Is each type of strengthening explained by implicature or neglect-zero?

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Collaborators

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A selection of strengthenings

1. **Some of the** squares are white
2. **Less than three** squares are black
3. **Each** squarehh is black or white

(□, □, □)	(■, ■, □)	(■, ■, ■)	(△, ▲, ▲)
×	✓	#	#
×	✓	#	#
#	✓	#	#

How do all the # come about?

A selection of strengthenings

More generally:

1. Some of the squares are white.
⇝ There are non-white squares. (**UPP**)

2. Less than three squares are black.
⇝ There are black squares. (**NE-Scope in ESQ**)

3. Each square is black or white.
⇝ There are black and white squares. (**DIV**)

4. [**1**—**3**]
⇝ There are squares. (**NE-Restr**)

Theoretical accounts differ

...in fundamental assumptions

- **Implicature**: negation of alternatives (Grice, 1975; Reinhart, 2004; Abusch & Rooth, 2004; Geurts, 2010; Franke, 2011; Crnič et al., 2015; Bar-Lev & Fox, 2023)
- **Neglect-zero**: ∅-models ignored
  - Simplified verification algorithm in W-quantifier account (Bott, Schlotterbeck & Klein, 2019)
  - Bias encoded by NE atom in BSML and extensions (Aloni, 2022; Aloni & van Ormondt, 2023)
- **Presupposition**: NE-RESTR in (strong) determiners (Strawson, 1952; de Jong & Verkuyl, 1985; Diesing, 1992; Geurts, 2008)

Theoretical accounts differ

...in empirical coverage

Strengthening	Negate alternatives	Presupposition	Neglect Zero
NE-RESTR	**(✓)**	**✓**	**✓**
NE-SCOPE	**✓**	**NA**	**✓**
UPP	**✓**	**NA**	**NA**
DIV	**✓**	**NA**	**✓**

Theoretical accounts differ

1. **Some of the** squares are white
2. **Less than three** squares are black
3. **Each** square is black or white

(□, □, □)	(■, ■, □)	(■, ■, ■)	(△, ▲, ▲)
×	✓	#	#
×	✓	#	#
#	✓	#	#

Theoretical accounts also differ in assumptions about processing

Implicatures

1. Access literal meaning
2. Generate alternatives (potentially strengthened recursively)
3. Negate alternatives

Reduced rates in embedded positions (e.g. in questions) since step 2 may depend on embedding context

Theoretical accounts also differ in assumptions about processing

Neglect-zero

1. Consider only non-empty models (because of cognitive bias and simplicity)
2. Potentially include also empty models
   - Via extra rule in algorithmic W-quantifier account
   - Via global or local suspension of bias in BSML and extensions

Expected also in embedded positions (e.g. in questions) because step 1 does not depend on embedding

Presupposition

1. Check presupposition
2. Evaluate other meaning aspects
   (e.g. answer polar question)

Projection (e.g. from questions) expected

There is empirical work on all mentioned assumptions

We tested predictions derived from these assumptions experimentally using data from:

1. question-answering
2. priming

Experiment 1: Question-Answering Task

Neglect-Zero Effects in the Interpretation of Quantifiers and Disjunction

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Aims

Direct cross-experimental comparison of the processing profile *(response behavior and RT) of UPP, DIV, NE-Scope and NE-Restr*

Test for their ***robustness in polar questions***

Design

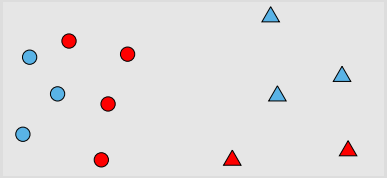
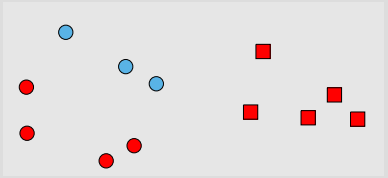
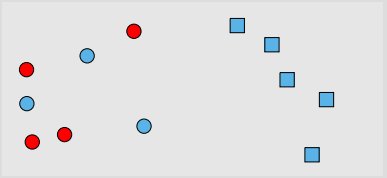
Three sub-experiments, within participants

- **Experiment 1a**: empty-set (ES) vs. non-empty-set (NES) quantifiers
  (e.g. *no* vs. *every*)
- **Experiment 1b**: Disjunction embedded under a universal quantifier
- **Experiment 1c**: *some*

all embedded in polar questions

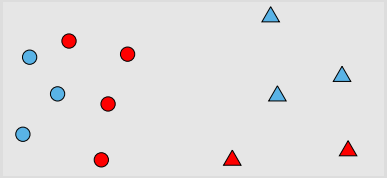
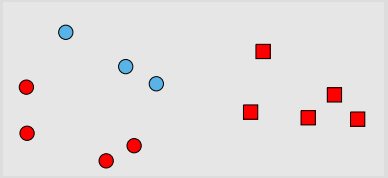
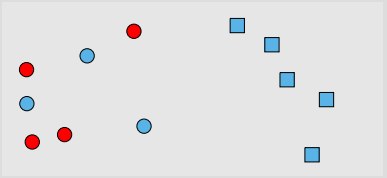
Experiment 1a: ES & NES quantifiers

Are more than four squares blue?

∅ *restrictor*	∅ *scope*	⊤	⊥
			

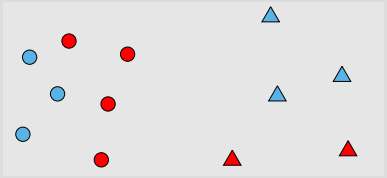
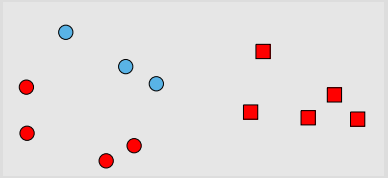
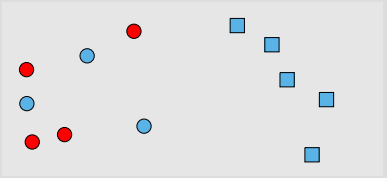
Experiment 1a: ES & NES quantifiers

Are fewer than four squares blue?

∅ *restrictor*	∅ *scope*	⊥	⊤
			

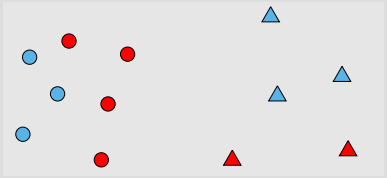
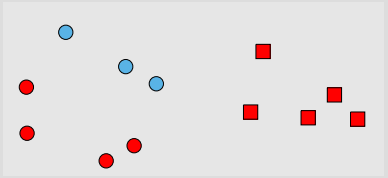
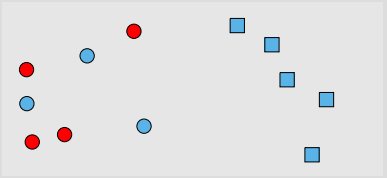
Experiment 1a: ES & NES quantifiers

Is every square blue?

