Putting bare plurals into context

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Putting this talk into context

This is part of a larger project on 'homogeneity effects' in natural language

- **Bare plurals**: Frank opened presents
- **Definite plurals**: Frank opened his presents
- **Summative predicates**: Frank's flag is green
- **Free Choice**: Frank is allowed to invite his sister or brother

Today I will report on the subproject on **bare plurals** (collaboration with Yizhen Jiang)

Theories of bare plurals

Bare plurals and polarity

Generally bare plurals are read with **plurality inferences** in positive enrivonments; but are number neutral in negative environemnts (Farkas & De Swart 2010, Ivlieva 2014, Križ 2017, Mayr 2015, Sauerland 2003, Spector 2007, Sudo 2023, Zweig 2009)

1. "Frank opened presents."
   ≈ Frank opened **more than one** present
2. "Frank didn't open presents."
   ≈ Frank didn't open **any** present

2. is stronger than the semantic negation of 1.

(We put aside the generic/kind readings of bare plurals)

Theoretical approaches

Currently there are two types of theories of bare plurals:

- **Implicature-based approach** (Ivlieva 2014, Mayr 2015, Spector 2007, Sudo 2023, Zweig 2009)
- **Homogeneity-based approach** (Križ 2017)

(See Sudo 2023 for a more detailed review)

Implicature-based view

Utterances in natural language often convey more meaning thatn what the uttered words and phrases mean

- E.g. "Do you speak Korean? --- My sister does." ➠ the speaker doesn't.

Paul Grice hypothesised that one can draw extra inferences based on reasoning about what the speaker **could** have said instead (e.g. "Yes I do") and why they didn't said it

Such inferences are generally called **implicatures**

The implicature-based approach to bare plurals holds that they are semantically number-neutral but trigger implicatures that entail plural meaning

Implicature-based view (cont.)

Certain words and phrases systematically trigger implicatures, e.g. *some*, *or*, etc.

- "Frank speaks French or German" ➠ Frank doesn't speak both
- This is considered to come from reasoning about an alternative utterance of "Frank speaks French **and** German", which would be more informative

Negation changes the situation

- "Frank doesn't speak French or German" has no implicature
- "Frank doesn't speak French and German" is not more informative

Implicature-based view (cont.)

According to the implicature-based view, **bare plurals** also trigger an implicature

- Bare plurals are semantically number-neutral (so they are actually not 'plural'!)
- Upon encountering a bare plural, one reasons about why the speaker didn't use a singular indefinite instead
  - "Frank opened presents"
  - "Frank opened a present"

Theories differ with respect to how exactly the implicature is drawn in relation to the singular counterpart (see Sudo 2023 for an overview and a proposal)

Crucially, bare plurals in negative sentences have no implicatures, so they stay number-neutral, "Frank didn't open presents"

Homogeneity-based approach

Križ 2017 proposes to deal with the interaction with negation directly in trivalent semantics

$$[\![\text{Frank opened presents}]\!]^w = \begin{cases} T & \text{if Frank opened } \textbf{more than one} \text{ present in } w \\ F & \text{if Frank opened } \textbf{no} \text{ present in } w \\ \# & \text{if Frank opened } \textbf{exactly one} \text{ present in } w \end{cases}$$

$$[\![\text{not S}]\!]^w = \begin{cases} T & \text{if } [\![\text{not S}]\!]^w = F \\ F & \text{if } [\![\text{not S}]\!]^w = T \\ \# & \text{otherwise, i.e. if } [\![\text{not S}]\!]^w = \# \end{cases}$$

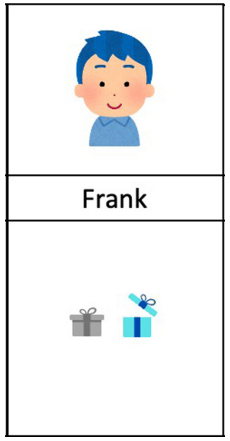
Križ puts forward a similar theory for definite plurals; his intuition is that the same interpretive mechanism is behind definite and bare plurals

Context-sensitivity

Both theories predict number-neutral readings to be available in some contexts

Intuitively "Frank opened presents" feels true-ish when Frank opened one present

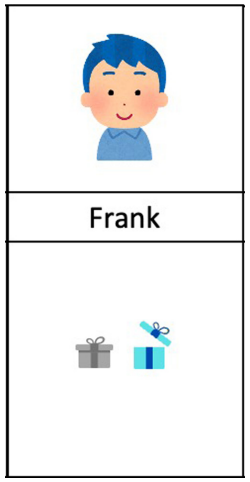
- **Implicature-based**: Implicatures are context-dependent inferences; If the singular alternative is not 'relevant', no implicature will be drawn
- **Homogeneity-based**: # can be sometimes pragmatically regarded as 'the same thing' as T or F; definite plurals also show such context sensitivity



Predictions for negative sentences

The two theories differ with respect to their predictions for "Frank didn't open presents"

- **Implicature-based**: There is no implicature here, so the bare plural just means number-neutral, and the sentence is false when Frank opened exaclty one present
- **Homogeneity-based**: This is as trivalent as its positive counterpart, and should show the same degree of context-sensitivity, when Frank opened exactly one present



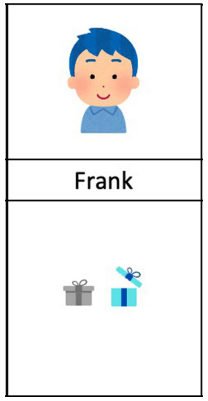
Summary so far

Positive: "Frank opened presents."

- Strong: Frank opened >1
- Weak: Frank opened ≥1

Negative: "Frank didn't presents."

- Strong: ¬(Frank opened ≥1)
- Weak: ¬(Frank opened ≥1)



- **Asymmetric view** (implicature-based): Weak readings are harder to obtain in negative sentences than in positive sentences
- **Symmetric view** (homogeneity-based): Weak readings are *ceteris paribus* avaialble equally in positive and negative sentences

Truth-value judgments in context

We can't simply compare the truth-value judgments of positive and negative sentences with respect to a scenario where Frank opened exactly one preset, because:

- The judgments are supposed to be context-dependent
- But positive and negative sentences have different truth-conditions, so might have different preferences for contexts
- Furthermore, truth-conditionally equivalent positive and negative sentences are typically used in different contexts, e.g., "Frank is outside" vs. "Frank is not inside"

☞ **Context manipulation**: How much context-sensitivity do positive and negative sentences exhibit?

Experiment 1

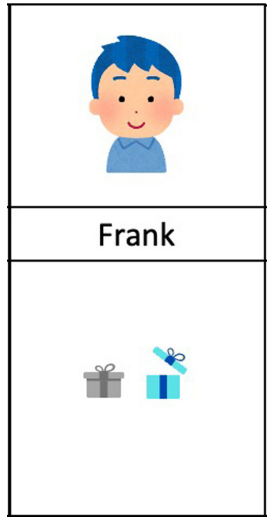
Bare plurals in simple positive and negative sentences

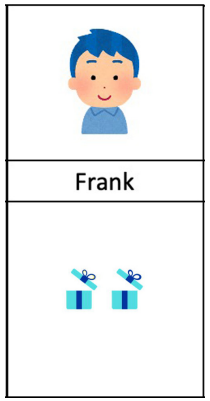
Design

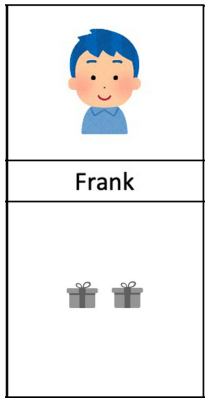
- **Positive**: Frank opened presents
- **Negative**: Frank didn't open presents

