### Putting plurals into context

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#### **Definite and bare plurals**

- Definite plurals: Fred opened his presents.
- Bare plurals: Fred opened presents.

Certain aspects of the interpretations of these expressions are **context-sensitive**.

- Non-maximal readings of plural definites
- Weak readings of bare plurals

We raise evidence against Križ's (2017) view that the same interpretive mechanism is responsible for the context-sensitivity of definite and bare plurals

#### Part 1

# **Definite plurals**

Collaboration with Petra Augurzky, Marion Bonnet, Richard Breheny, Alexandre Cremers, Cornelia Ebert, Clemens Mayr, Jacopo Romoli, and Markus Steinbach

# **Definite plurals**

#### 1. Homogeneity

- "Frank opened his presents"  $\approx$  Frank opened <u>all</u> of his presents
- "Frank didn't open his presents"  $\approx$  Frank didn't open <u>any</u> of his presents

#### 2. Non-maximality

 $\circ$  "The doors are open" → Enough doors are open maybe not all



(image from Haslinger 2022)

### **Non-maximality**

Non-maximal readings are context-dependent

- "Frank opend his presents."
  - He's not supposed to open any of his presents before the guests arrive ···· TRUE
  - He's supposed to open all of his presents in front of the guests ···· FALSE





### **Polarity and non-maximality**

- 1. Symmetric view: Non-maximal readings are *ceteris paribus* avaiable equally in positive and negative sentences (Križ 2016, Križ & Spector 2021)
- 2. Asymmetric view: Non-maximal readings are hard to obtain in negative sentences than in positive sentences (Magri 2014, Bar-Lev 2018, 2021)

- Positive: Frank opened his presents.
- Negative: Frank didn't open his presents.



# Križ's symmetric theory

Križ's (2015, 2016) symmetric theory is based on trivalent semantics

 $\llbracket Frank opened his presents \rrbracket^w = \begin{cases} 1 & \text{if Frank opened all of his presents in } w \\ 0 & \text{if Frank opened none of his presents in } w \\ \# & \text{if Frank opened some but not all of his presents in } w \end{cases}$ 

Non-maximality is pragmatics: Context may let us treat some #-worlds as 0- or 1-worlds

- Did Frank open any of his presents?  $\rightarrow$  #-worlds are practically 1-worlds
- Did Frank open all of his presents?  $\rightarrow$  #-worlds are practically 0-worlds

# **Projection through quantifiers**

Križ assumes that homogeneity projects through quantifiers via supervaluation

$$\llbracket \mathsf{E} \mathsf{very} \ \mathsf{boy} \ \mathsf{opened} \ \mathsf{his} \ \mathsf{presents} 
rbracket^w = egin{cases} 1 \\ 0 \\ \# \end{cases}$$

if every boy opened all of his presents in 
$$w$$
  
if at least one boy opened none of his presents in  $w$   
otherwise

$$\llbracket No \text{ boy opened his presents} 
rbracket^w = \begin{cases} 1\\ 0\\ 0 \end{cases}$$

 $\begin{cases} 1 & \text{if no boy opened any of his presents in } w \\ 0 & \text{if at leaset one boy opened all of his presents in } w \\ \# & \text{otherwise} \end{cases}$ 

#### **Previous experimental research**

#### • Križ & Chemla 2015

- Intermediate judgments in gappy situations for positive, <u>negative</u>, non-monotonic
- More non-maximal readings for positive than for negative
- Tieu, Križ & Chemla 2019
  - Adults <u>accepted negative more often than positive</u> in gappy situations
  - Children accepted positve more often than negative in gappy situations
- $\Rightarrow$  Asymmetry between positive and negative but not exactly as predicted by the Asymmetric view

#### **Context manipulation**

But it's not fair to directly compare positive and negative sentences

- In previous studies, positive and negative stimuli had different truth-conditions
- Positive and negative sentences are typically used in different contexts
  - "The dogs are inside"
  - "The dogs are not outside"

Context manipulation to test how context modulates the non-maximal readings of definite plurals in positive and negative sentences

#### **Experiment 1**

Definite plurals under every vs. no

# Design

Based upon Križ & Chemla's 2015 Experiment C1

Truth-value judgment task with a 5-point Likert scale (Completely false—Completely true)

#### Sentences

Bound pronoun to make sure no scopes over plural definite

- Every: "Every boy opened his presents."
- No: "No boy opened his presents."

