Man and Woman: the Last Obstacle for Boolean Coordination

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1 Introduction

- The same word, *and*, can be used both intersectively and collectively.

(1) a. John **lies and cheats**. *(intersective)*
b. That **liar and cheat** can not be trusted. *(intersective)*

(2) a. **John and Mary** met in the park last night. *(collective)*
b. A **man and woman** met in the park last night. *(collective)*

- Analytical options:

1. Posit lexical ambiguity (e.g., Link, 1984).
2. Unify based on "non-boolean" set/sum formation (Heycock and Zamparelli, 2005).
3. **This talk**: Unify based on (boolean) intersection (Winter, 2001).

- Analyzing the intersective behavior is easy:

(3) $[\![\text{liar and cheat}]\!] = \lambda x.\mathbf{liar}(x) \wedge \mathbf{cheat}(x)$

- What about the collective behavior?

- In a nutshell: *and* interacts with independently motivated type shifters.
$[\![[_{N'}\ \textit{man and woman}]\!] = [\![[_{DP}\ \textit{a man and a woman}]]\!]$

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2 Analysis: Boolean *And* plus Type Shifters

2.1 The Boolean Assumption in Winter (2001)

- Basic meaning of *and* (e.g., Gazdar, 1980; Winter, 2001) is intersection

(4) $$[\![\text{and}_{bool}]\!] = \sqcap_{\langle\tau,\tau\tau\rangle} =_{def} \begin{cases} \wedge_{\langle t,tt\rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z) \sqcap_{\langle\sigma_2,\sigma_2\sigma_2\rangle} Y(Z) & \text{if } \tau = \sigma_1\sigma_2 \end{cases}$$

- Winter's idea: "distill" generalized quantifiers into (collective) individuals:

(5) $\text{min} =_{def} \lambda Q_{\tau t}\lambda A_\tau.\ A \in Q \wedge \forall B \in Q.\ [B \subseteq A \rightarrow B = A]$

- For example:

(6) a. $[\![\text{John}]\!] = \{P \mid j \in P\}$
b. $[\![\text{Mary}]\!] = \{P \mid m \in P\}$
c. $[\![\text{John and}_{bool} \text{ Mary}]\!] = \{P \mid j \in P\} \cap \{P \mid m \in P\}$
d. $[\![\text{min(John and}_{bool} \text{ Mary)}]\!] = \{\{j, m\}\}$

- Collective predicates are predicates of sets of individuals:
$[\![\text{met (in the park)}]\!] = \{P_{et} \mid P \in \textbf{met}\}$

- Existential closure acts in this case as a silent determiner:

(7) a. **Existential closure:** $E =_{def} \lambda P_{\tau t}\lambda Q_{\tau t}.\ P \cap Q \neq \emptyset$
b. $[\![\text{E(min(}\lambda P.P(\text{john}) \sqcap \lambda P.P(\text{mary})))]\!] = \lambda C_{\langle et,t\rangle}.\{j, m\} \in \text{C}$

2.2 Application to Noun Coordination

- Basic idea: same operators as before, but in different order.

- Assume that E may apply to nouns and nominals (N') without affecting their syntactic category.

(8) $[\![[_{N'} \text{ E(man) and}_{bool} \text{ E(woman)}]]\!]$
$= [\![[_{DP} \text{ a man and}_{bool} \text{ a woman}]]\!]$
$= \lambda P_{et}\exists x\exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y)$

- We need to "distill" this before further use:

(9) $[\![\text{min(E(man) and}_{bool}\text{ E(woman))}]\!]$
$= \lambda P_{et}\exists x\exists y.\mathbf{man}(x) \wedge \mathbf{woman}(y) \wedge P = \{x, y\}$

- Abbreviate this predicate as **mw-pair**.

- This is of type $\langle et, t\rangle$. Determiners expect arguments of type $\langle et\rangle$.

- With Winter, I assume this mismatch is repaired by determiner fitting *dfit*:

(10) $\text{dfit} =_{def} \lambda D_{\langle et,\langle et,t\rangle\rangle}\lambda A_{\langle et,t\rangle}\lambda B_{\langle et,t\rangle}.D(\bigcup A)(\bigcup(A \cap B))$

- Winter motivates this operator by sentences like (11):

(11) No students met.

- Assume that *students* denotes the set of all nonempty sets of students.

- The dfit operator allows us to combine the GQ with the collective predicate:

(12) $[\![\text{dfit(no)(students)(met)}]\!]$
$= [\![\text{no}]\!](\bigcup \text{students})(\bigcup (\text{students} \cap [\![\text{met}]\!]))$
$= [\![\text{no}]\!](\mathbf{student})(\bigcup \{P \in \mathbf{met} : P \subseteq \mathbf{student}\})$
$= \neg\exists x.\ [\mathbf{student}(x) \wedge \exists P.\ P(x) \wedge \mathbf{meet}(P) \wedge \forall y.P(y) \rightarrow \mathbf{student}(y)]$
"No student is a member of a set of students that met".