∅ *restrictor*	∅ *scope*	⊤	⊥
			

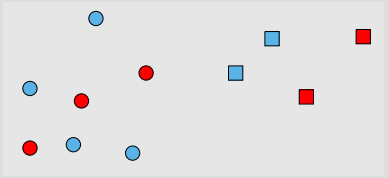
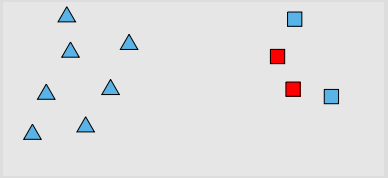
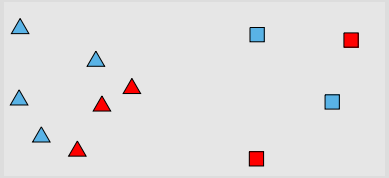
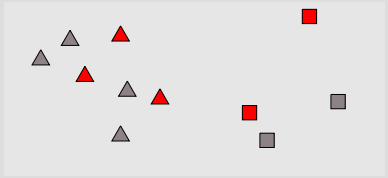
Experiment 1a: ES & NES quantifiers

Is no square blue?

∅ *restrictor*	∅ *scope*	⊥	⊥
			

Experiment 1b: Disjunction under universal quantifier

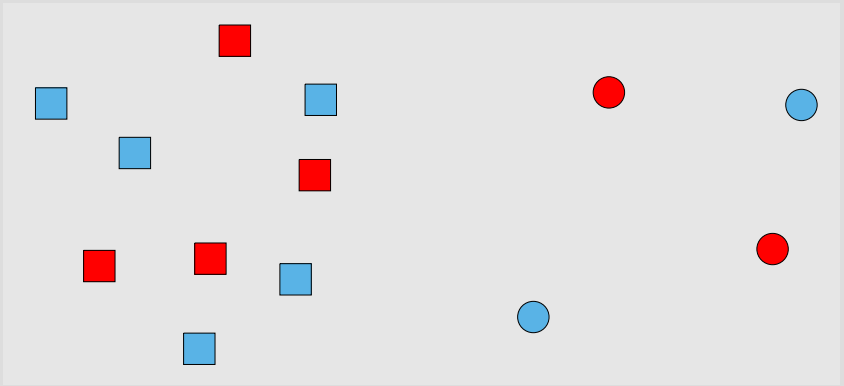
Is every triangle either blue or red?

∅ restrictor	*D-violation*	⊤	⊥
			

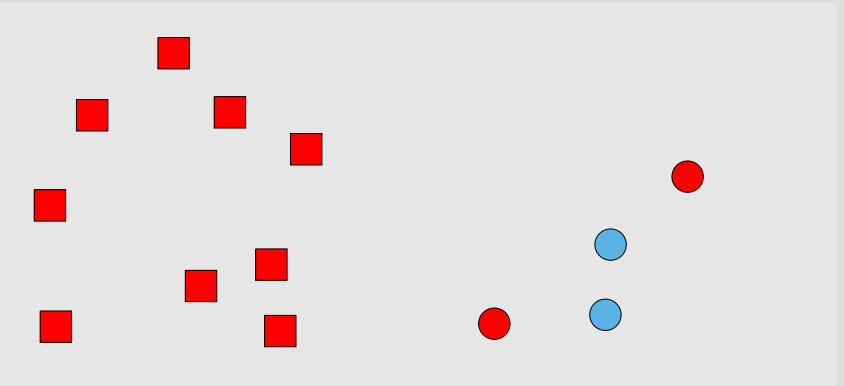
Experiment 1c: Scalar item *some*

Are some squares red?

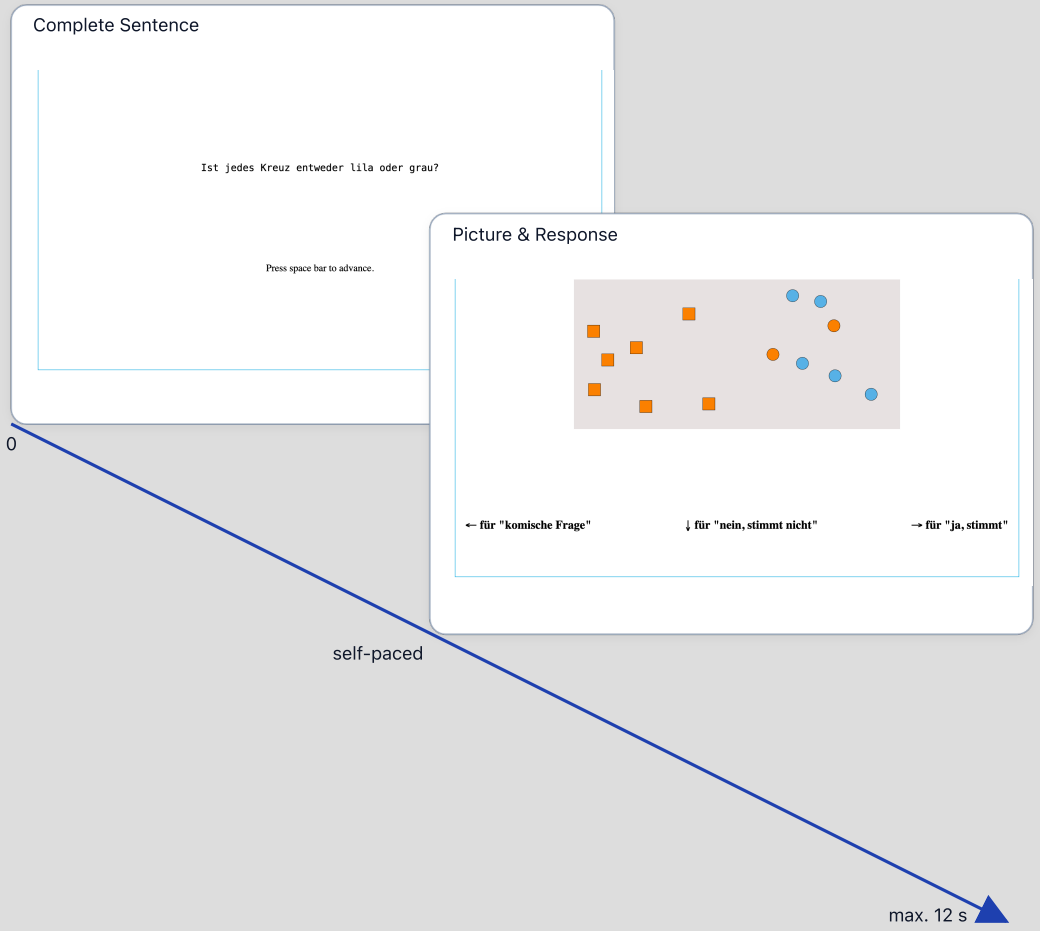
some but not all



all



Procedure


Complete Sentence
Ist jedes Kreuz entweder lila oder grau?
Press space bar to advance.
Picture & Response
← für "komische Frage"
↓ für "nein, stimmt nicht"
→ für "ja, stimmt"
0
self-paced
max. 12 s