#### **Pictures**

Every				N	lo		
Every boy opened his presents.			No bo	by opene	d his pre	sents.	
<b>@</b>			<b>@</b>	<b>@</b>	2	<b>2</b>	
Frank	Mike	Nathan		Nathan		Frank	Mike

#### Control

<u>@</u>				
Frank	Mike	Nathan	Leo	
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Frank	Mike	Nathan	Leo
***	*** *** ***	***	

### **Context manipulation (b/w-subject)**

Two families (four kids each) with different family rules about presents

<b>Existential Context</b>	Universal Context
Opening the presents is <u>prohibited</u> before the guests arrive.	Opening the presents is <u>required</u> before the guests arrive.
Every ···• TRUE (Lax) No ···• FALSE (Strict)	<b>Every</b> ···• FALSE (Strict) <b>No</b> ···• TRUE (Lax)

#### **Predictions**



#### Procedure

- For each quantifier, 2 targets, 4 true controls, 4 false controls, (2 false targets)
- Experiment hosted on SoSci Survey GmbH
- 192 participants on Prolific.ac, 7 excluded for low accuracy (<75%) for controls

#### Data analysis

- Mixed effects ordinal logistic model fitted to the target conditions
  - **CONTEXT** (more true vs. more false; sum-coded)
  - **QUANTIFIER** (Every vs. No<sup>Ref</sup>; treatment-coded)

#### • CONTEXT×QUANTIFIER

• Mixed effects: by-subject intercept, by-subject slope for QUANTIFIER, correlation

#### **Results**



#### Summary

- Main effect of QUANTIFIER: Every > No
- Simple effect of CONTEXT on No
- BUT CONTEXT×QUANTIFIER interaction: Larger effect of CONTEXT for **Every**

The interaction is not directly predicted by Križ's symmetric theory



#### **Experiment 2**

Definite plurals under every vs. not every

# Design

Just like Exp 1, except no was replaced by not every

- Every: "Every boy opened his presents."
- Not every: "Not every boy opened his presents."

#### **Pictures**

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Frank	Mike	Nathan	Leo	
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#### **Predictions**



#### Procedure

- For each quantifier, 4 targets, 4 true controls, 4 false controls
- Experiment hosted on SoSci Survey GmbH
- 192 participants on Prolific.ac, 10 excluded for low accuracy (<75%) for controls

#### Data analysis

- Mixed effects ordinal logistic model fitted to the target conditions
  - **CONTEXT** (more true vs. more false; sum-coded)
  - **QUANTIFIER** (Every vs. Not every<sup>Ref</sup>; treatment-coded)

#### • CONTEXT×QUANTIFIER

• Mixed effects: by-subject intercept, by-subject slope for QUANTIFIER, correlation

#### **Results**



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### Summary

- Non-maximal readings for both Every and Not every
- Context manipulation had similar robust effects for both quantifiers

This is as predicted by Križ



### **Discussion: definite plurals**

#### Discussion

- Experiment 1: Asymmetric, Every > No
- Experiment 2: **Symmetric**, **Every = Not every**

Križ symmetric view could explain these results with auxiliary assumptions about prior bias

- No is strongly biased towards context where a plural definite in its scope is read homogeneously; Our context manipulation had a mild effect due to the prior bias
- Every and Not every are more neutral, therefore more prone to context manipulation

But a theory of why this so is yet to be worked out

# Next step: Exactly 2

Non-monotonic quantifiers will allow us to test the effect of polarity on non-maximality using the same sentence

"Exactly two boys opened their presents."

