Embedded Disjunctions and the Best Response Paradigm

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The issue: Embedded Implicature

Example

- Kate found her blue or her red marble.

$+>$ Scalar: Kate did not find her blue and her red marble.

$+>$ Clausal: $\Diamond$ /$\Diamond\neg$ Kate did find her blue marble;
$\Diamond$ /$\Diamond\neg$ Kate did find her red marble;

Un–embedded disjunctions:

- Not licensed if speaker knows world (cooperativity, quantity)
- Give rise to ignorance implicature

Aim:

- Experimental study of embedded disjunctions
- Context: Speaker knows exact state of world

Test sentences: Embedded Implicature of Disjunctions

- All of the girls found their red or their blue marble.
- Some of the girls found their red or their blue marble.
- All of the girls found their red, their blue, or their green marble.
- Some of the girls found their red, their blue, or their green marble.

Embedded Implicature

Test implicature of complex sentences:

(A) the embedded exclusive reading of disjunction,
e.g. $\forall(r \vee b) \ +\!\!> \ \textit{all either r or b}$;

(B) the global implicature: $\exists(r \vee b)$ and $\exists(r \vee b \vee g) \ +\!\!>$
none $r \wedge b$, none $r \wedge g$, and none $b \wedge g$;

(C) the exhaustive implicature: $\forall(r \vee b)$ and $\exists(r \vee b) \ +\!\!>$
none found their green marble;

(D) the *existence implicature* of the embedded disjunctions, for example
$\forall(r \vee b) \ +\!\!>$ all $(r \vee b)$ to some $r \wedge$ some b.

Theoretical problem

Example (Items)

1. All of the girls found their red or their blue marble.
2. Some of the girls found their red or their blue marble.

- Chierchia (2004): (2) $+>$ some $(r \dot{\vee} b)$ and $\neg$ all $(r \vee b)$
- Sauerland (2004): (1) $+>$ $\neg$ all $(r \wedge b)$
- Franke (2009):
  (1) $+>$ $\neg$ some $(r \wedge b)$
  (2) $+>$ some $(r \vee b)$ and $\neg$ some $(r \wedge b)$
- Benz (2012): not addressed.

Theoretical problem

Example (Items)

1. All of the girls found their red or their blue marble.
2. Some of the girls found their red or their blue marble.
3. All of the girls found their red and their blue marble.
4. Some of the girls found their red and their blue marble.

- Franke (2009): (4) $+>$ some $(r \wedge b)$ and $\neg$ all $(r \vee b)$
- none: explanation of: none found their green marble.
- only Sauerland (2004): (1), (2) $+>$ some r and some b.

Section 1

Previous Experimental Studies on Embedded Implicature)

Experiments on embedded implicature

Previous studies:

- Existence of embedded implicature still controversial
- Previous experimental paradigms show inconsistent findings and have all been criticized on methodological grounds
  Geurts & Pouscolous 2009, Chemla & Spector 2011, Geurts & v. Tiel 2013

Best response paradigm (Gotzner & Benz, in revision): Design goals

- Develop organic action-based task to avoid metalinguistic judgments
- Connect scenario to game-theoretic model to derive precise predictions for utterance interpretation in context
- Experimental evidence for embedded implicature of *some* (under *every* and *some* itself)

The best response paradigm: Methods

Scenario:

- 4 girls who each own a set of 4 special edition marbles;
- marbles get lost during play (Degen & Goodman, 2014)
- girls have to clean up and find their marbles
- mother offers rewards to girls

Reward system:

- chocolate: girl finds all 4 of her marbles
- candy: girl finds fewer than 4 of her marbles
- gummy bears: girl finds none of her marbles (consolation prize)