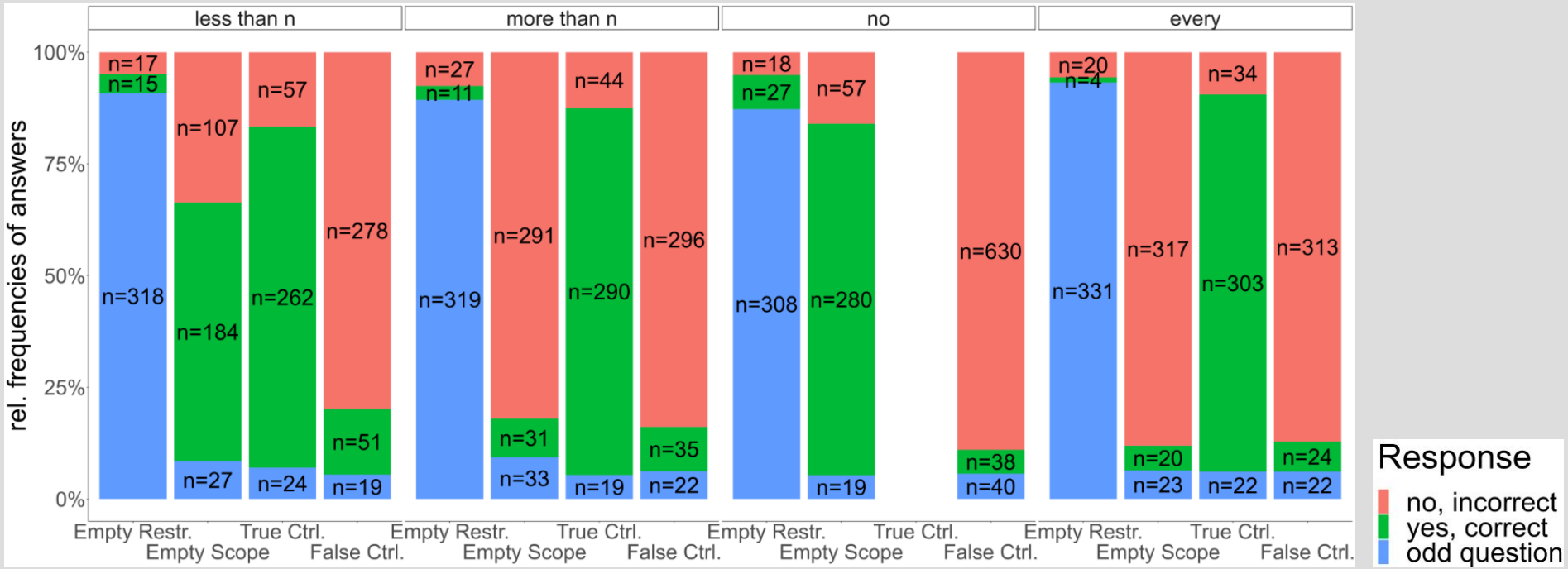
Predictions

- **NE-Restr**: "odd question" responses with fast RT (assuming presupposition account)
- **UPP**: Reduced amount of strengthening with delay in rejecting literal interpretation (assuming implicature account)
- **NE-Scope**: Substantial amount of strengthening slow RT but no extra delay in rejecting literal interpretation (assuming W-quantifier account, as special case of neglect-∅)
- **DIV**: Substantial amount of strengthening with no delay (assuming neglect-∅ account based on BSML)

Results

Experiment 1a

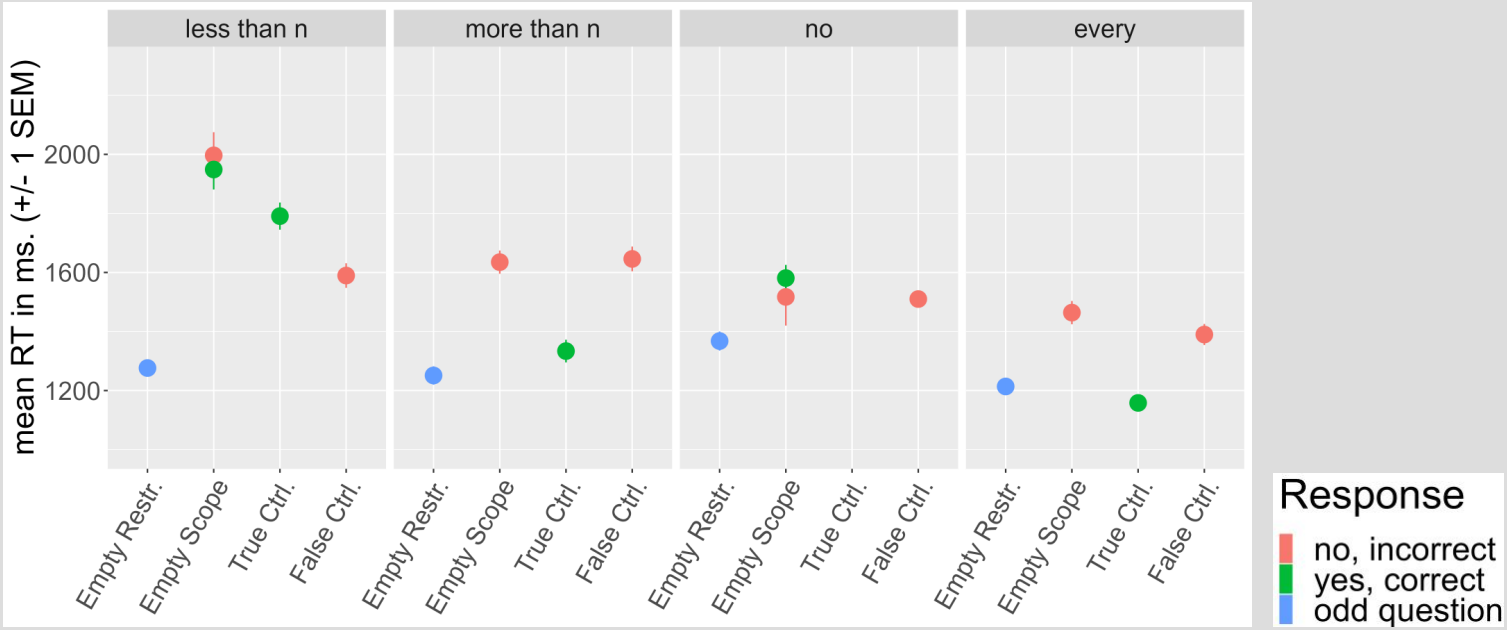
Response distributions



- Questions with *empty restrictors* judged as odd
- 34% *"no, incorrect"* responses for *Less than n* with *empty scope*