We varied the proper name (w/i-subject) and the gender of the children (b/w-subject)

Pictures





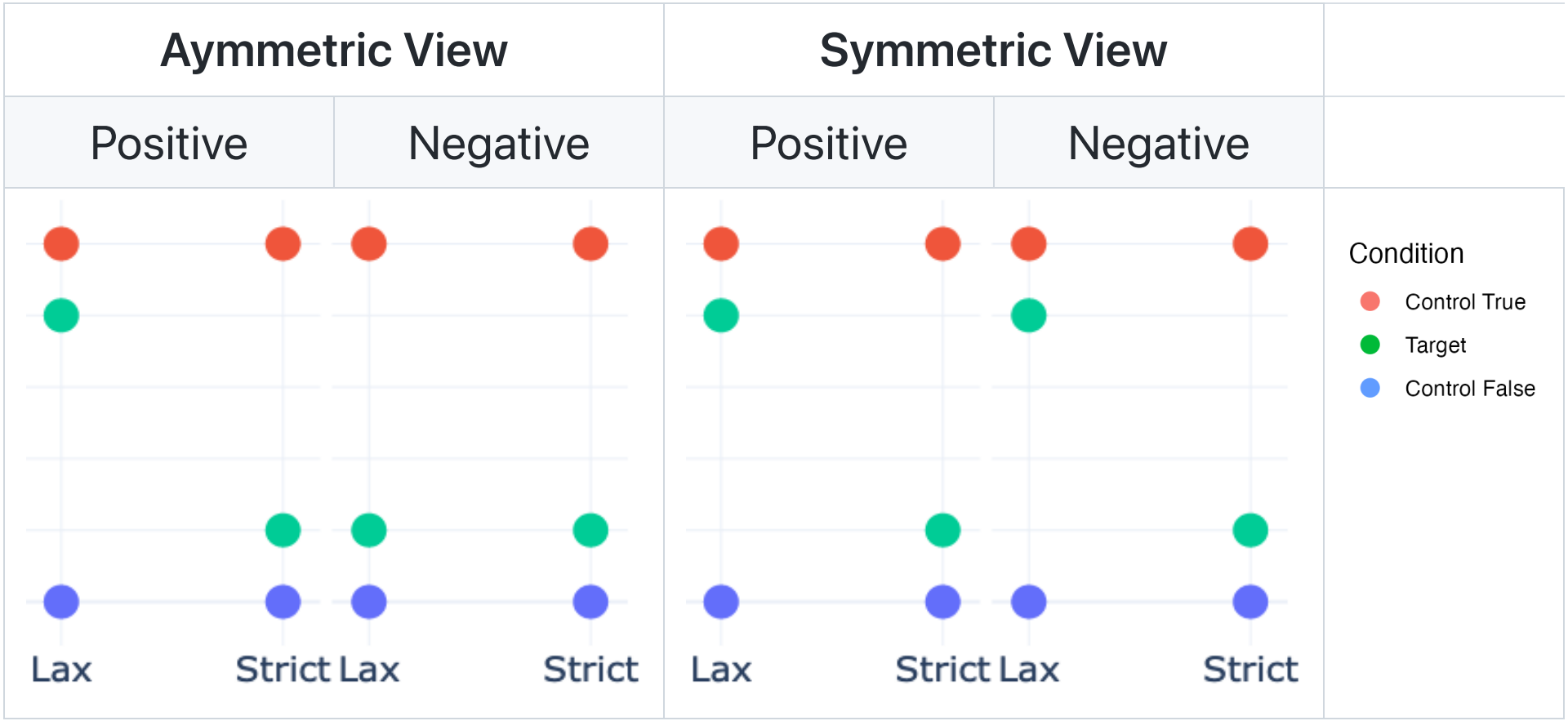


Context manipulation (b/w-subject)

	
Existential Context	**Universal Context**
You must keep each present closed (before the guests arrive)!	You must open each present (before the guests arrive)!
Positive ⇢ TRUE (Lax) **Negative** ⇢ FALSE (Strict)	**Positive** ⇢ FALSE (Strict) **Negative** ⇢ TRUE (Lax)

(In Augurzky et al. 2023 we tested plural definites in the same setting)

Predictions



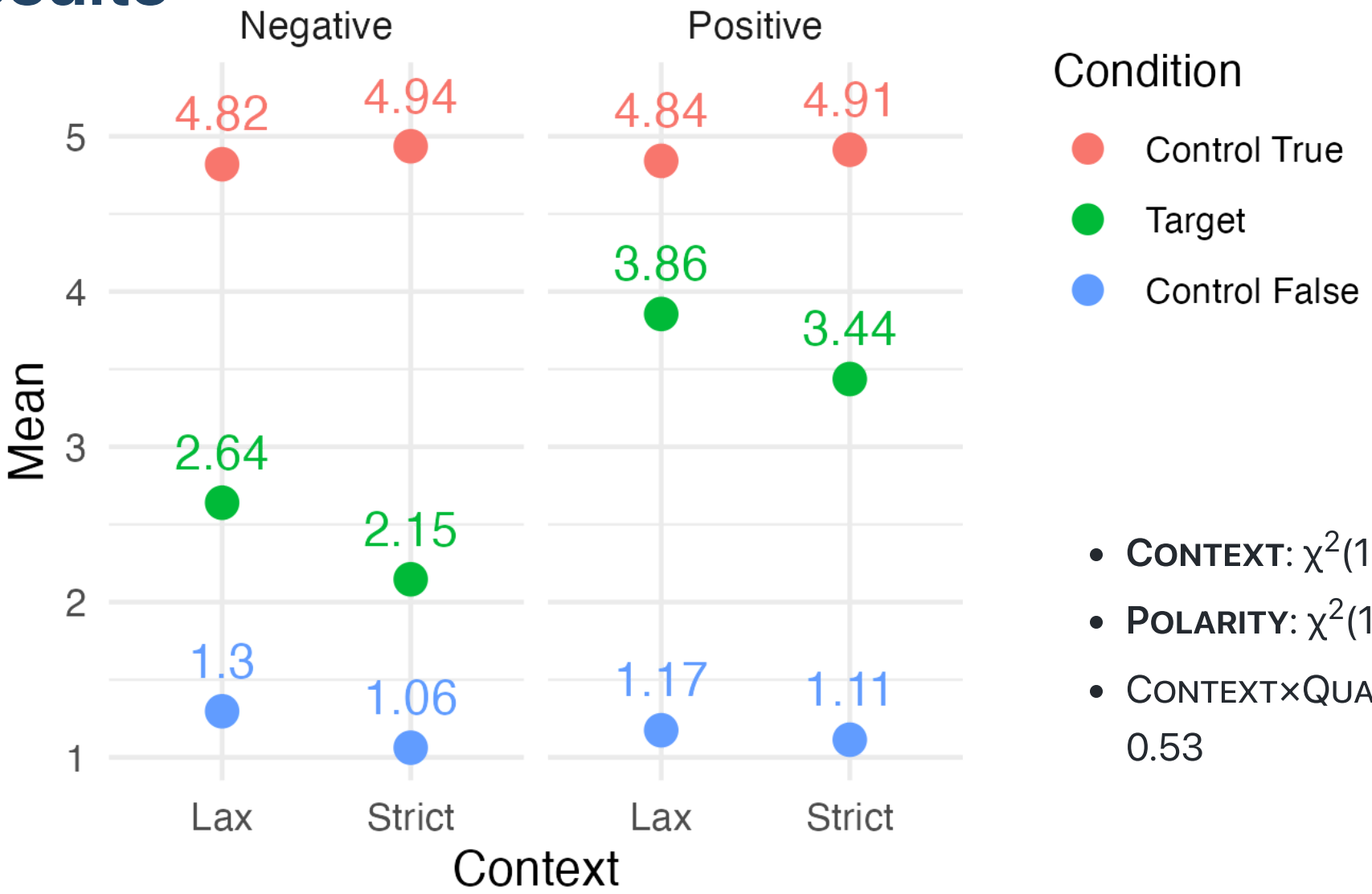
Procedure

- For each polarity, 4 targets, 4 true controls and 4 false controls
- Experiment hosted on Gorilla.sc
- 192 participants on Prolific, 8 excluded for low accuracy (≤75%)