No	Non-maximality in Pos			No	n-maxim	nality in N	leg
Nathan	Leo	Frank	Mike	Frank	Mike	Nathan	Leo
***	***	***	*** ** <mark>*</mark>	# <b>1</b> # <b>1</b> # <b>1</b> # <b>1</b>	9 9 9 9 9 9 9 9 9 9 9 9 9 1 9 1 9 1 9 1		/   /   /   /   /   /   /   /   /   /

(We actually ran this experiment; the results are largly symmetric)

### **Asymmetric view**

The asymmetric view has to explain:

- 1. Symmetry between Every and Not every
- 2. Effect of context manipulation for No

#### Implicature theory (Bar-Lev 2018, 2021)

- Plural definites is semantically existential, can be strengthened by Exh
- Strengthening with a subset of alternatives = non-maximality
- Exh is anti-licensed in negative contexts

 $\Rightarrow$  **No** receive 'no >  $\exists$ ' reading, no non-maximal reading possible

### 1. Non-maximality under Not every

Robust non-maximality for *not every* 

- 'Not every' is semantically negative, but has a robust indirect SI, which renders the scope of 'not every' non-monotonic overall
- Exh is anti-licensed in negative contexts but not in non-monotonic contexts

#### Next step: SI version of Exp 2

- "Every boy opened some of his presents."
- "Not every boy opened some of his presents."

#### 2. Non-maximality under No via covers

- Bar-Lev 2021 proposes a second mechanism for non-maximal readings
  - **[[open]]** →  $\lambda x.\lambda y. \underline{x \text{ in } C}$  and y opened x
  - Due to distributivity, this won't matter in positive sentences
  - In negative sentences, coarse covers will result in non-maximal readings
- The effect of context on **No** can be explained with the assumption that the universal context made the singleton cover (for each boy) salient
- Potential issues
  - No was judged somewhat true in the Existential condition too
  - If covers could be accommodated, it would break the symmetry for Exp 2

#### **Interim conclusion**



- Plural definites have non-maximal readings in both positive and negative sentences
- No is less affected by context than every or not every

These observations pose issues for both Symmetric and Aymmetric theories of nonmaximality for plural definites

#### Part 2

#### **Bare plurals**

Collaboration with Yizhen Jiang

### **Bare plurals and polarity**

Bare plurals are generally read with plurality inferences in positive enrivonments; but are number neutral in negative environemnts (Farkas & De Swart 2010, Ivlieva 2014, Križ 2017, Sauerland 2003, Spector 2007, Sudo to appear)

- "Frank opened presents."
  - $\approx$  Frank opened <u>more than one</u> present (**Strong**)
  - ? Frank opened at least one present (Weak)
- "Frank didn't open presents."
  - ≈ Frank didn't open <u>any</u> present (Strong)
  - $\circ$  ?  $\neg$  (Frank open more than one present) (Weak)

Weak readings seem to be available as non-default readings

### Polarity and plurality inference

- 1. Symmetric view: Weak readings are *ceteris paribus* avaialble equally in positive and negative sentences (Križ 2017)
- 2. Asymmetric view: Weak readings are harder to obtain in negative sentences than in positive sentences (Farkas & De Swart 2010, Ivlieva 2014, Sauerland 2003, Spector 2007, Sudo to appear)

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



# Križ's symmetric theory of bare plurals

Križ (2017) proposes that the same interpretive mechanism is behind the behaviour of bare plurals and the homogeneity of deifnite plurals

$$\llbracket Frank \text{ opened his presents} \rrbracket^w = \begin{cases} 1\\ 0\\ \# \end{cases}$$

if Frank opened **all** of his presents in wif Frank opened **none** of his presents in wif Frank opened **some but not all** of his presents in w

 $\llbracket \mathsf{Frank opened presents} \rrbracket^w = \begin{cases} 1 & \text{if Frank opened more than one present in } w \\ 0 & \text{if Frank opened no present in } w \\ \# & \text{if Frank opened exactly one present in } w \end{cases}$ 