Instructions

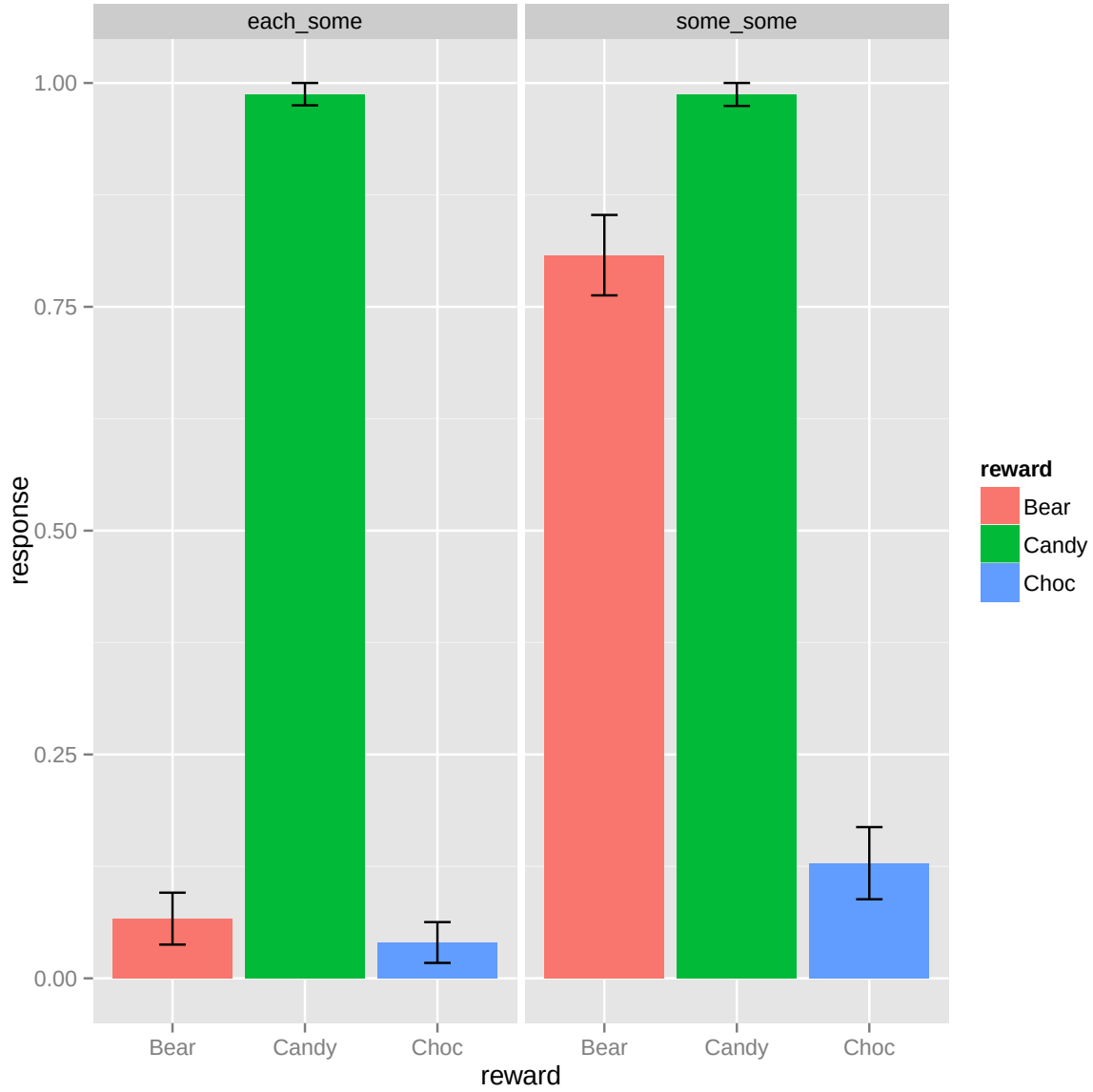
- Mother tells participants how many marbles each girl found
- Task: Participants are asked to buy sweets for the girls

Example

Sentence: **No girl found any of her marbles**

Chocolate	☐	YES	*X*	No
Candy	☐	YES	*X*	No
Gummy bear	*X*	YES	☐	No

Results


each_some
some_some
1.00
0.75
0.50
0.25
0.00
response
Bear
Candy
Choc
Bear
Candy
Choc
reward
reward
Bear
Candy
Choc

Section 2

Embedded Disjunctions in the Best Response Paradigm

Critical Items

Example (Items)

