

## Putting plural definites into context<sup>1</sup>

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**Abstract.** Theories of plural definites differ with respect to ‘non-maximal readings’ of plural definites in positive and negative sentences. The implicature approach predicts an inherent asymmetry where plural definites allow for non-maximal readings in positive sentences but not in negative ones. The non-implicature approach makes symmetric predictions that non-maximal readings should be available to the same degree in positive and negative sentences. Previous experimental work found evidence for an asymmetry between positive and negative cases, but since they did not control for potential contextual effects, it remains to be a possibility that positive and negative sentences were judged against different implicit contexts that had different effects on the availability of non-maximal readings. In this paper, we report on two experiments using a picture-sentence verification task, testing the effect of context on the non-maximal readings of plural definites in positive and negative sentences. We tested sentences containing the plural definite ‘*his/her presents*’ under a positive quantifier ‘*every boy/girl*’ and two negative quantifiers ‘*no boy/girl*’ and ‘*not every boy/girl*,’ manipulating what was relevant in the context. Our results indicate that while non-maximal readings under all three quantifiers are modulated by context, the effect size is smaller for *no* than for the other two quantifiers. We argue that these findings pose challenges for both types of theories, and discuss possible amendments of each approach in order to account for our findings.

**Keywords:** plural definites, homogeneity, non-maximality, implicatures, relevance

### 1. Introduction

Sentences containing a plural definite expression like *his presents* exhibit two main properties, *homogeneity* and *non-maximality*. Homogeneity has to do with true-value gaps (Schwarzschild 1994; Löbner 2000; Breheny 2005; Gajewski 2005; Magri 2014 among others). Specifically, while (1) tends to be interpreted akin to its universal counterpart in (2), its negation in (3) does not merely suggest the negation of (2), but rather something stronger, similar to the paraphrase in (4).

(1) Frank opened his presents.

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- (2) Frank opened all of his presents.
- (3) Frank didn't open his presents.
- (4) Frank didn't open any of his presents.

Non-maximality has to do with the fact that the truth-conditions of sentences containing plural definites are not as rigid as those containing quantifiers, at least in some speech contexts (Krifka 1996; Brisson 1998; Lasersohn 1999; Breheny 2005; Malamud 2012; Križ 2015 among others). For example, in a context in which all we care about is whether Frank opened any presents at all – say because it was important to keep every present closed before the guests arrived – (1) can be judged true even if Frank opened some but not all of his presents.

In the theoretical literature it is debated whether homogeneity and non-maximality arise from some core property of plural definites, but regardless of this question, any theory of plural definites has to tell us where these two properties come from (see Malamud 2012; Križ 2016; Križ and Spector 2021; Magri 2014; Bar-Lev 2018, 2021 for discussion). For the purposes of the present paper, we will broadly classify current theories of plural definites into implicature and non-implicature approaches. We will briefly sketch both views below.

### 1.1. The implicature approach

The implicature approach (Magri 2014; Bar-Lev 2018, 2021) captures homogeneity by appealing to a basic existential semantics for plural definites. To illustrate the idea, consider a context in which the relevant presents are commonly known to be *a*, *b* and *c*, and nothing else. In such context, the literal meaning of (1) is analysed as in (5): Frank opened at least one of *a*, *b* and *c*.

$$(5) \quad \exists x \in \{a, b, c\}(\text{opened}(f, x))$$

(5) is obviously too weak to capture the intuitively perceived interpretation of (1), but its negation immediately accounts for the observed reading of (2).

$$(6) \quad \neg \exists x \in \{a, b, c\}(\text{opened}(f, x))$$

In order to capture the positive case, the implicature approach argues that the basic existential semantics is strengthened by an implicature. The details of how the implicature strengthening works are not crucial for our purposes here, and we refer the interested reader to Magri (2014) and Bar-Lev (2021). What matters for us is that the strengthened meaning corresponds to the maximal reading we are after as in (7). For expository purposes, we will assume that implicatures (of the relevant kind) arise due to a phonologically silent operator *EXH*.

$$(7) \quad \llbracket \text{EXH}(\text{Frank opened his presents}) \rrbracket \Leftrightarrow \forall x \in \{a, b, c\}(\text{opened}(f, x))$$

No such strengthening applies to the negative sentence, because *EXH* normally cannot appear in the direct scope of negation.

