakobson.
  b. He invited Jakobson.

One way to account for this under the HKH-style approach is by assuming that the answer is exhaustified with respect to the question.

For any set Q of propositions and for any proposition p,

(54) $\mathsf{enrich}(p)(Q) = \lambda w_s.\, p(w) = 1$ and for any $q \in Q$, if q is stronger than p, $q(w) = 0$

A simple sentence like "He invited Jakobson" is interpreted as a complete answer.

(55) a. $Q = \{\, \lambda w'_s.$ Chomsky invited x in $w' \mid x$ is a person or people in $w \,\}$
  b. $p = \lambda w'_s.$ Chomsky invited Jakobson in w'

(56) $\lambda w'_s$. Chomsky invited Jakobson in w' and
Chomsky did not invite Jakobson and Halle in w' and
Chomsky did not invite Jakobson and Ross in w' and
Chomsky did not invite Jakobson, Halle, and Ross in w' and $\cdots$

It correctly accounts for the fact that a negative answer does not get strengthened: There's no stronger proposition in Q.

(57) a. $Q = \{\, \lambda w'_s$. Chomsky invited x in $w' \mid x$ is a person or people in $w\,\}$
b. $p = \lambda w'_s$. Chomsky didn't invite Jakobson in w'

The partition approach fails to account for the contrast between the positive question (52) vs. negative question (53) because under the partition approach, they mean the same thing.

(58) $\lambda w_s.\lambda w'_s.\ \{\, x \in D_e \mid \text{Chomsky invited } x \text{ in } w \,\} = \{\, x \in D_e \mid \text{Chomsky invited } x \text{ in } w' \,\}$
$= \lambda w_s.\lambda w'_s.\ \{\, x \in D_e \mid \text{Chomsky didn't invite } x \text{ in } w \,\} = \{\, x \in D_e \mid \text{Chomsky didn't invite } x \text{ in } w' \,\}$

5 Uniqueness presuppositions of singular *which*-phrases

Nothing so far derives the presupposition of (59) that Chomsky saw only one cat.

(59) Which cat did Chomsky see?

5.1 The HK-style approach

Dayal 1996 proposes that all questions presuppose that there is a maximally informative true answer in the set of propositions. Assuming the HK-style denotation without presuppositions:

(60) a. $\lambda w_s.\ \{\, \lambda w'_s$. Chomsky saw x in $w' \mid x$ is a cat in $w\,\}$
b. $\lambda w_s.\ \lambda p_{\langle s,t\rangle}$. for some cat x in w. $p = \lambda w'_s$. Chomsky saw x in w'

(61) For any $Q \subseteq D_{\langle s,t\rangle}$ and for any $w \in D_s$,
Q contains a maximally informative true answer with respect to w iff for some $p \in Q$, $p(w) = 1$ and for each $q \in Q$, if $q(w) = 1$, then p entails q.

Dayal's presupposition:

(62) For any question intension $Q \subseteq D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$,
asking (a question denoting) Q is felicitous with respect to context set c, only if in each $w \in c$, $\mathsf{set}(Q(w))$ contains a maximally informative true answer with respect to w.

For (61), (62) amounts to the requirement that for each $w \in c$, $\{\, \lambda w'_s$. Chomsky saw x in $w' \mid x$ is a cat in $w\,\}$ contain a maximally informative true answer with respect to w. This can only be the case if for each $w \in c$, Chomsky saw exactly one cat in w, because if he saw two cats, there would be two true propositions, neither of which entails the other.

5.2 Exhaustification

Fox 2018 observes that we can understand (62) as arising from a requirement to have the question partition the context set with exhaustification.

(63) $\mathsf{Exh}(p)(Q) = \lambda w_s.\, p(w) = 1$ and for all $q \in Q$, if $q(w) = 1$, then p entails q

(64) For any question intension $Q \subseteq D_{\langle s,\langle\langle s,t\rangle,t\rangle\rangle}$,
asking (a question denoting) Q is felicitous with respect to context set c, only if for each $w \in c$, $\{\, \{\, w' \mid \mathsf{Exh}(p)(Q)(w') = 1 \,\} \mid Q(w)(p) = 1 \,\}$ is a partition on c.