Data analysis

- Mixed effects ordinal logistic model fitted to the target conditions
  - **Context** (more true vs. more false; sum-coded)
  - **Polarity** (Positive vs. Negative^{Ref}; treatment-coded)
  - **Context×Quantifier**
  - Mixed effect: by-subject random intercept (full model didn't converge)

Results



- **CONTEXT**: $\chi^2(1) = 54.47, p < 0.001$
- **POLARITY**: $\chi^2(1) = 604.6, p < 0.001$
- CONTEXT×QUANTIFIER: $\chi^2(1) = 0.4, p = 0.53$

Summary

- POSITIVE > NEGATIVE
- **Symmetric effect** of CONTEXT on POLARITY

The symmetric effect is more in line with the Symmetry view (homogeneity-based) than the Asymmetric view (implicature-based).

In particular, negative sentences exhibited context-sensitivity, which is not directly predicted by the Asymmetric view.

Bare plurals under quantifiers

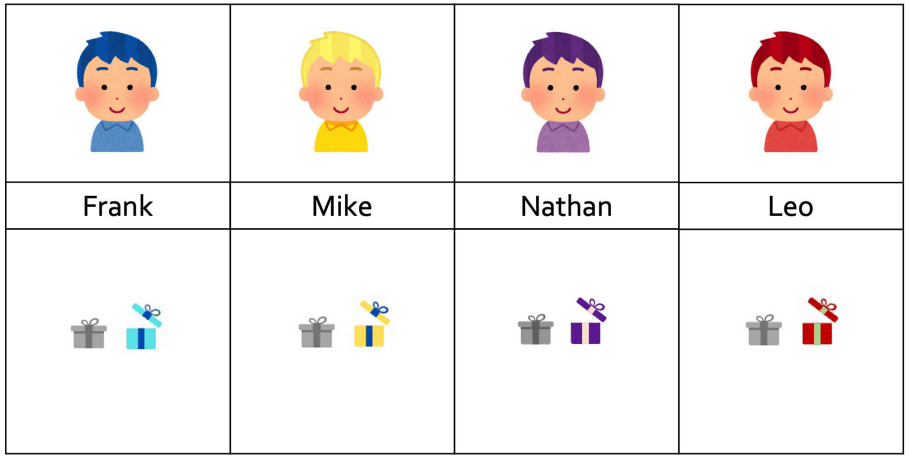
Bare plurals under quantifiers

The results of Experiment 1 favour the Symmetric view (homogeneity-based)

The two views also make divergent predictions for bare plurals in quantified sentences

E.g.

- **Positive**: "Every boy opened presents"
- **Negative**: "No boy opened presents"



Implicature-based approach: Asymmetry

Implicature-based theories predict multiple readings for **Positive**, but one for **Negative**

- **Positive**: "Every boy opened presents"
    i. Strong (full plural): Every boy opened >1
    ii. Weak (number-neutral/no implicature): Every boy opened ≥1
    iii. (Intermediate (partial-plural) Every boy opened ≥1 and at least some boys >1)
- **Negative**: "No boy opened presents"
    i. Strong (number-neutral/no implicature): No boy opened ≥1

Compare: "Every boy sang or danced" vs. "No boy sang or danced"

Homogeneity-based approach: Symmetry

According to Križ 2017, the trivalent meaning of bare plurals should 'project' through quantifiers via supervaluation (detailed omitted)

$$[\![\text{Every boy opened presents}]\!]^w = \begin{cases} 1 & \text{if every boy opened more than one present in } w \\ 0 & \text{if one or more boys opened no present in } w \\ \# & \text{otherwise} \end{cases}$$

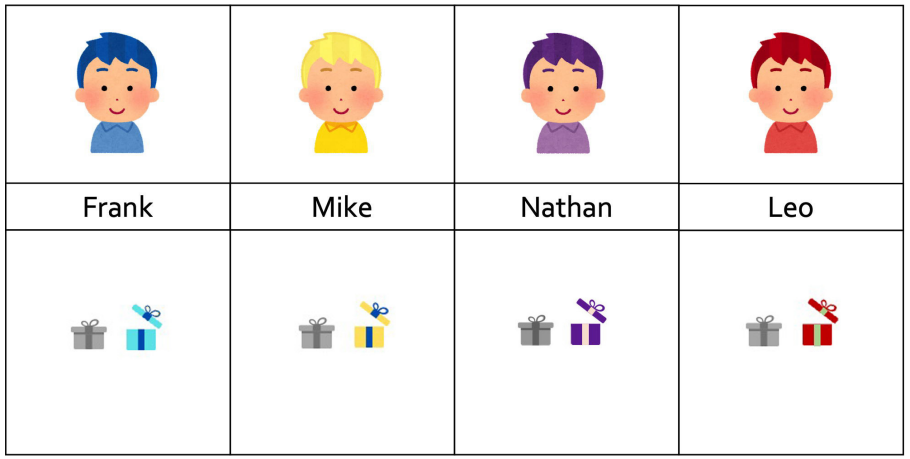
$$[\![\text{No boy opened presents}]\!]^w = \begin{cases} 1 & \text{if no boy opened any present in } w \\ 0 & \text{if one or more boys opened more than one present in } w \\ \# & \text{otherwise} \end{cases}$$

Both meanings are non-trivially trivalent so should show context-sensitivity, when each boy opened exacty one present

Divergent predictions

1. **Asymmetric view** (implicature-based): More context-sensitivty for **Positive** than for **Negative**
2. **Symmetric view** (homogeneity-based): Same degree of context-sensitivty for **Positive** and **Negative**

- **Positive**: "Every boy opened presents."
- **Negative**: "No boy didn't open presents."