Finally, as suggested by Bar-Lev (2018, 2021) non-maximality can be assimilated to the contextual modulation of implicatures. He assumes that the strengthened meaning of the positive example above is obtained by quantifying over the alternatives whose literal meanings are given in (8).

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- (8)  $\exists x \in \{a, b, c\}(\text{opened}(f, x))$   
 $\exists x \in \{a, b\}(\text{opened}(f, x))$   
 $\exists x \in \{b, c\}(\text{opened}(f, x))$   
 $\exists x \in \{a, c\}(\text{opened}(f, x))$   
 $\exists x \in \{a\}(\text{opened}(f, x))$   
 $\exists x \in \{b\}(\text{opened}(f, x))$   
 $\exists x \in \{c\}(\text{opened}(f, x))$

Bar-Lev assumes that in some contexts, some of these alternatives can be ignored, or pruned, and such pruned sets of alternatives can give rise to weaker truth-conditions, which amount to non-maximal readings. For instance, the strengthening of (1) over the alternatives whose literal meanings are in (9) gives rise to a meaning paraphrasable as Frank opened at least two of *a*, *b*, and *c*.

- (9)  $\exists x \in \{a, b, c\}(\text{opened}(f, x))$   
 $\exists x \in \{a, b\}(\text{opened}(f, x))$   
 $\exists x \in \{b, c\}(\text{opened}(f, x))$   
 $\exists x \in \{a, c\}(\text{opened}(f, x))$

In sum, the implicature approach postulates an existential literal meaning for plural definites, which straightforwardly accounts for negative sentences, and derives the stronger truth-conditions of positive sentences with implicatures. In Bar-Lev's version of the theory, non-maximal readings arise in context where some alternatives can be pruned.

### 1.2. The non-implicature approach

The non-implicature approach is either based on families of interpretations or a trivalent semantics, and also involves a pragmatic mechanism for contextual modulation (Križ 2015, 2016; Križ and Spector 2021). To briefly illustrate, we sketch Križ's (2016) trivalent theory, which captures homogeneity by analysing sentences like (1) and (2) as receiving a truth-value gap unless Frank opened all or none of his presents.

- (10) *Frank opened his presents* is  $\begin{cases} \text{TRUE} & \text{if Frank opened all of his presents} \\ \text{FALSE} & \text{if Frank opened none of his presents} \\ \# & \text{otherwise} \end{cases}$

- (11) *Frank didn't his presents* is  $\begin{cases} \text{TRUE} & \text{if Frank opened none of his presents} \\ \text{FALSE} & \text{if Frank opened all of his presents} \\ \# & \text{otherwise} \end{cases}$

In order to account for non-maximal readings, Križ (2016) proposes that perceived truth-values can differ from the semantic truth-values in certain contexts. That is, when a sentence that has a non-trivially trivalent meaning is used against a context where it denotes  $\#$ , it can be judged as effectively true or effectively false, if  $\#$  is enough to achieve the immediate conversational goal.

By way of illustration, consider a context in which we are trying to answer the question of whether Frank opened any of his presents. In other words, we would like to know if the possible world we are in is one where Frank opened none of his presents or one where he opened

some or all of his presents. Suppose now that you know that Frank opened some but not all of the presents. Križ's theory allows you to use the sentence in (1) to inform the interlocutors that the true answer to the question under consideration is positive, meaning Frank opened at least one of the presents, despite the fact that the truth-value the sentence denotes is #, because in the current context, we do not really care about the difference between the possible worlds in which (1) denotes TRUE and those in which it denotes #.

Imagine now that the question under discussion is whether or not Frank opened all of his presents. In this case, a sentence like (1) will be judged as effectively false, because now we do not care about the difference between the possible worlds in which the sentence denotes # and those in which it denotes FALSE.

The same holds for the negative case in (3) but in the opposite direction: (3) would be judged as effectively false in the first context above, and effective true in the second.

In sum, under the non-implicature approach, definite plurals give rise to non-bivalent meaning, which feeds pragmatics in such a way that non-classical truth-values can be deemed to be effective true and effectively false, depending on the interlocutors' interests.