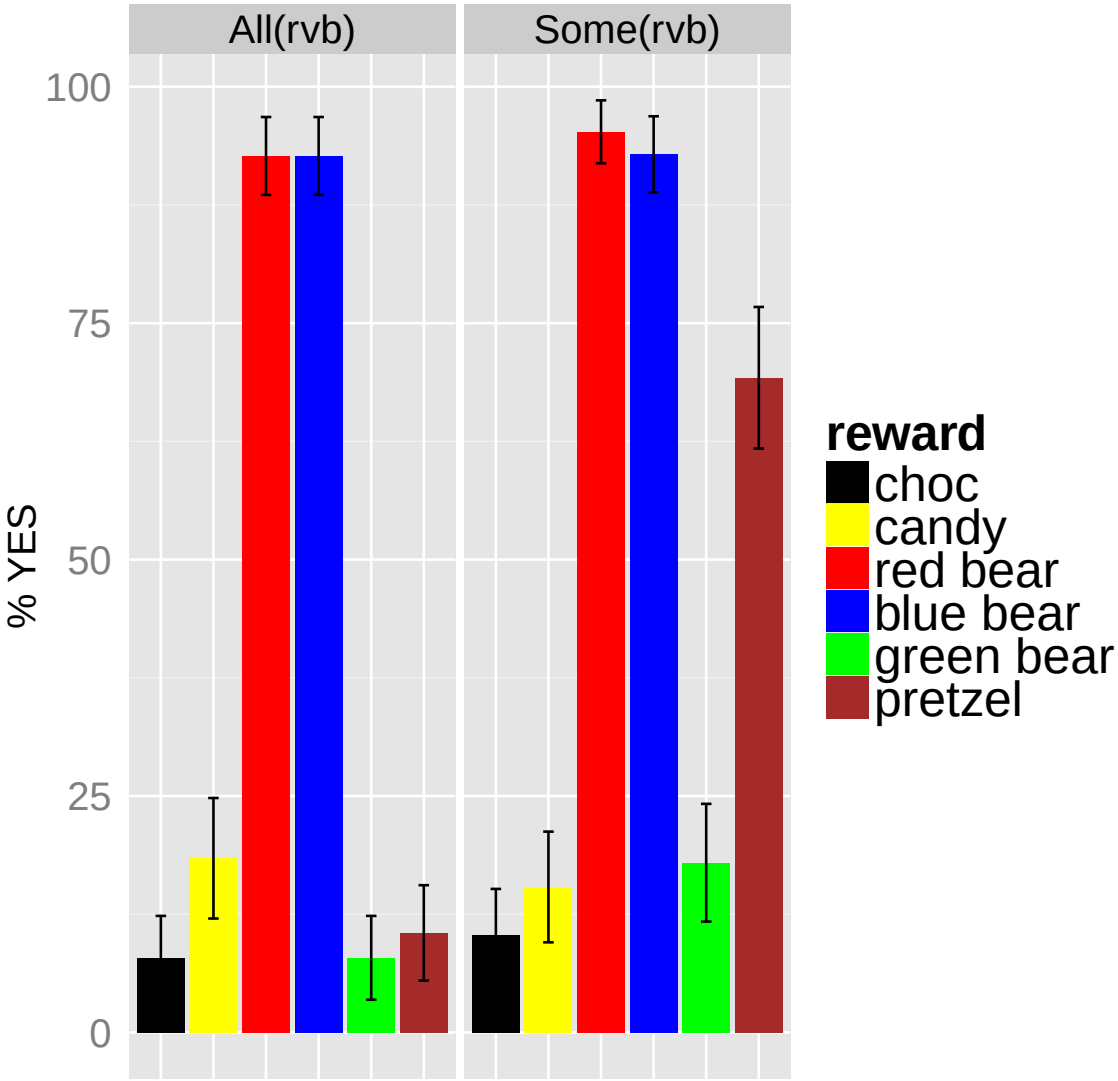
1. All of the girls found their red or their blue marble.
2. Some of the girls found their red or their blue marble.
3. All of the girls found their red, their blue, or their green marble.
4. Some of the girls found their red, their blue, or their green marble.