Experiment 2

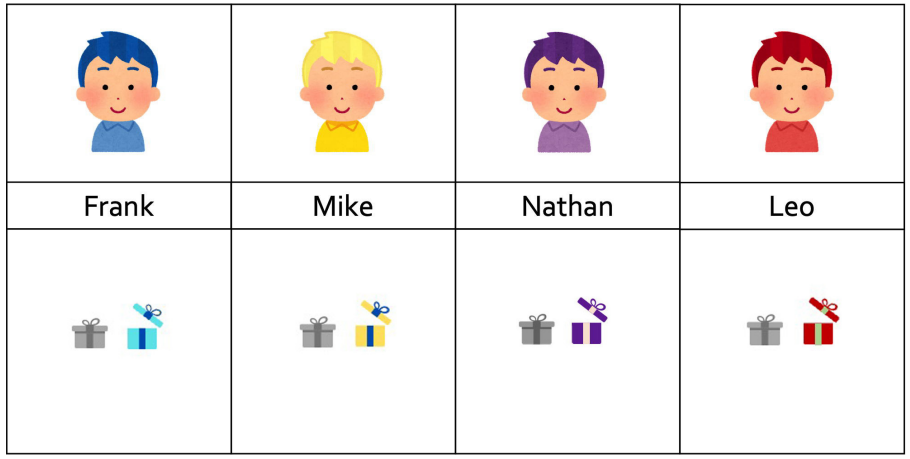
Bare plurals under *every* vs. *no*

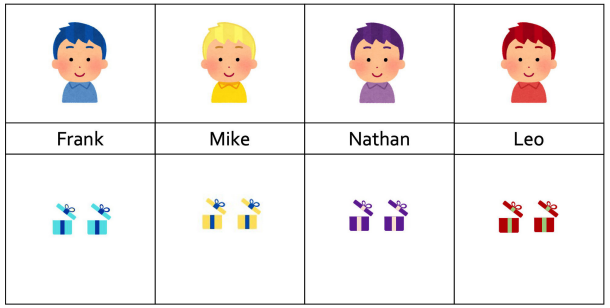
Design

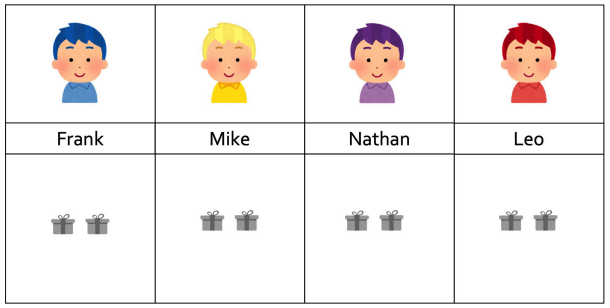
Same task as Experiments 1

- **Positive**: Every boy opened presents
- **Negative**: No boy opened presents

Pictures







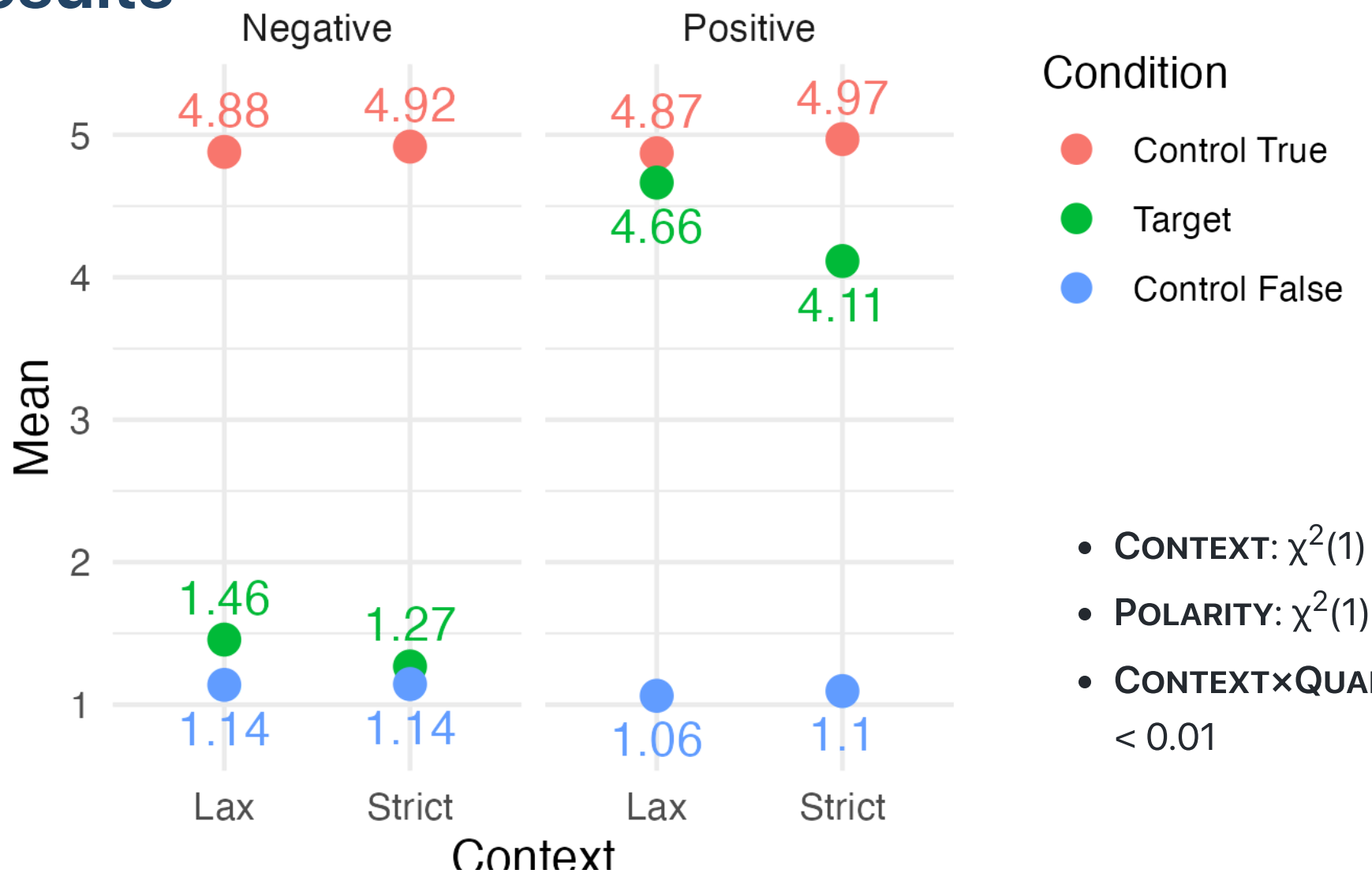
Procedure

- For each polarity, 4 targets, 4 true controls and 4 false controls
- Experiment hosted on Gorilla.sc
- 192 participants on Prolific, 3 excluded for low accuracy (≤75%)

Data analysis

- Mixed effects ordinal logistic model fitted to the target conditions
  - **Context** (more true vs. more false; sum-coded)
  - **Polarity** (Positive vs. $\text{Negative}_{\text{Ref}}$; treatment-coded)
  - **Context×Quantifier**
  - Mixed effects: by-subject intercept, by-subject slope for Polarity, correlation

Results



- **CONTEXT**: $\chi^2(1) = 10.0$, $p < 0.01$
- **POLARITY**: $\chi^2(1) = 1538.9$, $p < 0.001$
- **CONTEXT×QUANTIFIER**: $\chi^2(1) = 9.8$, $p < 0.01$

Summary

- POSITIVE ≫ NEGATIVE
- **Asymmetric effect** of CONTEXT: **Every** > **No**

The asymmetric effect of CONTEXT is not straightforwardly predicted by the symmetric view

It is more straightforwardly compatible with the asymmetric view, but the difference bewteen Experiments 1&2 is a problem for every theory

There is another aspect of quantified sentences for which the two apporach make different predictions

Partial plurality

Partial plurality

Bare plurals in certain quantified environments give rise to **partial plurality readings**

- "Every boy opened presents"
  i. **Full plurality**: Every boy opened >1
  ii. **Partial plurality**: Every boy opened ≥1 and some boys opened >1
- "Exactly one boy opened presents"
  i. **Full plurality**: One boy opened >1 and no other boys opened >1
  ii. **Partial plurality**: One boy opened >1, and no other boys opened ≥1

Implicature-based aproach

Implicature-based theories derive partial plurality for **Positive** but not for **Negative**

- **Positive**: "Every boy opened presents"
    i. Strong (full plural): Every boy opened >1
    ii. Weak (number-neutral/no implicature): Every boy opened ≥1
    iii. (Intermediate (partial-plural) Every boy opened ≥1 and at least some boys >1)
- **Negative**: "No boy opened presents"
    i. Strong (number-neutral/no implicature): No boy opened ≥1

Compare: "Every boy sang or danced" vs. "No boy sang or danced"