# 'Non-maximality'

Križ's theory predicts bare plurals to show 'non-maximality'

$$\llbracket \mathsf{Frank} \ \mathsf{opened} \ \mathsf{presents} 
rbracket^w = egin{cases} 1 \ 0 \ y \end{bmatrix}^w$$

if Frank opened **more than one** present in w if Frank opened **no** present in wif Frank opened **exactly one** present in w **\**#

#### E.g. Frank received two presents.

• "Did he open either of the presents?"  $\rightarrow$  #-worlds are practically true

0

• "Did he open both of the presents?"  $\rightarrow$  #-worlds are practically false



#### **Experiment 3**

Bare plurals in simple positive and negative sentences

# Design

Same task as Experiments 1 and 2, including family rules

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

NB: Unlike with definite plurals, there is no worry about inverse scope in Negative

#### **Pictures**





#### 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<sup>Ref</sup>; treatment-coded)
  - CONTEXT×QUANTIFIER
  - Mixed effect: by-subject random intercept (full model didn't converge)



- CONTEXT×QUANTIFIER:  $\chi^2(1) = 0.4$ , p =

#### Summary

- Symmetric effect of CONTEXT on POLARITY
- The effect size in POSITIVE is smaller than in Experiments 1 and 2

The symmetry is as predicted by Križ's (2017) symmetric account

But recall definite plurals behaved differently in different negative contexts

To make the results more comparable to Experiment 1, we tested bare plurals under *every* and *no* 

#### **Experiment 4**

Bare plurals under every vs. no

# **Projection through quantifiers**

According to Križ's theory, the trivalent meaning of bare plurals should interact with quantifiers in the same way as in the case of definite plurals

$$\llbracket \mathsf{E} \mathsf{very} \ \mathsf{boy} \ \mathsf{opened} \ \mathsf{presents} 
rbracket^w = egin{cases} 1 \\ 0 \\ \# \end{cases}$$

if every boy opened more than one present in wif one or more boys opened no present in wotherwise

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

Non-maximality shoul be observed here too, e.g., when each boy opened one present

### Design

Same task as Experiments 1-3

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

#### **Pictures**





Frank	Mike	Nathan	Leo
**	¥¥	<b>*</b> *	<b>* *</b>

#### 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. Negative<sub>Ref</sub>; treatment-coded)
  - CONTEXT×QUANTIFIER
  - Mixed effects: by-subject intercept, by-subject slope for POLARITY, correlation



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- **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

#### Summary

- Asymmetric effect of CONTEXT: Every > No
- Similar to the results of Experiment 1, but smaller effect size in POSITIVE

The asymmetric effect is not straightforwardly predicted by Križ's symmetric account, but the similarity between definite and bare plurals is encouraging

The difference bewteen Experiment 3 (simple sentences) vs. Experiment 4 (quantified sentences) is a problem for every theory of bare plurals

So far Križ's theory seems to be an appealing option, but its treatment of **partial plurality** will be an issue

#### **Experiment 5**

Partial plurality under every and no

# **Partial plurality**

Certain quantified environments are considered to give rise to partial plurality readings

• "Every boy opened presents"

i. Every boy opened more than one present

ii. Every boy opened at least one present and some boys opened more than one

• "Exactly one boy opened presents"

i. Exactly one boy opened more than one present

ii. One boy opened more than one present, and the other boys opened none

### Partial plurality as non-maximality

In Križ's theory, a bare plural under every receives a *full* plurality reading

0

$$\llbracket \mathsf{E} \mathsf{very} \ \mathsf{boy} \ \mathsf{opened} \ \mathsf{presents} 
rbracket^w = egin{cases} 1 \\ 0 \\ \# \end{cases}$$

if every boy opened more than one present in wif one or more boys opened no present in wotherwise

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

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

 $\rightarrow$  Some #-worlds are practically true



#### Partial plurality under no

Križ expects a similar reading under *no* as well (unlike asymmetric theories)

$$\llbracket \mathsf{No} ext{ boy opened presents} 
rbrace ^w = egin{cases} 1 \\ 0 \\ \# \end{cases}$$

if no boy opened any present in wif one or more boys opened more than one present in wotherwise