- My LF for sentence (2b) is:

(13) $[\![\text{dfit(a)(min(E(man) and}_{bool}\text{ E(woman))(meet\_in\_the\_park)}]\!]$
$= \exists(\bigcup \mathbf{mw\text{-}pair})(\bigcup(\mathbf{mw\text{-}pair} \cap \mathbf{meet\_in\_the\_park}))$
$= \exists x.\exists y.\mathbf{man}(x) \wedge \mathbf{woman}(y) \wedge \mathbf{meet\_in\_the\_park}(\{x, y\})$
"At least one man-woman pair met in the park."

- Bonus: using *dfit* makes sure the two people attend the same meeting.

3 Comparison to Previous Work

- Improvement on Link (1984): no lexical ambiguity, hence no redundancy.

- Generalizes to S, VP, DP coordination since our conjunction is boolean.

3.1 Heycock and Zamparelli (2005)

Heycock and Zamparelli (2005): only one entry for *and*, but non-boolean

(14) $[\![\text{and}_{coll}]\!] = \lambda Q_{\langle\tau t,t\rangle}\lambda Q'_{\langle\tau t,t\rangle}\lambda P_{\tau t}\exists A_{\tau t}\exists B_{\tau t}.\ Q(A) \wedge Q'(B) \wedge P = A \cup B$

- Essentially, this combines two sets of sets by computing their cross-product.
- But instead of combining two elements into a pair, it forms their union.
- Nouns and VPs denote sets of singletons. Proper nouns denote singletons or their Montague lifts.

(15) $[\![\text{man and}_{coll}\text{ woman}]\!]$
$= \lambda P_{et}\exists A_{et}\exists B_{et}.\ |A| = 1 \wedge A \subseteq \textbf{man} \wedge |B| = 1 \wedge B \subseteq \textbf{woman} \wedge P = A \cup B$
$= \lambda P_{et}\exists x\exists y.\ \textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x, y\}$

- This is equivalent to my denotation, but uses non-boolean *and*.
- Non-boolean *and* has problems with non-upward-entailing quantifiers:

(16) No man and no woman smiled.

- Suppose a man (John) and a woman (Mary) smile, and nobody else smiles.
- Here we judge (16) to be false but it turns out to be predicted true:

(17) a. $[\![\text{no man}]\!] = \lambda Q_{\langle et,t\rangle}.\neg\exists X_{\langle et\rangle}.[\![\text{man}]\!](X) \wedge Q(X)$
b. $[\![\text{no woman}]\!] = \lambda Q_{\langle et,t\rangle}.\neg\exists X_{\langle et\rangle}.[\![\text{woman}]\!](X) \wedge Q(X)$

- *No man* in (17a) holds of the set A = $\{\{m\}\}$, since A contains no man.
- *No woman* in (17b) holds of the set B = $\{\{j\}\}$, since B contains no woman.
- So *no man and no woman* holds of A ∪ B, that is, $\{\{j\}, \{m\}\}$
- But this set is precisely the denotation of *smiled.* So (16) comes out as true!

- Heycock and Zamparelli suggest scope-splitting negative-concord analyses:

(18) *no man* $\approx$ ⟦not⟧ + ... + ⟦some man⟧ (Ladusaw, 1992)

- First problem: this doesn't work well with coordination.
- Suppose that John and only John smiled.

(19) a. Mary and nobody else smiled. *(false)*
b. It's not the case that Mary and someone else smiled. *(true)*

- Second problem: Standard English doesn't have negative concord.

3.2 Winter (1995, 1998)

- Winter (1995, 1998) takes noun coordination to require pair-forming *and*.

(20) ⟦man and$_{pair}$ woman⟧ $= \langle \lambda x.\mathbf{man}(x), \lambda x.\mathbf{woman}(x)\rangle$

- This ordered pair is propagated upwards, a bit like in alternative semantics.
- At any point, $\sqcap$ can be applied. So, *and* can take variable scope.
- This correctly predicts the two readings of (21):

(21) Every linguist and philosopher knows the Gödel Theorem.
a. Everyone who is both a linguist and a philosopher knows the Gödel Theorem.
b. Every linguist knows the Gödel Theorem, and every philosopher knows the Gödel Theorem.