Homogeneity approach

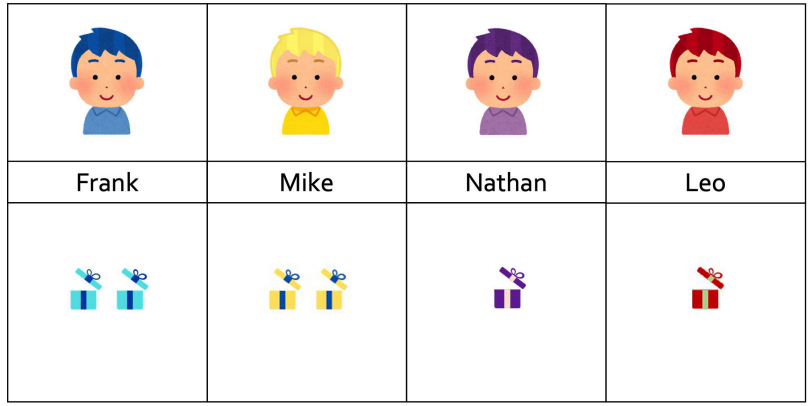
The homogeneity approach assigns a *full* plurality reading for **Positive**

$$[\![\text{Every boy opened presents}]\!]^w = \begin{cases} T & \text{if every boy opened more than one present in } w \\ F & \text{if one or more boys opened no present in } w \\ \# & \text{otherwise} \end{cases}$$

He claims that partial plurality is to be explained pragmatically as 'non-maximality'

E.g. "Did each boy open each of his presents?"

→ Some #-worlds are practically True-words



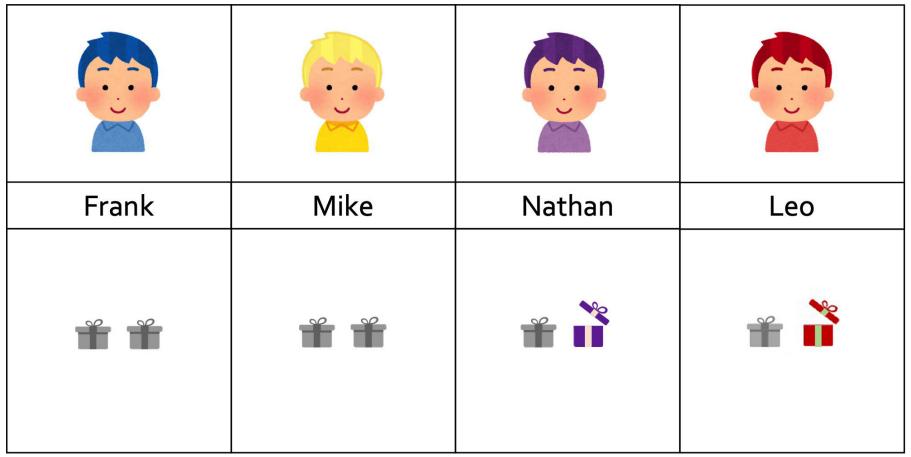
Partial plurality under *no*

The homogeneity approach derives a similar reading under *no* as well

$$[\![\text{No boy opened presents}]\!]^w = \begin{cases} 1 & \text{if no boy opened any present in } w \\ 0 & \text{if one or more boys opened more than one present in } w \\ \# & \text{otherwise} \end{cases}$$

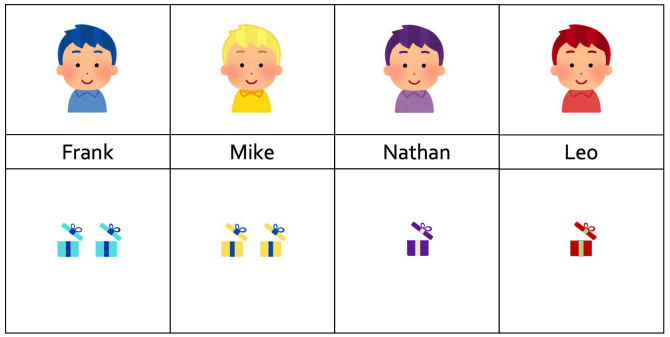
E.g. "Did each boy open each of his presents?"

→ Some #-worlds are practically True-worlds



Summary: Partial Plurality

Positive: "Every boy opened presents."



Negative: "No boy didn't open presents."

1. **Asymmetric view** (implicature-based): **Positive** has a partial plurality reading (plainly true), **Negative** does not (plainly false); Neither should be context-dependent
2. **Symmetric view** (homogeneity-based): Partial plurality is not a semantic reading, but the same pragmatic phenomenon as before; both **Positive** and **Negative** should be context-dependent

Experiment 3

Partial plurality under *every* and *no*

Design

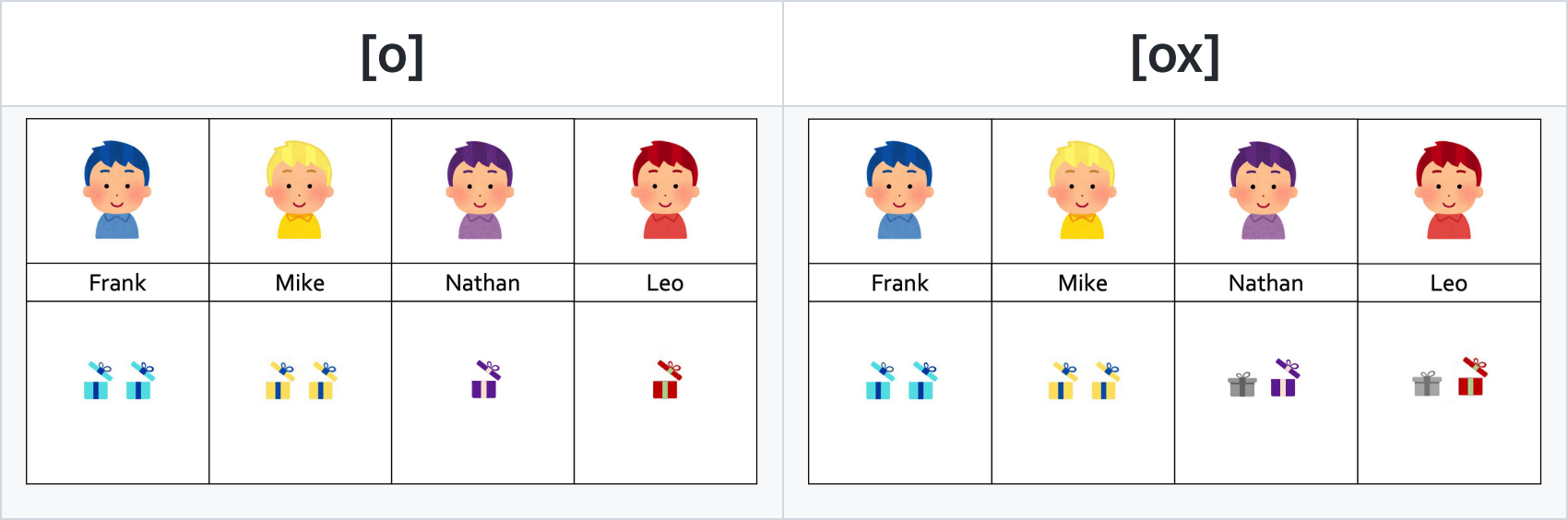
Same task as Experiments 1&2; and same quantified sentences as Experiment 2

- **Positive**: Every boy opened presents
- **Negative**: No boy opened presents

But different pictures, namely, 'partial plurality pictures' such that:

- The Asymmetric (implicature-based) view predicts **Positive** to be plainly true, and **Negative** to be plainly false
- The Symmetric (homogeneity-based) view predicts the same degree of context-sensitivity as Experiment 2 for both **Positive** and **Negative**