Experiment on disjunction under embedding

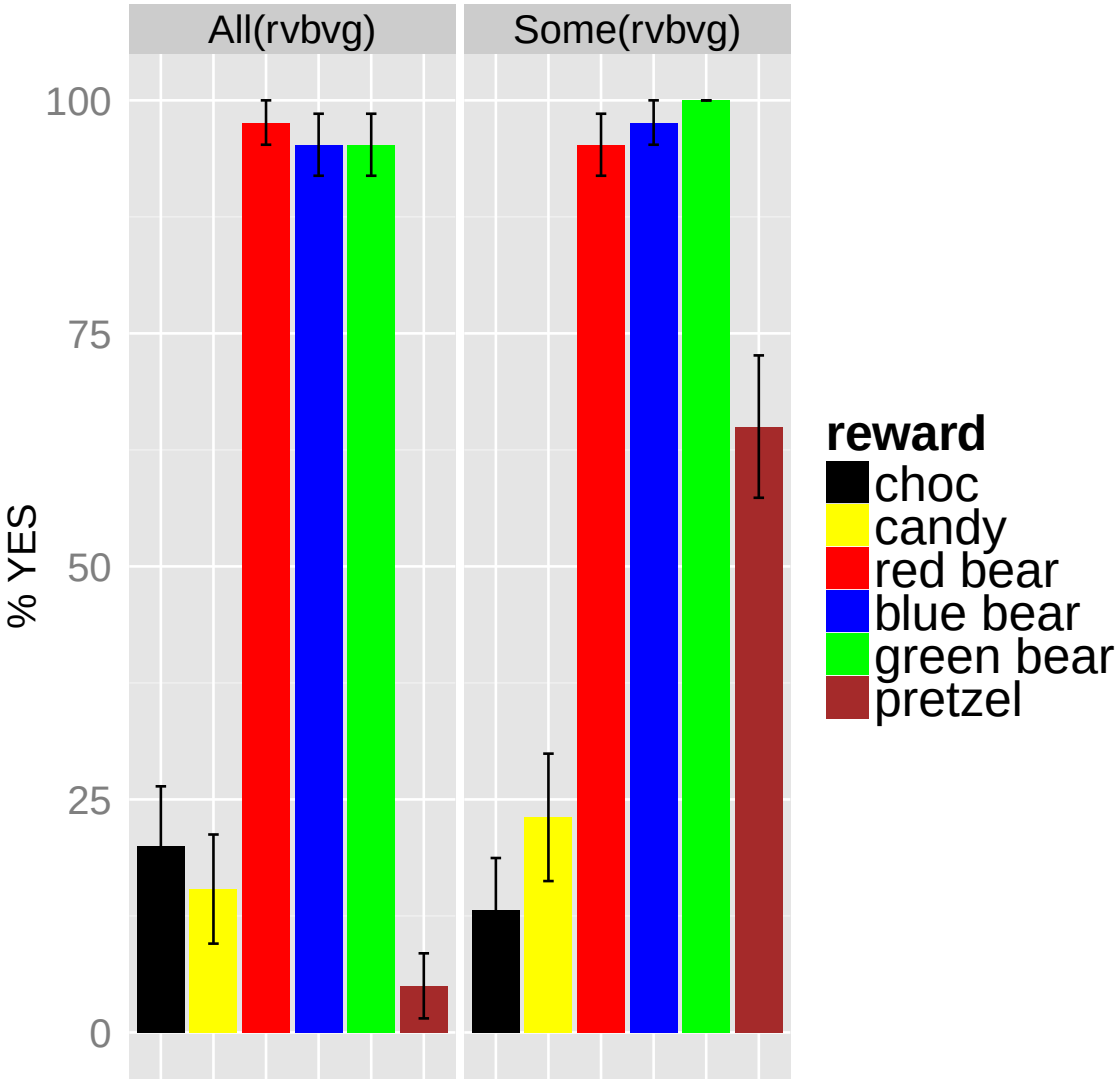
Methods

- Same task and instructions as in best response paradigm
- New reward system:
  - chocolate: all 3 marbles
  - candy: 2 marbles
  - gummy bear: 1 marble
    - green gummy bear: green marble
    - red gummy bear: red marble
    - blue gummy bear: blue marble
  - pretzel stick: 0 marbles

Results


All(rvb)
Some(rvb)
100
75
50
25
0
% YES
reward
choc
candy
red bear
blue bear
green bear
pretzel

Results


All(rvbvg)
Some(rvbvg)
100
75
50
25
0
% YES
reward
choc
candy
red bear
blue bear
green bear
pretzel

Section 3

A Model of the Experiment

The Experiment as Signalling Game

Playing the game:

1. Mother = speaker knows actual world
2. Mother chooses an utterance
3. Subject chooses an action: buying sweets
4. Game ends

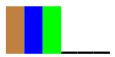
- Game structure common knowledge
- Game of pure coordination: preferences aligned

Preferences:

- Every girl should get her appropriate sweet
- No superfluous sweets should be bought

Possible Worlds Defined by Reward System

- 6 different rewards
- reward system distinguishes $2^6 - 1 = 63$ worlds
- with 4 girls $\sum_i^4 \binom{6}{i} = 56$ can be realised

pretzl	blue gb	green gb	red gb	candy	choc	world
1	1	1	1	0	0	
1	1	1	0	0	0	
1	1	0	0	1	0	
			...			