Experiment 1a

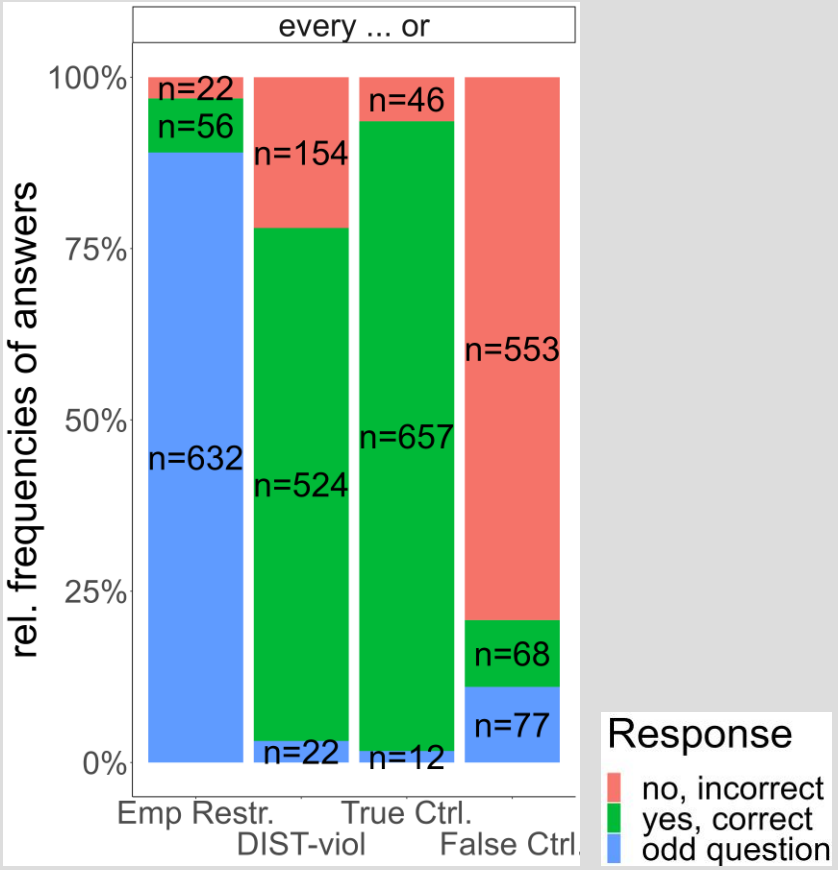
Judgment RT (of 'legit' responses)



- Empty restrictors judged fast
- *Answer polarity* × *monotonicity* interaction (Just & Carpenter, 1971)
- Both responses for ES-quantifiers in zero models equally fast
- General delay in zero models for *fewer than n*

Experiment 1b

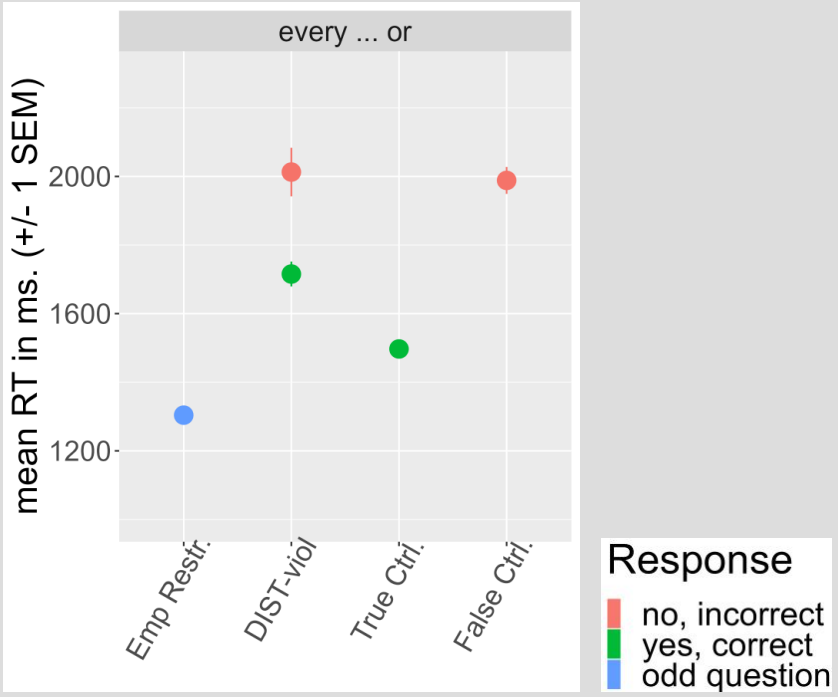
Response distributions



- Empty restrictors judged as odd
- ∅-models (violating DIV) accepted less often than true control

Experiment 1b

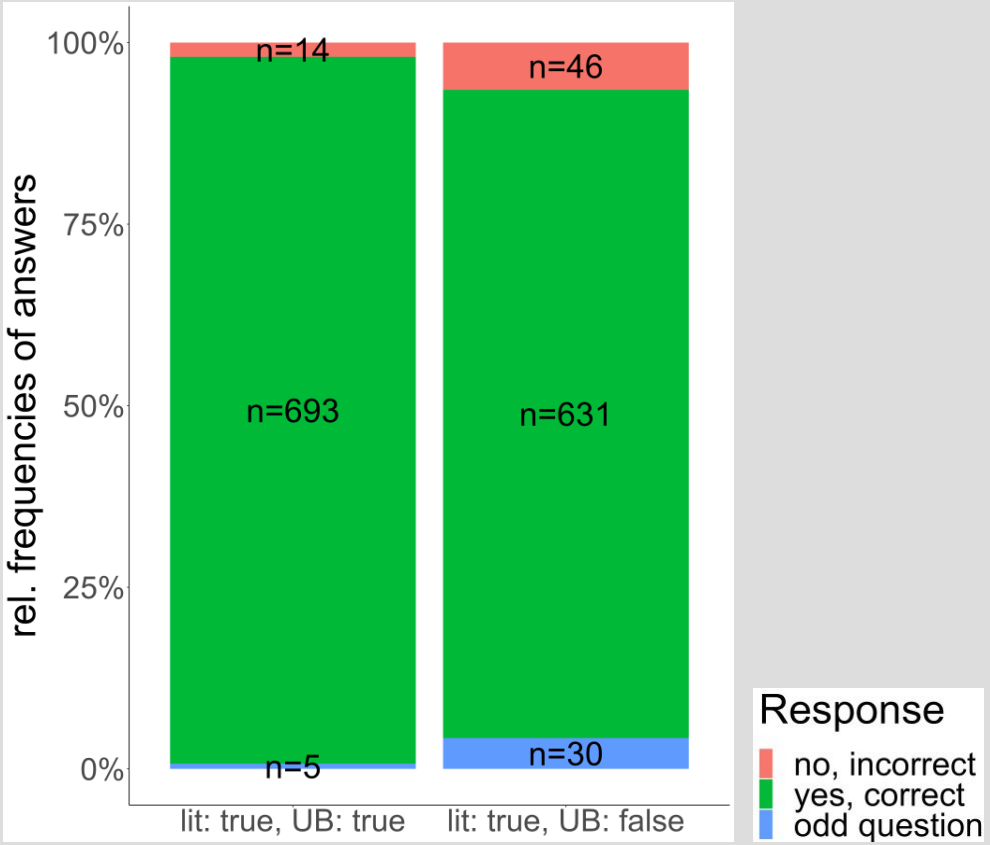
Judgment RT of "legit" responses



- Effect of answer polarity
- Evaluation of ∅-models comparable to false controls
- No evidence for enrichment costs