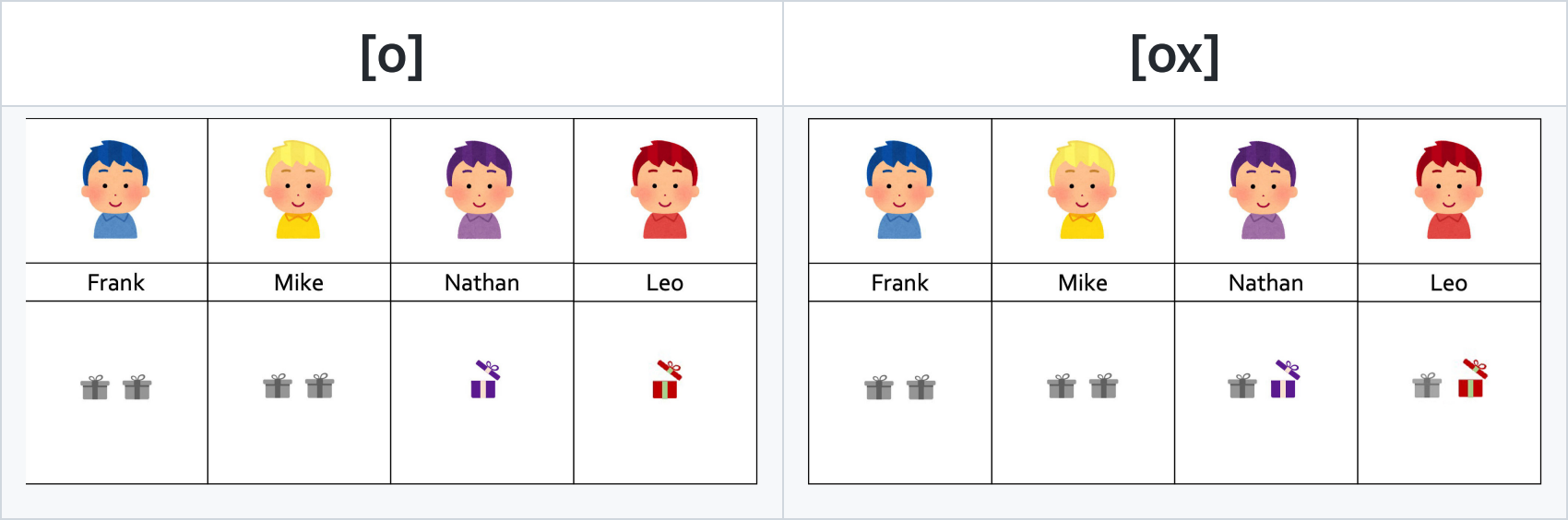
Target pictures: Every boy opened presents



Homogeneity approach predicts:

- **Existential** ('Don't open your presents!'): [o] = [ox] (practically true in both)
- **Required** ('Open your presents!'): [o] > [ox]

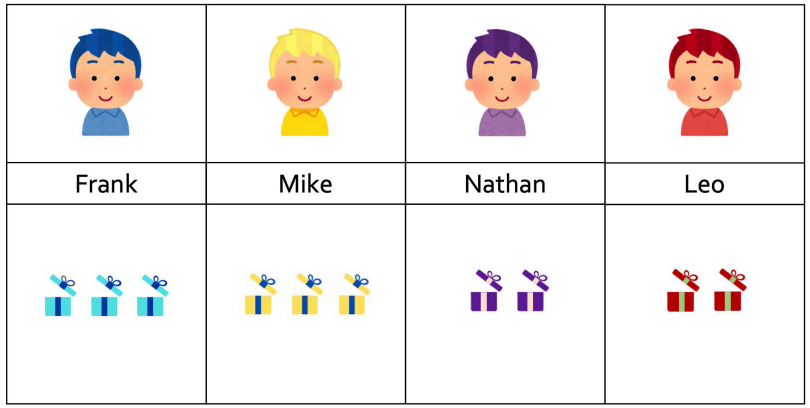
Target pictures: No boy opened presents

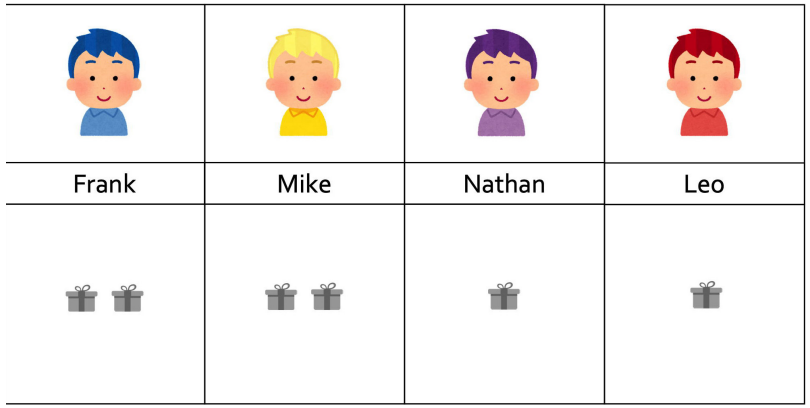


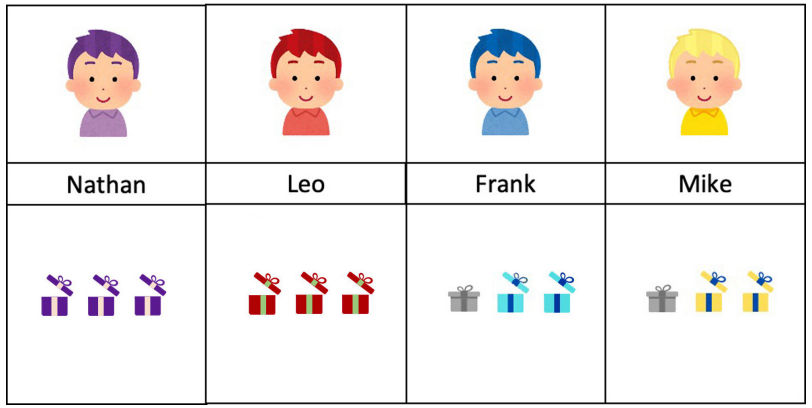
Homogeneity approach predicts:

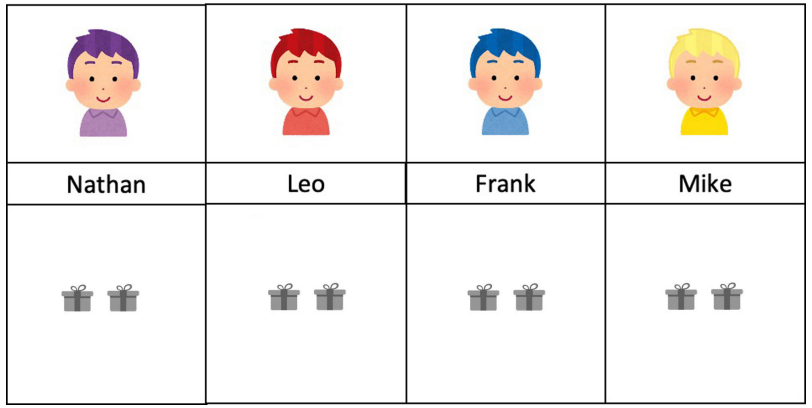
- **Existential** ('Don't open your presents!'): [o] = [ox] (practically false in both)
- **Required** ('Open your presents!'): [o] < [ox]