### 1.3. Divergent predictions

The two approaches make divergent predictions with respect to the non-maximal readings of plural definites in positive and negative sentences Bar-Lev (2021); Križ and Spector (2021). As explained above, the implicature approach predicts an inherent asymmetry. That is, since non-maximality is linked to the mechanism for contextual modulation of implicatures, only plural definites in positive sentences are predicted to allow for non-maximal readings. On the other hand, the non-implicature approach makes symmetric predictions that plural definites in both positive and negative sentences should be able to receive non-maximal readings.

Previous experimental studies raise some suggestive data regarding these divergent predictions. Križ and Chemla (2015) tested plural definites against various different grammatical contexts. Specifically, in addition to the simple positive and negative sentences like (1) and (3), they tested plural definites in quantified sentences like (12) and (13) below. The advantage of moving to quantified sentences like (12) and (13) is that, in the intended bound reading, they better control for the scope of the plural definite with respect to negation.

(12) Every boy opened his presents.

(13) No boy opened his presents.

Križ and Chemla presented such sentences with visual contexts representing 'non-maximal scenarios', where the sentence needs to be read non-maximally to be judged to be true (e.g., every boy opened some or all of his presents). In their results, they found that plural definites in sentences with *every* received intermediate truth-value judgments more often than plural definites in sentences with *no*. When taken at face value, this is more in line with the predictions of the implicature approach. However, they also observed that plural definites in negative sentences generally can receive non-maximal readings. Furthermore, given that their study did not specify what conversational context the sentences were meant to be judged against, it is possible that participants accommodated different contexts for different sentences. This is in fact not unlikely, given previous findings suggesting that negative sentences generally require

more contextual licensing (see Tian and Breheny 2019 and references therein), and that could well have had somehow affected the availability of the non-maximal reading.

Tieu et al. (2019) is an acquisition study that tested plural definites occurring in positive and negative sentences against non-maximal scenarios. While child participants accepted positive sentences more often than negative sentences, which squares well with the results reported in Križ and Chemla (2015), adult participants accepted positive sentences more often than negative sentences. In addition, their experiments also did not specify the intended conversational context and therefore their results also leave open the possibility that different contexts were likely to be assumed for positive and negative sentences.

## 2. The experiments

We report on two web-based experiments that use a picture-sentence verification task. The design of the experiments largely follows Križ and Chemla (2015) with one crucial difference, namely, we presented explicit conversational contexts. Experiment 1 compared plural definites occurring in the scope of *every* and *no*, while Experiment 2 compared sentences containing *every* with sentences containing another negative quantifier, *not every*. Concretely, we tested the following sentences.

$$(14) \quad \left. \begin{array}{l} \text{Every} \\ \text{No} \\ \text{Not every} \end{array} \right\} \left\{ \begin{array}{l} \text{boy} \\ \text{girl} \end{array} \right\} \text{ opened } \left\{ \begin{array}{l} \text{his} \\ \text{her} \end{array} \right\} \text{ presents.}$$

In both experiments, we manipulated the intended conversational context. We prepared two contexts. The UNIVERSAL context is purported to make salient the question whether all presents were open, as it is expected in the context that each boy opens all of his presents. In the EXISTENTIAL context, on the other hand, it is expected that no boy opens any of his presents, whereby making salient the question whether any presents were open. Participants were instructed to judge how well the sentences described the scenarios shown in the picture on a five-point Likert scale ranging from ‘completely true’ to ‘completely false’.

The predictions of the two approaches with respect to our experimental manipulation are summarised in Table 1. Both approaches predict that plural definites in the scope of *every* should be able to receive maximal readings, the maximal readings are more readily available in the EXISTENTIAL context than in the UNIVERSAL context. For plural definites under negative quantifiers (*no* and *not every*), on the other hand, the two approaches make different predictions. The non-implicature approach predicts a similar difference in judgments but in the opposite direction, i.e., the sentences should be judged better in the UNIVERSAL context than in the EXISTENTIAL context. Under the implicature approach, on the other hand, plural definites in such negative sentences should not receive non-maximal readings, so should give rise to low acceptability in both contexts.