Experiment 1c

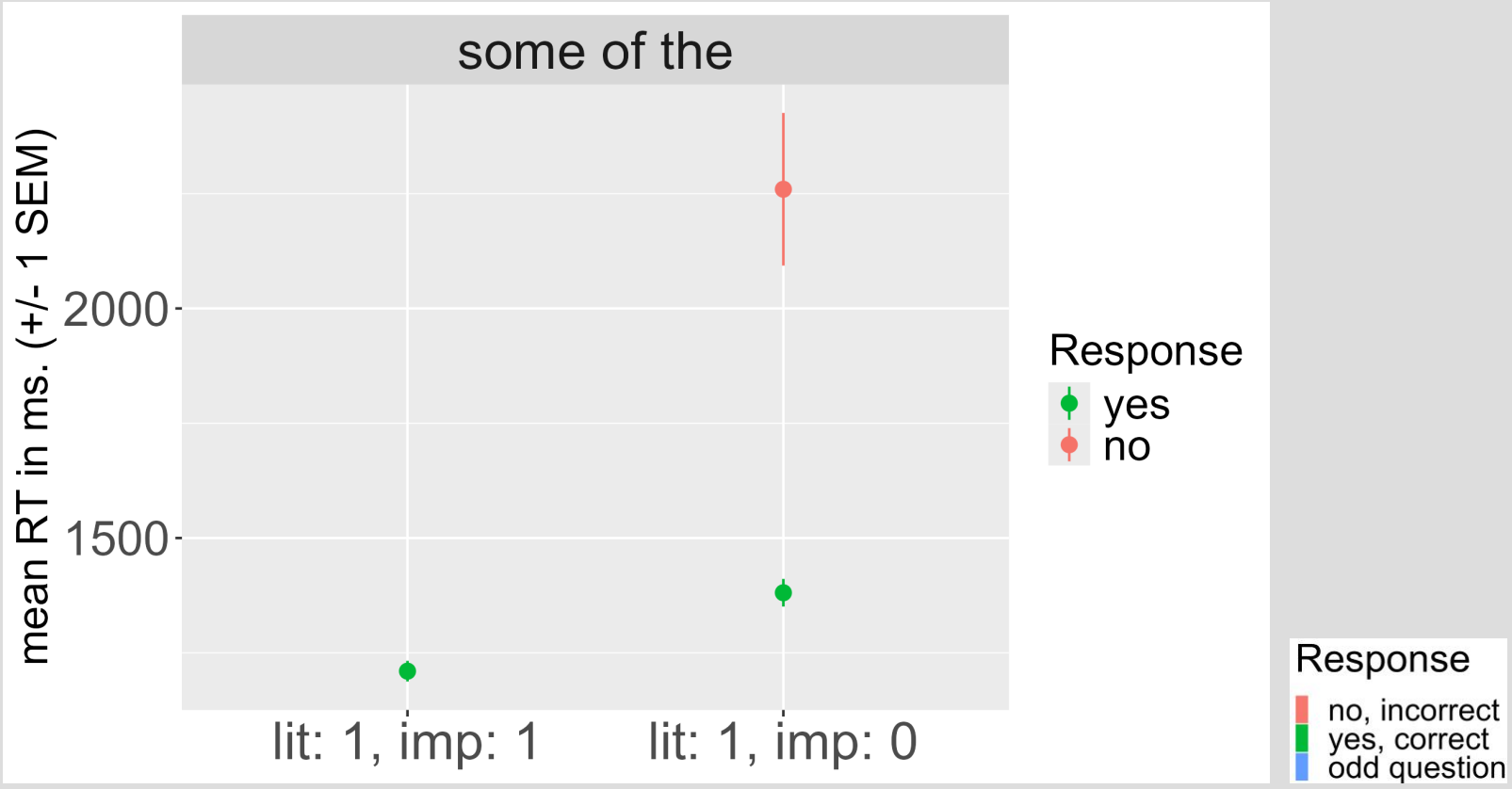
Response distributions



- More "*no-incorrect*" and "*odd-question*" responses in *all*- than in *some-but-not-all* models

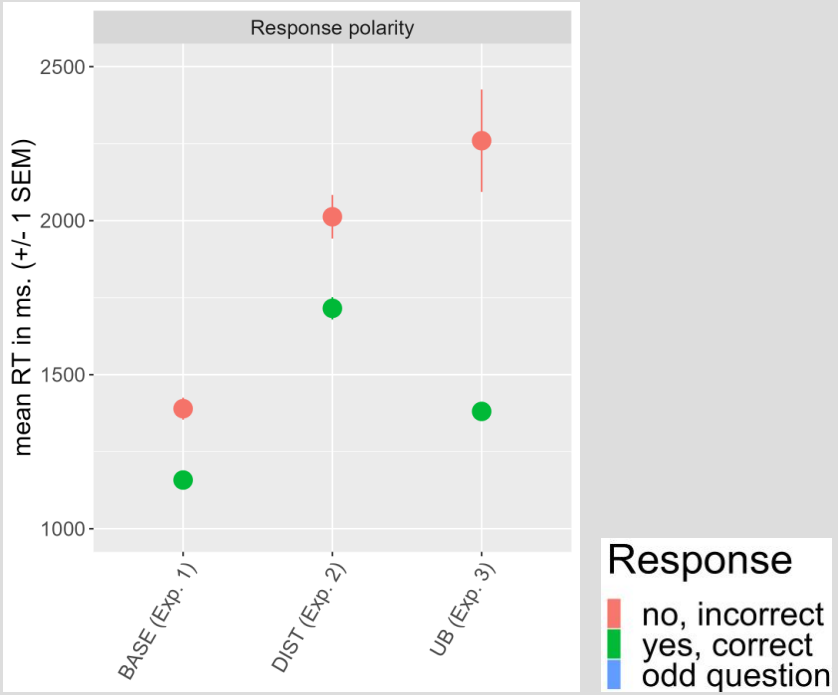
Experiment 1c

Judgment-RT (of 'legit' responses)



- Substantial slowdown in enriched *"no"* responses

Comparison of polarity effect across sub-experiments



- Slowdown in UPP on top of polarity effect

Discussion

Variation between phenomena

- **NE-Restr**: "odd question" responses with fast RT
- **UPP**: Reduced amount of strengthening with delay in rejecting literal interpretation
- **NE-Scope**: Substantial amount of strengthening slow RT but no extra delay in rejecting literal interpretation
- **DIV**: Substantial amount of strengthening with no delay

Discussion

Strengthenings and Theoretical Explanations

Strengthening	Negate alternatives	Presupposition	W-quantifier	Neglect Zero
NE-Restr	**(✓)**	**✓**	**NA**	**✓**
NE-Scope	**✓**	**NA**	**✓**	**✓**
UPP	**✓**	**NA**	**NA**	**NA**
DIV	**✓**	**NA**	**X**	**✓**

Are different computations involved in NE-Scope vs. DIV?

Discussion

- However, **'processing profiles' may be difficult to interpret**, e.g. due to multiple factors being at play (cf. answer-polarity effects)
- Therefore, a **more direct test of shared vs. distinct computations** would be desireable

Experiment 2: Across-Construction Priming

Neglect zero: evidence from priming across constructions

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(CogSci Proceedings 2025)

Motivation & aims

Background

- Structural priming can reveal shared semantic and pragmatic computations (e.g. Raffray & Pickering, 2010; Feiman & Snedeker, 2016; Marty et al., 2024)
- In particular, priming has been shown among scalar inferences with '*some*' and *numerals* but not *Free Choice disjunction* (explained by neglect zero)
  1. Some of the houses have a fence
     ⇝ There are houses without a fence
  2. There are four houses
     ⇝ There are no more than four houses
  3. You may go to the blue or the red truck
     ⇝ You may go to the blue truck and you may got to the red truck

(Meyer & Feiman, 2021; in line with Aloni, 2022)

Current experiment

- Uses cross-construction priming to test for shared computations in NE-Scope, DIS & UPP:
  1. Some of the squares are white
     $\Rightarrow$ There are non-white squares (**UPP**)
  2. Less than three squares are black
     $\Rightarrow$ There are black squares (NE-Scope in **ESQ**)
  3. Each square is black or white
     $\Rightarrow$ There are black and white squares (**DIV**)

Same computations involved?