- But it overgenerates:

(22) ⟦No girl sang and danced⟧ $\neq$ ⟦No girl sang and no girl danced⟧

(23) a. ⟦no girl⟧ $= \lambda P.\neg\exists x[\mathbf{girl}(x) \wedge P(x)]$
b. ⟦sang and$_{pair}$ danced⟧ $= \langle \lambda x.\mathbf{sing}(x), \lambda x.\mathbf{dance}(x)\rangle$
c. (23a)((23b)) $= \langle \neg\exists x[\mathbf{girl}(x)\wedge\mathbf{sing}(x)], \neg\exists x[\mathbf{girl}(x)\wedge\mathbf{dance}(x)]\rangle$
d. Application of $\sqcap$: $\neg\exists x[\mathbf{girl}(x)\wedge\mathbf{sing}(x)]\wedge\neg\exists x[\mathbf{girl}(x)\wedge\mathbf{dance}(x)]$
e. = ⟦No girl sang and$_{pair}$ no girl danced⟧

- The problem arises because boolean intersection can be delayed.
- To prevent this, Winter (1998) would have to make VP an "island" for $\sqcap$.
- As for me, I have to prevent E from applying to verbs.
- The latter is natural since E is a choice-function operator (Winter, 2001).

4 *And* vs. *Or*

- I assume Gazdar (1980)'s entry for *or*:

(24) $[\![\text{or}_{bool}]\!] = \sqcup_{\langle\tau,\tau\tau\rangle} =_{def} \begin{cases} \vee_{\langle t,tt\rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z) \sqcup_{\langle\sigma_2,\sigma_2\sigma_2\rangle} Y(Z) & \text{if } \tau = \sigma_1\sigma_2 \end{cases}$

- Bergmann (1982): Why is (25a) equivalent but not (25b)?

(25) a. Every cat and dog is licensed. $\Leftrightarrow$ Every cat or dog is licensed.
b. A cat and dog came running in. $\not\Leftrightarrow$ A cat or dog came running in.

- My answer: Two equivalent LFs for the sentences in (25a):

(26) a. dfit(every)(min(E(cat) and$_{bool}$ E(dog)))(dist(be_licensed))
b. $\bigcup\{\{x,y\}|\mathbf{cat}(x)\wedge\mathbf{dog}(y)\} \subseteq \bigcup\{\{x,y\}|\mathbf{cat}(x)\wedge\mathbf{dog}(y)\wedge\{x,y\} \subseteq \mathbf{be\_licensed}\}$

(27) a. every(cat or$_{bool}$ dog)(be_licensed)
b. $\mathbf{cat} \cup \mathbf{dog} \subseteq \mathbf{be\_licensed}$

- My account generates only nonequivalent LFs for the sentences in (25b):

(28) a. dfit(a)(min(E(cat) and$_{bool}$ E(dog)))(dist(come_running_in))
b. $\exists x \exists y.\mathbf{cat}(x) \wedge \mathbf{dog}(y) \wedge \{x,y\} \subseteq \mathbf{come\_running\_in}$

(29) a. a(cat or$_{bool}$ dog)(come_running_in)
b. $\exists x.(\mathbf{cat}(x) \vee \mathbf{dog}(x)) \wedge \mathbf{come\_running\_in}(x)$

5 The Non-Ambiguity of *Or*

- Unlike *and*, *or* never has boolean/collective "ambiguity" (Payne, 1985).
- Why is this so? The answer for noun coordination:
- *N1 and N2* can be "N1 and$_{bool}$ N2" or "min(E(N1) and$_{bool}$ E(N2))".
  These structures lead to different readings, as we have seen.
- *N1 or N2* can be "N1 or$_{bool}$ N2" or "min(E(N1) or$_{bool}$ E(N2))".
  These two structures evaluate to almost the same thing, and determiner fitting obliterates the remaining difference:

(30) Every cat or dog was licensed.

(31) dfit(every) (min(E(cat)) or$_{bool}$ min(E(dog))) (dist(be_licensed))
$= \text{dfit(every)}\ \ (\min(\{P|P \cap \mathbf{cat} \neq \emptyset \vee P \cap \mathbf{dog} \neq \emptyset\})\ \ (\{P|P \neq \emptyset \wedge P \subseteq \mathbf{be\_licensed}\})$
$= \bigcup\{\{x\}|x \in (\mathbf{cat} \cup \mathbf{dog})\} \subseteq \bigcup(\{\{x\}|x \in (\mathbf{cat} \cup \mathbf{dog})\} \cap \{P|P \neq \emptyset \wedge P \subseteq \mathbf{be\_licensed}\}$
$= (\mathbf{cat} \cup \mathbf{dog}) \subseteq ((\mathbf{cat} \cup \mathbf{dog}) \cap \mathbf{be\_licensed})$
$= (\mathbf{cat} \cup \mathbf{dog}) \subseteq \mathbf{be\_licensed}$
= dfit(every) (min(cat or$_{bool}$ dog)) (dist(be_licensed))

6 Summary and Outlook

- The boolean option is arguably the only unproblematic one outside the DP.
- I have shown that it is also preferrable within the DP.
- Next steps:
  - plural nouns (e.g. *Ten men and women got married today*)
  - "hydras" (e.g. *every man and woman who met*) (Link, 1984).
  - agreement across languages (Heycock and Zamparelli, 2005)

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