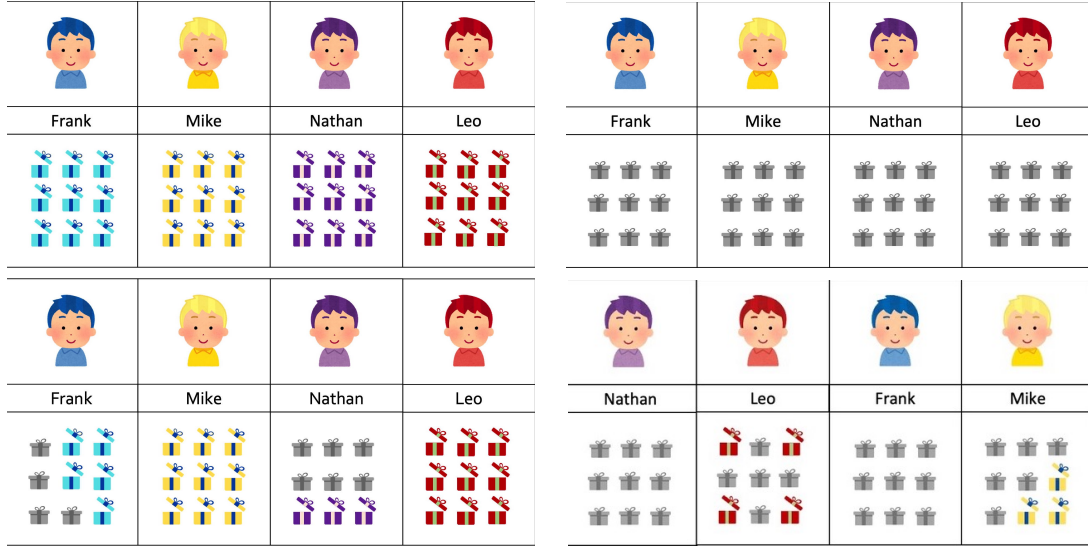
### 2.1. Experiment 1

#### 2.1.1. Methods

In our first experiment, we compared sentences involving the quantifiers *every* and *no* with a plural definite in their scope. Each sentence was accompanied by one of three types of

	<i>every</i>		<i>no, not every</i>	
	EXISTENTIAL	UNIVERSAL	EXISTENTIAL	UNIVERSAL
Implicature	HIGH	LOW	LOW	LOW
Non-implicature	HIGH	LOW	LOW	HIGH

Table 1: Predictions of the two approaches. Difference in predictions is highlighted in gray.

Figure 1: Examples of pictures used in Experiment 1. The top two pictures are items in the CONTROL conditions. The bottom left picture was a target item for *every* and the bottom right picture was a target item for *no*.

pictures. Each picture showed four boys/girls, each with nine presents each, as in the examples in Figure 1. The pictures in the CONTROL conditions depicted uniform situations, either with all the presents closed (indicated by grey), or with all the presents open, and therefore the sentences should receive clear true or false responses. Note that the control pictures that should elicit true responses for sentences with *every* should elicit false responses for sentences with *no* and vice versa.

The pictures in the TARGET condition depict non-maximal scenarios, where two of the four children opened some but not all of their presents. We prepared two types of TARGET pictures that differ with respect to what the other two boys did, namely, pictures where the other boys opened all of their presents and pictures where the other boys opened none of their presents. While we tested both sentences with *every* and sentences with *no* against both types of target pictures, we later noticed that their non-maximal readings are true in different target pictures. We only included in the analysis data from those pictures that could make the sentences true.

At the beginning of the experiment, the participant was introduced to either the EXISTENTIAL context or the UNIVERSAL CONTEXT, together with a practice session. Both contexts were about particular rules about opening presents in some hypothetical family with either four boys or four girls. In the UNIVERSAL context, the children were instructed by their parents to open the presents they have received from their grandparents before they arrive to their house. In the

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Family rule: Opening the presents is prohibited before the guests arrive.

(a)

Were the rules respected?

yes no

Kim opened her presents.

completely true completely false

Next

(b)

Figure 2: An example display from Experiment 1. The parents of the family and the family rule were displayed on the top of the screen as in (a), followed by a picture of the boys with their presents, which in turn was followed by the secondary and primary questions as in (b).

EXISTENTIAL context, the children are instructed to wait until their grandparents arrive, before they can open the presents.