1. **Some of the** squares are white
2. **Less than three** squares are black
3. **Each** square is black or white

(□, □, □)	(■, ■, □)	(■, ■, ■)	(△, ▲, ▲)
×	✓	#	#
×	✓	#	#
#	✓	#	#

Same computations involved here?

1. **Some of the** squares are white
2. **Less than three** squares are black
3. **Each** square is black or white

(□, □, □)	(■, ■, □)	(■, ■, ■)	(△, ▲, ▲)
×	✓	#	#
×	✓	#	#
#	✓	#	#

Hypotheses & Predictions

Based on previous results and theoretical considerations (e.g. Bott, Schlotterbeck & Klein, 2019; Aloni, 2022):

- Priming between DIV and ESQ (since they may both involve the neglect zero bias)
- No priming between UPP and ESQ...
- and between UPP and DIV (since computations may differ)

Design

Three sub-experiments, between participants

- **Experiment 2a**: DIV ⇨ ESQ?
- **Experiment 2b**: UPP ⇨ ESQ?
- **Experiment 2c**: ESQ ⇨ ESQ?

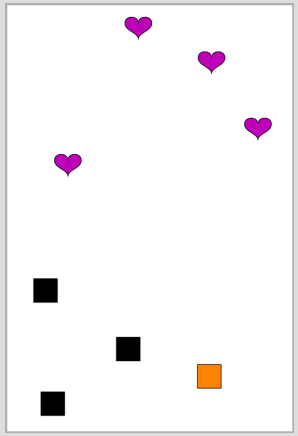
In addition, we included a baseline with no priming to check for overall adaptation effects

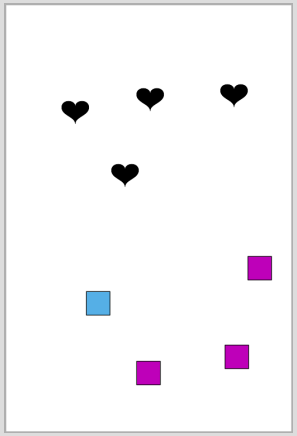
Experiment 1a: DIV ⇨ ESQ?

Choose the card that fits

Each of the hearts is orange or purple ⇨ Fewer than three of the squares are blue

critical prime *distractor* *better picture* *target*





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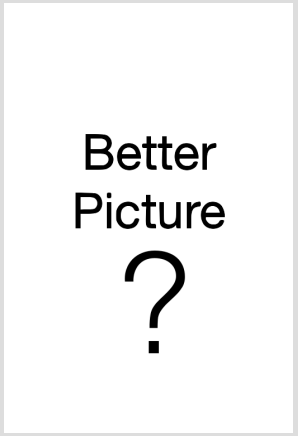
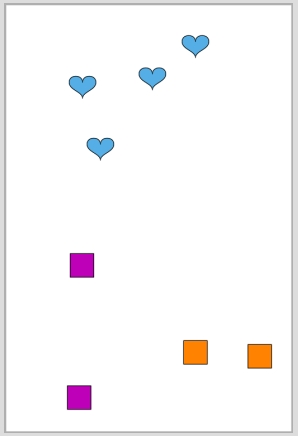


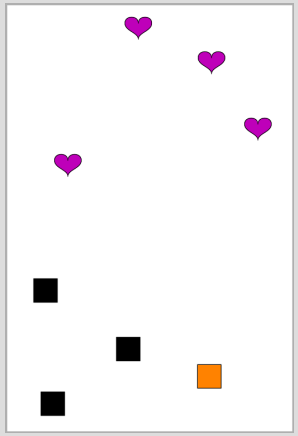


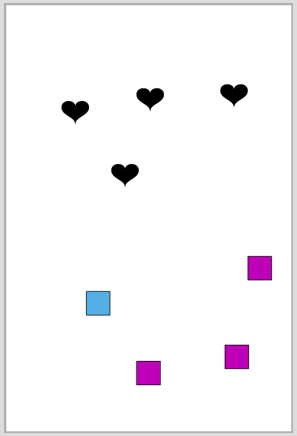
Experiment 1a: DIV ⇨ ESQ?

Choose the card that fits

Each of the squares is black or orange ⇨ Fewer than three of the hearts are purple

control prime *distractor* *better picture* *target*





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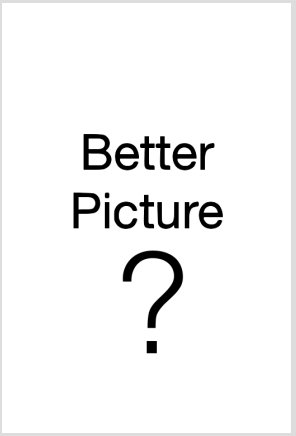
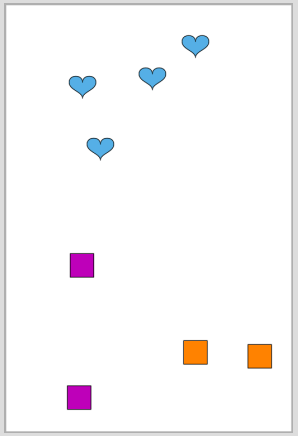


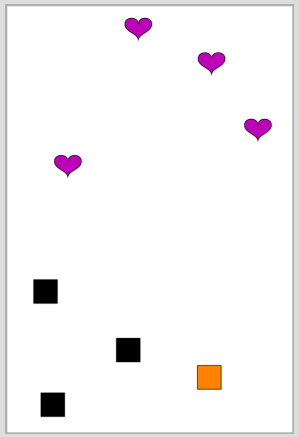


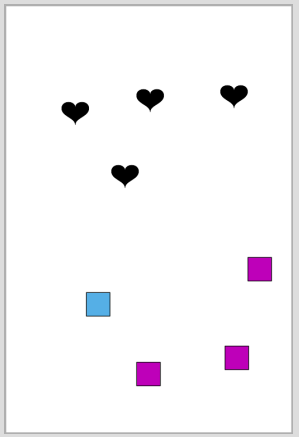
Experiment 1b: UPP ⇨ ESQ?