Control pictures









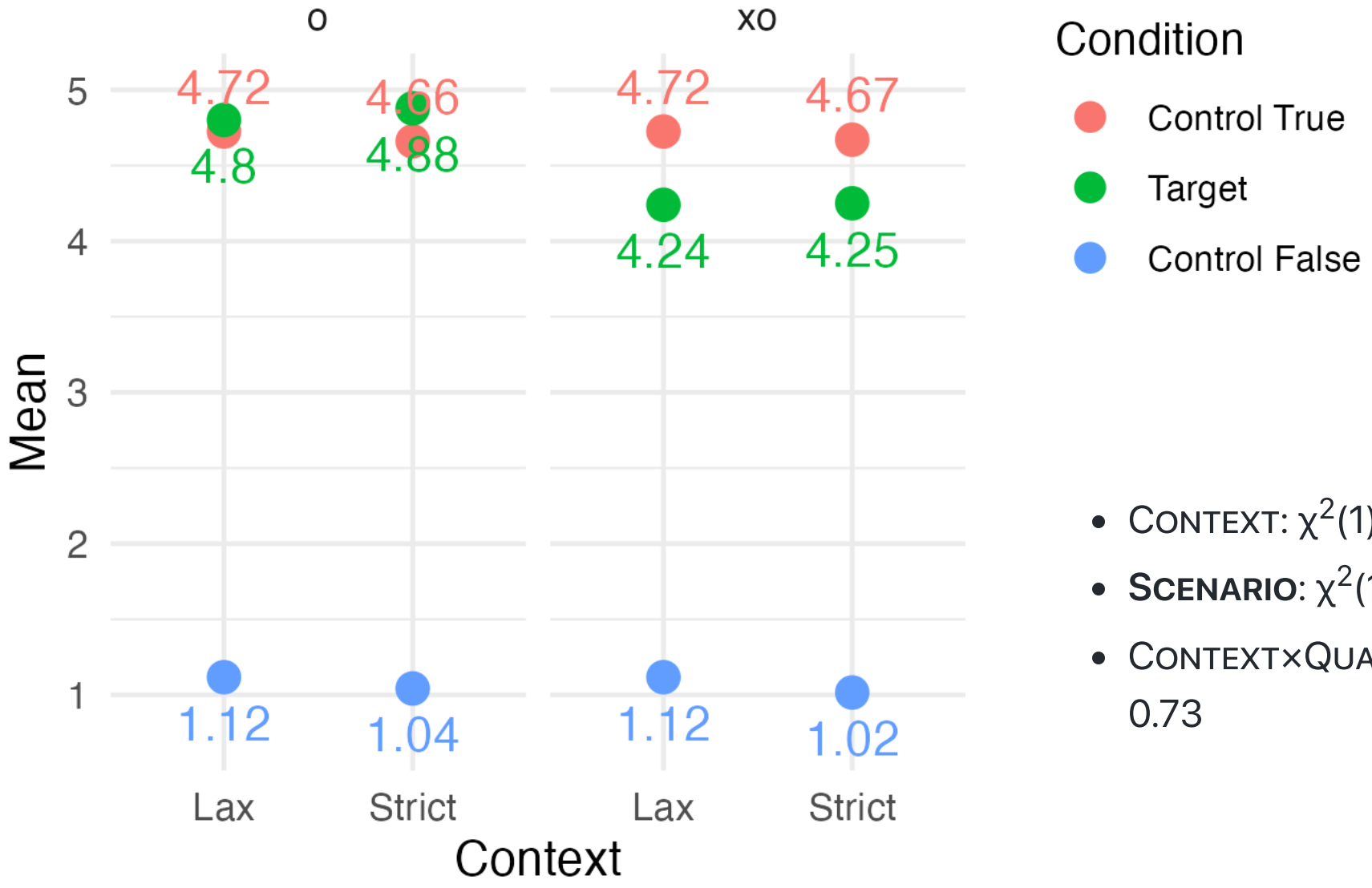
Procedure

- For each polarity, 4 [o]-targets, 4 [ox]-targets, 8 true controls and 8 false controls
- Experiment hosted on Gorilla.sc
- 96 participants on Prolific, 0 excluded for low accuracy (≤75%)

Data analysis

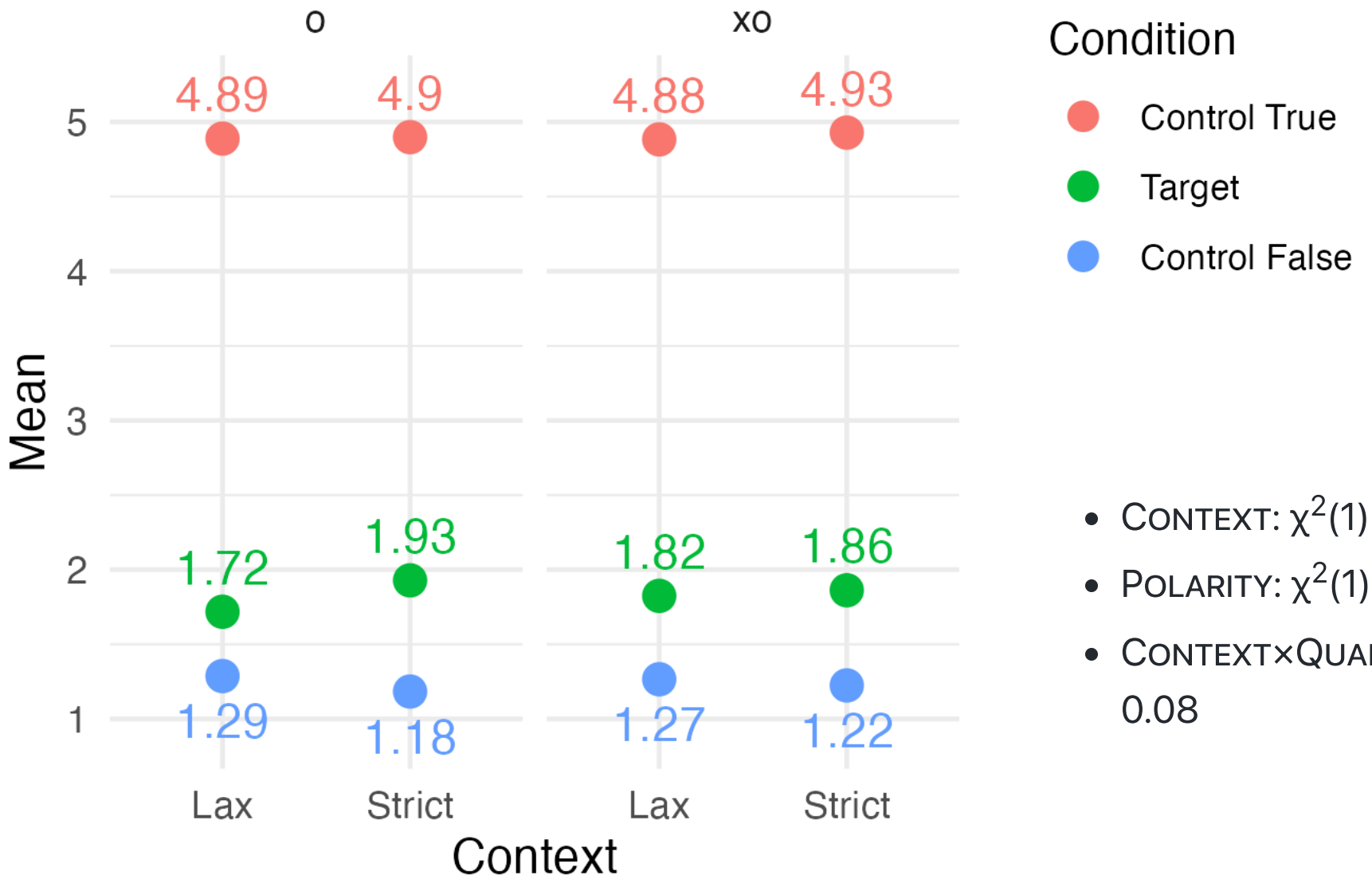
- Mixed effects ordinal logistic model fitted to the target conditions for each polarity
  - **Context** (more true vs. more false; sum-coded)
  - **Scenario** ([ox] vs. [o]^{Ref}; treatment-coded)
  - **Context×Scenario**
  - Mixed effects: by-subject intercept, by-subject slope for Scenario, correlation