In order to make sure that the participants paid attention to and remembered the context, we administered a secondary task to be answered before each sentence-picture judgment trial. This secondary task was to judge on each trial whether the family rule ('Opening the presents is prohibited' or 'Opening the presents is required') was respected or not by clicking on *yes* or *no*. Figure 2 contains an experimental display for one example trial. On the top of each display, participants were reminded of the family rule with a picture of the boys' parents together with the description of the rules. Directly below this picture, the experimental picture for the picture sentence verification task was shown (control or mixed).

The experimental factors manipulated were CONTEXT (EXISTENTIAL or UNIVERSAL), PICTURE (TARGET, CONTROL-TRUE, CONTROL-FALSE) and POLARITY (POSITIVE = *every* or NEGATIVE = *no*). Among these, CONTEXT was a between-subject factor. We also counterbalanced the position of the *Yes* and *No* buttons for the primary task, the order of the end points of the Likert scale, and the gender of the children (boys or girls).

The experimental sentences were spread over 8 lists. Each list contained 24 experimental items, half with the positive quantifier *every* and the other half with the negative quantifier *no*. For each sentence, there were 4 CONTROL-TRUE items, 4 CONTROL-FALSE items, and 4 TARGET items. As mentioned above, 2 of the TARGET items would not make the sentence true regardless of the availability of a non-maximal reading, so we excluded them from the analysis. The experimental items appeared in a randomized order for each participant.

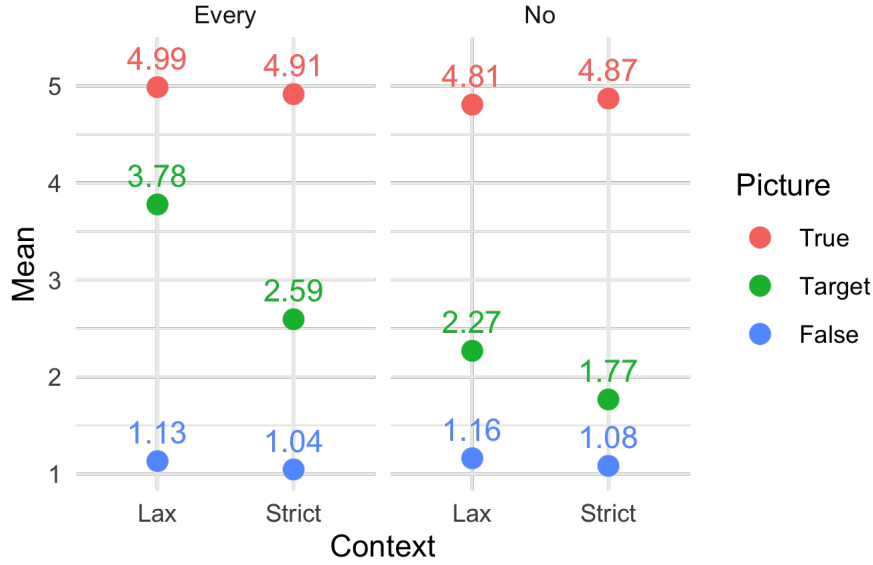


Figure 3: Mean acceptability ratings in Experiment 1. CONTEXT is recoded as LAX (favors non-maximality) or STRICT (favors maximality).

192 native speakers of English were recruited from Prolific ([www.prolific.co](http://www.prolific.co)) and paid 1.50 GBP for their participation. Seven were excluded for low (<75%) accuracy on the main judgment task on the CONTROL items, where responses above 3 for CONTROL-FALSE and responses below 3 for CONTROL-TRUE were considered to be errors).

### 2.1.2. Results and discussion

Figure 3 shows the mean acceptability ratings for the different conditions after recoding CONTEXT into LAX (EXISTENTIAL for *every*, UNIVERSAL for *no*) and STRICT (UNIVERSAL for *every*, EXISTENTIAL for *no*). LAX contexts should improve the acceptability in the TARGET condition, while STRICT contexts should not.

For statistical analysis, we carried out a cumulative logistic mixed-effects model analysis (Christensen 2022) on mixed conditions with CONTEXT (sum-coded), POLARITY (treatment-coded with *no* as baseline) and their interaction as fixed effects, and random by-subject intercepts and slopes. While we would have ideally included the CONTROL conditions in the model, floor and ceiling effects led to convergence issues in the ordinal logistic regression. However, since performance on the CONTROL conditions is near-perfect, no information is lost from their non-inclusion. The model revealed a significant simple effect of CONTEXT (CONTEXT had an effect on *no*;  $\chi^2(1) = 49$ ;  $p < .001$ ) and a significant main effect of POLARITY (*every* is more acceptable than *no*;  $\chi^2(1) = 93$ ;  $p < .001$ ), as well as a significant interaction (*every* is more sensitive to CONTEXT than *no*;  $\chi^2(1) = 11$ ;  $p < .001$ ).