Choose the card that fits

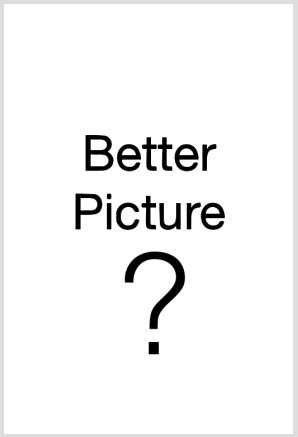
Some of the hearts are purple ⇨ Fewer than three of the squares are blue

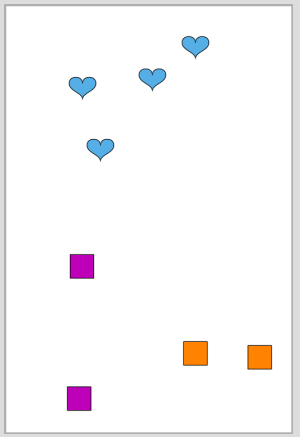
critical prime *distractor* *better picture* *target*





⇨



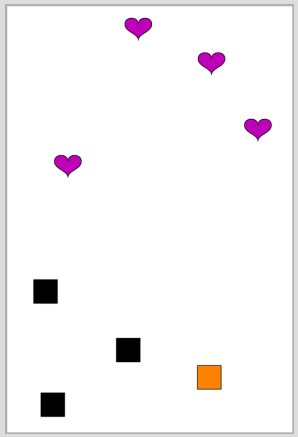


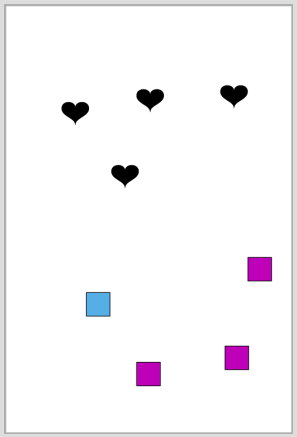
Experiment 1b: UPP ⇨ ESQ?

Choose the card that fits

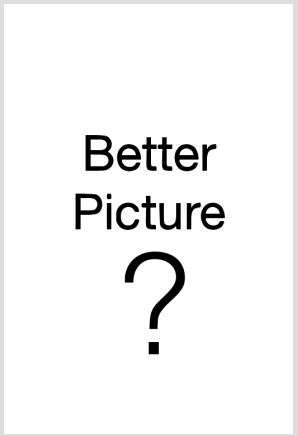
Some of the squares are black ⇨ Fewer than three of the hearts are purple

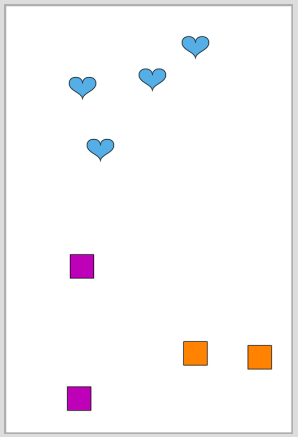
control prime *distractor* *better picture* *target*





⇨



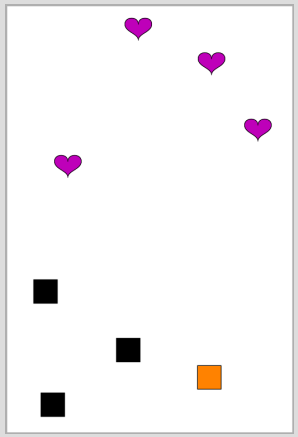


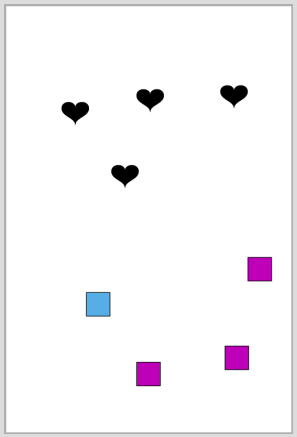
Experiment 1c: ESQ ⇨ ESQ?

Choose the card that fits

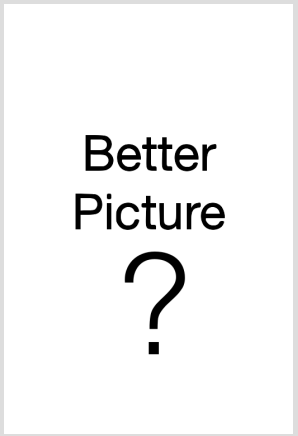
At most two of the hearts are black ⇨ Fewer than three of the squares are blue

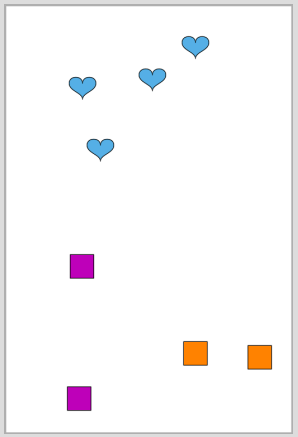
critical prime *distractor* *better picture* *target*





⇨



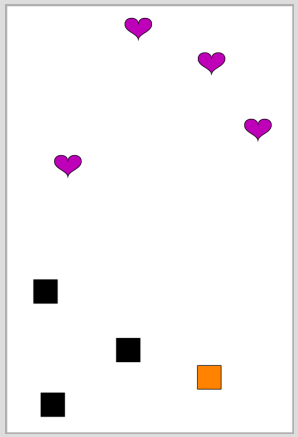


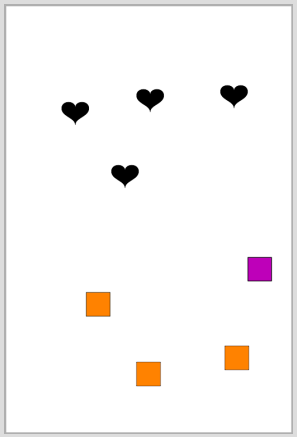
Experiment 1c: ESQ ⇨ ESQ?

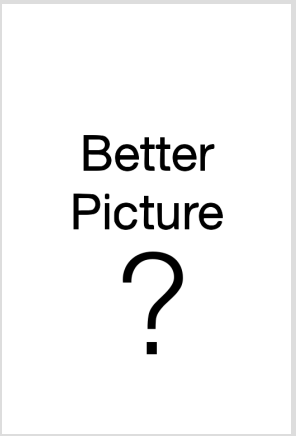
Choose the card that fits

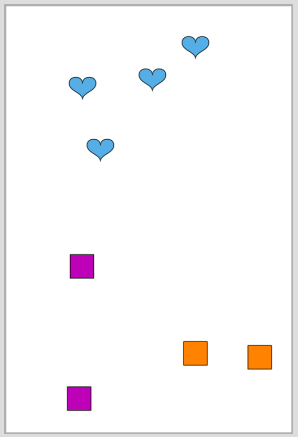
At most two of the squares are orange ⇨ Fewer than three of the hearts are purple