Each cell of the partition is $\{\, w' \mid$ Chomsky saw x in w', and saw in w' no other cats in $w \,\}$ for different different cats x in w. Since this should exhaust c, it follows that it's known that Chomsky saw exactly one cat throughout c.

NB: We can't use Exh to account for the observation about negative answers.

(65) a. Who did Chomsky invite?
b. He didn't invite Jakobson.

- Since (65b) entails no member of the set of propositions, Exh will strengthen it with the negations of these propositions, resulting in: Chomsky invited no one.
- We need to assume that partition is made with Exh, which negates non-weaker alternatives, while the answer is interpreted with enrich, which only negates stronger alternatives.

5.3 Adding presuppositinos

Let's move to the Heim-style presuppositional analysis under the *de dicto* reading with a domain variable (because the *de re* reading is the same as above, except for $\perp$).

(66) $\lambda w_s.\lambda p_{\langle s,t\rangle}:$ each $x \in g(\mathbf{X}_{\hat{e}})$ is a cat in w.
for some $x \in g(\mathbf{X}_{\hat{e}})$, $p = \lambda w'_s:$ x is a cat in w'. Chomsky saw x in w'

As explained above, This will require that for each $w \in c$, each $x \in g(\mathbf{X}_{\hat{e}})$ be a cat in w.

We can universally project the presupposition through Exh (cf. Spector & Sudo 2017).

(67) $\mathsf{Exh}(p)(Q) = \lambda w_s:$ $w \in \mathrm{dom}(p)$ and for each $q \in Q$, $w \in \mathrm{dom}(q)$.
$p(w) = 1$ and for all $q \in Q$, if $q(w) = 1$, then p entails q

5.4 A potential issue: nested questions

(68) Which$_{\mathbf{X}_{\hat{e}}}$ book by which$_{\mathbf{Y}_{\hat{e}}}$ Russian author did Chomsky read?

This will create propositions with conflicting presuppositions:

(69) $$\lambda w_s.\lambda p_{\langle s,t\rangle}: \left[\begin{array}{l}\text{each } y \in g(\mathbf{Y}_{\hat{e}}) \text{ is a Russian author in } w\\ \text{each } x \in g(\mathbf{X}_{\hat{e}}) \text{ is a book by } y \text{ in } w\end{array}\right]. \text{ for some } x \in g(\mathbf{X}_{\hat{e}}),$$
$$p = \lambda w'_s: \left[\begin{array}{l}\text{each } y \in g(\mathbf{Y}_{\hat{e}}) \text{ is a Russian author in } w'\\ \text{each } x \in g(\mathbf{X}_{\hat{e}}) \text{ is a book by } y \text{ in } w'\end{array}\right]. \text{ Chomsky read } x \text{ in } w'$$

Even if we managed to weaken the presupposition:

(70) $$\lambda w_s.\lambda p_{\langle s,t\rangle}: \left[\begin{array}{l}\text{each } y \in g(\mathbf{Y}_{\hat{e}}) \text{ is a Russian author in } w\\ \text{each } x \in g(\mathbf{X}_{\hat{e}}) \text{ is a book by some } y' \in g(\mathbf{Y}_{\hat{e}}) \text{ in } w\end{array}\right]. \text{ for some } x \in g(\mathbf{X}_{\hat{e}}),$$
$$p = \lambda w'_s: \left[\begin{array}{l}\text{each } y \in g(\mathbf{Y}_{\hat{e}}) \text{ is a Russian author in } w'\\ \text{each } x \in g(\mathbf{X}_{\hat{e}}) \text{ is a book by } y' \in g(\mathbf{Y}_{\hat{e}}) \text{ in } w'\end{array}\right]. \text{ Chomsky read } x \text{ in } w'$$

Exh will conjoin the presuppositions of all the propositions, so we will still end up with the presupposition that each book in $g(\mathbf{X}_{\hat{e}})$ was written by all the Russian authors in $g(\mathbf{Y}_{\hat{e}})$, clearly an unwanted result.

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