Results: Every



- CONTEXT: $\chi^2(1) = 0.1$, $p = 0.75$
- **SCENARIO**: $\chi^2(1) = 48.5$, $p < 0.001$
- CONTEXT×QUANTIFIER: $\chi^2(1) = 0.1$, $p = 0.73$

Results: No



- CONTEXT: $\chi^2(1) = 2.0$, $p = 0.15$
- POLARITY: $\chi^2(1) = 0.6$, $p = 0.41$
- CONTEXT×QUANTIFIER: $\chi^2(1) = 2.9$, $p = 0.08$

Summary

- **Positive**: [o] > [ox]
- **Negative**: No effect

The Symmetric (homogeneity-based) view predits an interaction effect such that in **Required**

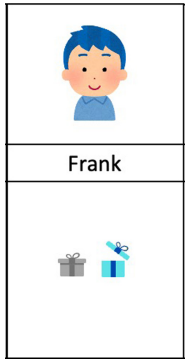
- **Every**: [o] > [ox]
- **No**: [o] < [ox]

Given the results of Experiment 2, we'd expect the differences to be detectable

The results are more in line with the Asymmetric (implicatured-based) view, but [o] > [ox] for **Positive** isn't directly captured

Discussion

Summary of experimental findings



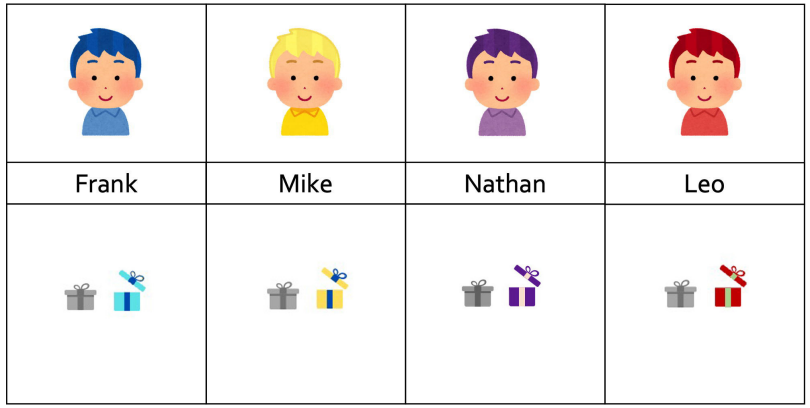
- Experiment 1: **Symmetric** results
  - "Frank opened presents" = "Frank didn't open presents"
- Experiment 2: **Asymmetric** results
  - "Every boy opened presents" > "No boy opened presents"
- Experiment 3: No context sensitivity in Experiment 3 wrt partial plurality

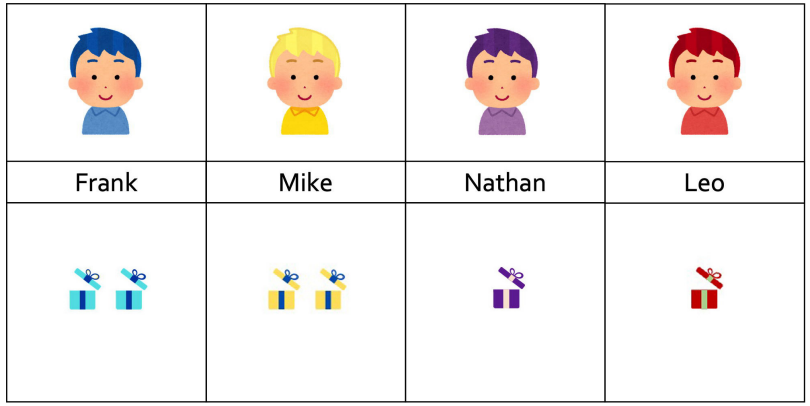
The difference between Experiments 2&3 is problematic for the homogeneity-based view

Partial plurality under *every*

$$[\![\text{Every boy opened presents}]\!]^w = \begin{cases} 1 & \text{if every boy opened more than one present in } w \\ 0 & \text{if one or more boys opened no present in } w \\ \# & \text{otherwise} \end{cases}$$

Under the homogeneity view, the sentence denotes # in both scenarios below, but we only observed context sensitivty for the left

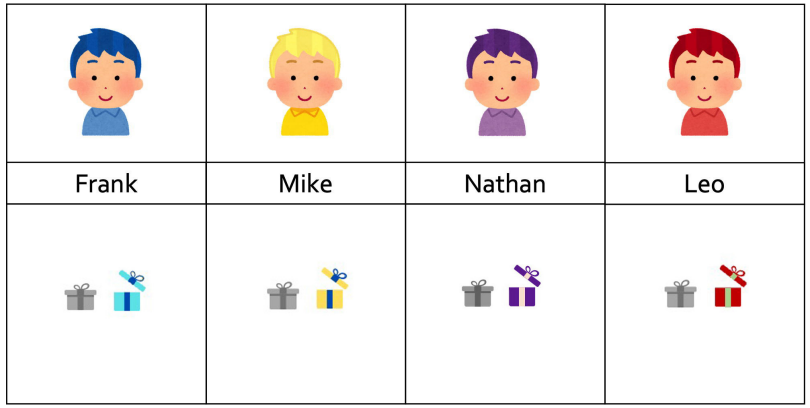


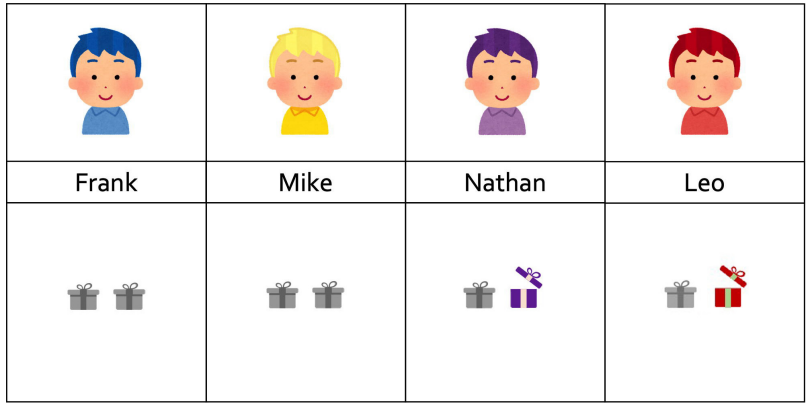


Partial plurality under *no*

Likewise for bare plurals under **No**

$$[\![\text{No boy opened presents}]\!]^w = \begin{cases} 1 & \text{if no boy opened any present in } w \\ 0 & \text{if one or more boys opened more than one present in } w \\ \# & \text{otherwise} \end{cases}$$





Conclusions

Križ's 2017 **homogeneity-based** theory makes wrong predictions for partial plurality

With respect to partial plurality, the **implicature-based** theories (Ivlieva 2014, Mayr 2015, Spector 2007, Sudo 2023, Zweig 2009) fare better, but there are some challenges

- **Negative** showed context-sensitivity in Experiments 1&2
- Larger effect size in Experiment 1 than in Experiment 2

Thanks!!

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