control prime *distractor* *better picture* *target*









Procedure

Succession of trials with prime-target pairs and fillers

Predictions

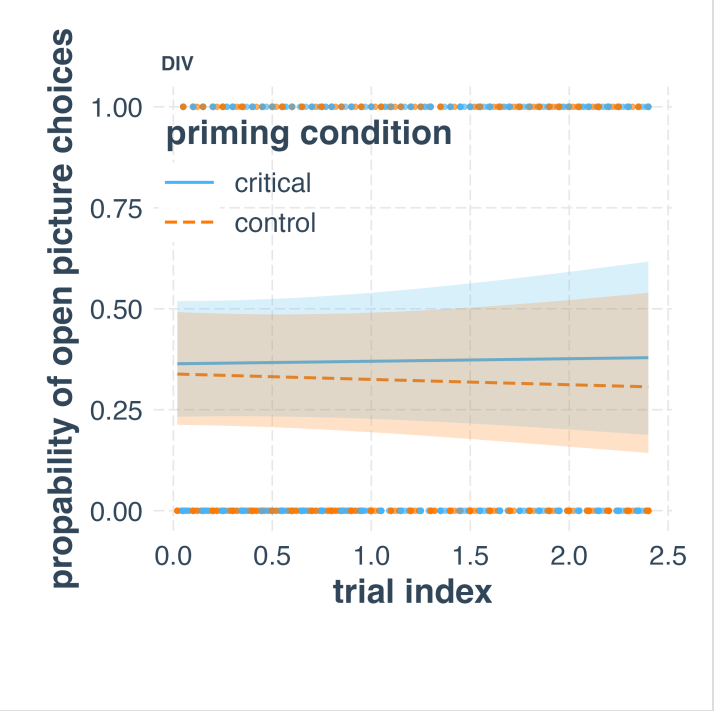
- Priming affects probability of open picture choices, indicative of ∅-model acceptance, in **DIV** ⇨ **ESQ** and **ESQ** ⇨ **ESQ**
- . . . but not in **UPP** ⇨ **ESQ**

Results

Baseline: *fillers* ⇨ ESQ

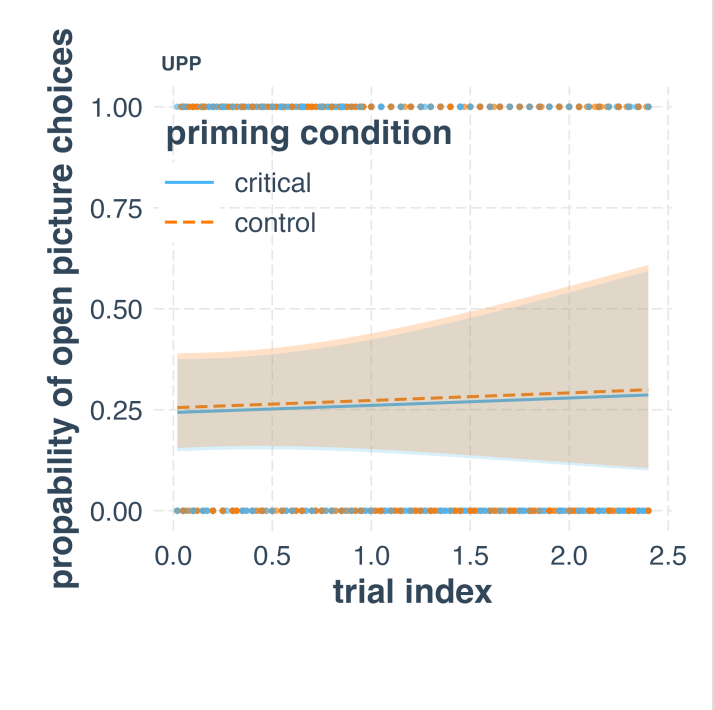
- About 49% open-picture, i.e. ∅-model, choices in target trials (indicative of non-strengthened interpretation)
- No change over the course of the experiment

Experiment 1a: DIV ⇨ ESQ



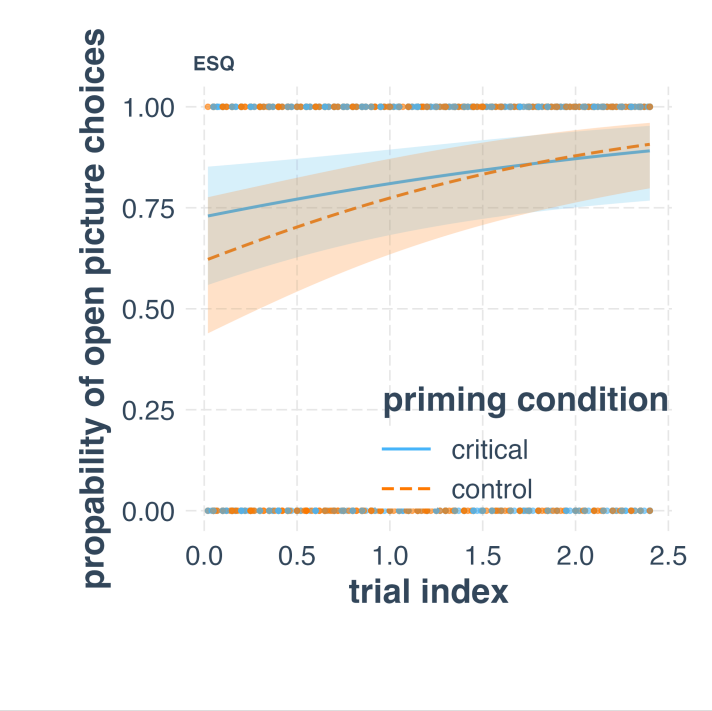
- Slightly but not significantly lower rate of open-picture choices than in BASELINE
- More open picture choices after *critical* than *control primes*, constant across *trials*

Experiment 1b: UPP ⇨ ESQ



- Lower rate of open-picture choices than in BASELINE, especially after *critical primes*
- But no effect of PRIMING CONDITION or TRIAL INDEX

Experiment 1c: ESQ ⇨ ESQ



- Higher rate of open-picture choices than in BASELINE, especially after *critical primes*
- Effect of TRIAL INDEX and a marginal effect of PRIMING CONDITION that did not replicate

Discussion

- **DIV ⇨ ESQ**: **Trial-to-trial priming**
- **UPP ⇨ ESQ**: **No priming** and overall lower rate of ∅-model choices
- **ESQ ⇨ ESQ**: **No trial-to-trial priming but global adaptation** (spill-over priming), at ceiling towards end of experiment

Discussion

- Shared computations in DIV & NE-Scope
- Different from UPP
- Local suspension of neglect zero in DIV ⇨ ESQ but global suspension in ESQ ⇨ ESQ (Aloni, 2022) due to similarity?
- Priming of 'existence check' (i.e. literal interpretation) might explain lower acceptance of ∅-models in UPP ⇨ ESQ

Conclusions & Outlook

Converging evidence

Strengthening	Negate alternatives	Presupposition	W-quantifier	Neglect Zero
NE-Restr	**(✓)**	**✓**	**NA**	**✓**
NE-Scope	**✓**	**NA**	**✓**	**✓**
UPP	**✓**	**NA**	**NA**	**NA**
DIV	**✓**	**NA**	**X**	**✓**

Are different computations involved in NE-Scope vs. DIV?

Further priming studies?

- ESQ ⇨ DIV: Trial-to-trial priming expected
- ESQ-COMP ⇦⇨ ESQ-COMP: Global adaptation expected if similarity-based explanation is correct (despite lexical identity, contra findings in syntactic priming; cf. Mahowald et al., 2016)
- FC ⇦⇨ ESQ: trial-to-trial priming expected
- . . .

Timing contrast between neglect-zero and implicature

- Strengthened interpretation first vs. last
- Relevant for online processing and acquisition
- Can be tested with different methods

Upcoming...

- Ramotowska et al. @ XPrag 2
- Klochowicz, Sbardolini & Aloni @ Sub 25
- . . .

Thank you!