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

 $\rightarrow$  Some #-worlds are practically true



### Design

Same task as Experiments 1-4

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

Same quantified sentences as Experiment 4, but different pictures

# **Target pictures: Every**



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

# **Target pictures: No**



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

### **Control pictures**

Frank	Mike	Nathan	Leo	

Frank	Mike	Nathan	Leo
<b>* *</b>	<b>*</b> *	Ť	

Nathan	Leo	Frank	Mike
		<b>₩1</b>	<b>≝</b> ∎ ∎

Nathan	Leo	Frank	Mike
**	<b>*</b>	<b>*</b> *	<b>*</b>

#### 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]<sup>Ref</sup>; treatment-coded)
  - CONTEXT×SCENARIO
  - Mixed effects: by-subject intercept, by-subject slope for SCENARIO, correlation

#### **Results: Every** XO 0 Condition 4.72 5 466 4.67**Control True** 4.88 4.8 Target 4 4.24 4.25 Control False Mean 3 2 1 0.73 1.12 1.12 1.04 1.02 Strict Strict Lax Lax Context

CONTEXT: χ<sup>2</sup>(1) = 0.1, p = 0.75

• Scenario: 
$$\chi^2(1) = 48.5$$
, p < 0.001

• CONTEXT×QUANTIFIER:  $\chi^2(1) = 0.1$ , p =

#### **Results: No**



**Control True** Target Control False

- 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

- Križ's predictions for **Required** 
  - **Every**: [o] > [ox]
  - **No**: [0] < [0X]
- Given the results of Experiment 3, we'd expect the differences to be detectable
- Contrary to Križ's predictions, no effect of CONTEXT
- The only reliable effect is [o] vs. [ox] for **Every**

### Discussion

### **Summary of experimental findings**

Non-maximality of definite plurals (Experiments 1–2)

- Effect of context: **Every = Not every > No**
- Not directly predicted by Križ but could be explained by different prior associations

#### Weak-readings of bare plurals (Experiments 3–4)

- Effect of context: Simple positive = Simple negative = Every > No
- also no directly predicted, but potentially explained by priors
- **BUT** Partial plurality observed in Expeirment 5 is problematic

### Partial plurality under every

$$\llbracket \text{Every boy opened presents} \rrbracket^w = \begin{cases} 1\\ 0 \\ \vdots \end{cases}$$

 $\begin{cases} 1 & \text{if every boy opened more than one present in } w \\ 0 & \text{if one or more boys opened no present in } w \\ \# & \text{otherwise} \end{cases}$ 

For Križ, the sentence denotes # in both scenarios below, but we only observed context sensitivty for the left



Frank	Mike	Nathan	Leo
		Ĩ	

#### Partial plurality under no

Likewise, Križ expect the same degree of context sensitivity for bare plurals under **No** in both types of pictures, but effect was only observed with the picture on the left

$$\llbracket \mathsf{No} \ \mathsf{boy} \ \mathsf{opened} \ \mathsf{presents} 
rbrace^w = egin{cases} 1 \\ 0 \\ \# \end{cases}$$

if no boy opened any present in wif one or more boys opened more than one present in wotherwise

Frank	Mike	Nathan	Leo
<b>*</b>	<b>i i</b>	<b>*</b>	<b>≝</b> ∎

Frank	Mike	Nathan	Leo
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#### Conclusions

There are certain appealing features of Križ's (2017) uniform treatment of definite plurals and bare plurals, e.g. languages without definiteness marking

- But its predictions for bare plurals under quantifiers are problematic
- Križ might still be right about plural definites

A different mechanism should be responsible for bare plurals, e.g. scalar implicatures (Farkas & De Swart 2010, Ivlieva 2014, Sauerland 2003, Spector 2007, Sudo to appear)

 But the effect of context observed in Experiments 3–4 is problematic for the scalar implicature theory

# Thanks!!