Inferring Interpretation from Choice of Sweets

Example

- **Target:** All of the girls found their red or their blue marble.
- **Choice:** red & blue gummy bears.

- 24 worlds semantically consistent with target
- 1 world consistent with choice

pretzl	blue gb	green gb	red gb	candy	choc	cons
0	1	1	1	1	1	–
0	1	1	1	1	0	–
0	1	1	1	0	1	–
0	1	1	1	0	0	–
0	1	0	1	1	1	–
0	1	0	1	1	0	–
0	1	0	1	0	1	–
0	1	0	1	0	0	✓

+ 16 other worlds

Effect of Epistemic Uncertainty

Example

- **Target:** All of the girls found their red or their blue marble.
- **Choice:** red & blue gummy bears.

- 3 additional information states consistent with choice

inf. state	pretzl	blue gb	green gb	red gb	candy	choc
I	0	1	0	1	0	0
II	0	1	0	1	0	0
	0	1	0	0	0	0
III	0	1	0	1	0	0
	0	0	0	1	0	0
IV	0	1	0	0	0	0
	0	0	0	1	0	0

Evaluation of Result

Example

- **Target:** All of the girls found their red or their blue marble.
- **Choice:** red & blue gummy bears.

All information states verify:

(A) the embedded exclusive reading: $\forall(r \vee b) \; +\!> \textit{all either r or b}$;

(C) the exhaustive implicature: $\forall(r \vee b) \; +\!> \textit{none found their green marble}$;

(D') the *existence implicature*: $\forall(r \vee b) \; +\!> \Diamond\text{some } r \wedge \Diamond\text{some } b$.

With information state I only (world ):

(D) the full *existence implicature*: $\forall(r \vee b) \; +\!> \text{some } r \wedge \text{some } b$.

Inferring Interpretation from Choice of Sweets

Example

- **Target:** Some of the girls found their red or their blue marble.
- **Choice:** red & blue gummy bears, pretzels.

- 48 worlds semantically consistent with target
- 1 world consistent with choice

pretzl	blue gb	green gb	red gb	candy	choc	cons
1	1	1	1	1	1	–
1	1	1	1	1	0	–
1	1	1	1	0	1	–
1	1	1	1	0	0	–
1	1	0	1	1	1	–
1	1	0	1	1	0	–
1	1	0	1	0	1	–
1	1	0	1	0	0	✓

+ 40 other worlds

Effect of Epistemic Uncertainty

Example

- **Target:** Some of the girls found their red or their blue marble.
- **Choice:** red & blue gummy bears, pretzels.

- 161 additional information states consistent with choice

inf. state	pretzl	blue gb	green gb	red gb	candy	choc
	1	1	0	1	0	0
	1	1	0	0	0	0
	1	0	0	1	0	0
	1	0	0	1	0	0
	0	1	0	1	0	0
	0	1	0	0	0	0
	0	0	0	1	0	0
	0	0	0	1	0	0

Evaluation of Result

Example

- **Target:** Some of the girls found their red or their blue marble.
- **Choice:** red & blue gummy bears, pretzels.

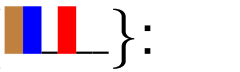
All information states verify:

(A) the embedded exclusive reading: $\exists(r \vee b) \; +\!> \textit{some either } r \textit{ or } b$;

(B) the global implicature: $\exists(r \vee b) \; +\!>$ none $r \wedge b$, none $r \wedge g$, and none $b \wedge g$;

(C) the exhaustive implicature: $\exists(r \vee b) \; +\!> \textit{none found their green marble}$;

(D') the *existence implicature*: $\exists(r \vee b) \; +\!> \Diamond$some $r \wedge \Diamond$some b.

With information state {  }:

(D) the full *existence implicature*: $\forall(r \vee b) \; +\!>$ some $r \wedge$ some b.

Discussion

Evidence for:

- Embedded implicature of disjunction.
- Exhaustive reading of embedded disjunctions.
- Weak existence implicature.

Problem:

- No existing theory can account for all observed readings
- How to ensure experimentally that listener is certain about state of the world?

Thank you for your attention!

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