This high performance shows that the participants did not have difficulties with the experimental task. The interaction effect between CONTEXT and POLARITY is compatible with the implicature approach, but poses a challenge for the non-implicature approach. However, the presence of non-maximal readings for *no* is challenging for the implicature approach, at least in the version



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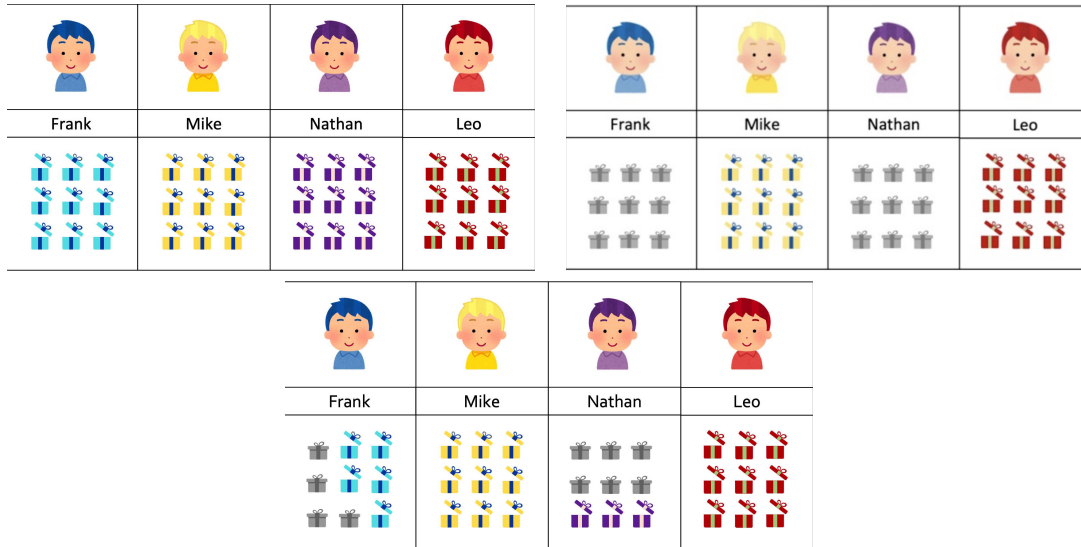


Figure 4: Examples of pictures used of Experiment 2. The top two pictures are items in the CONTROL condition and the bottom picture were is an item in the TARGET condition.

we presented above. We will discuss Bar-Lev’s (2021) idea that could make the implicature approach compatible with the simple effect of CONTEXT later.

## 2.2. Experiment 2

### 2.2.1. Methods

The design of Experiment 2 is essentially parallel to that of Experiment 1, with the negative quantifier being replaced by *not every*. One consequence of this change is that the same TARGET pictures could be used for both sentences. For all the items in the TARGET condition, two children opened some but not all of their presents, while the other two opened all of their presents. The CONTROL and TARGET pictures are illustrated in Figure 4.

The experimental sentences were spread over 8 lists. Each list contained 32 items as a whole, with 24 experimental and 8 filler items. Half of the experimental items contained the positive quantifier *every* and the other half the negative quantifier *not every*. For each experimental sentence, there were 4 CONTROL-TRUE items, 4 CONTROL-FALSE items, 4 TARGET items. Filler items were included in this experiment, because in the other conditions, the correct answer to the secondary *yes/no* task was uniformly ‘No’ in the EXISTENTIAL condition. The filler items consisted of four pictures in which none of the boys opened any of his presents. Pictures were accompanied with sentences containing proper names in place of the quantifiers. 4 of these sentences were positive and 4 of them were negative as in (15).

- (15) a. Frank opened his presents.  
b. Frank didn’t open his presents.

192 native speakers of English were recruited from Prolific ([www.prolific.co](http://www.prolific.co)) and paid 1.50 GBP for their participation. Ten were excluded for low (< 75%) accuracy on the control items.

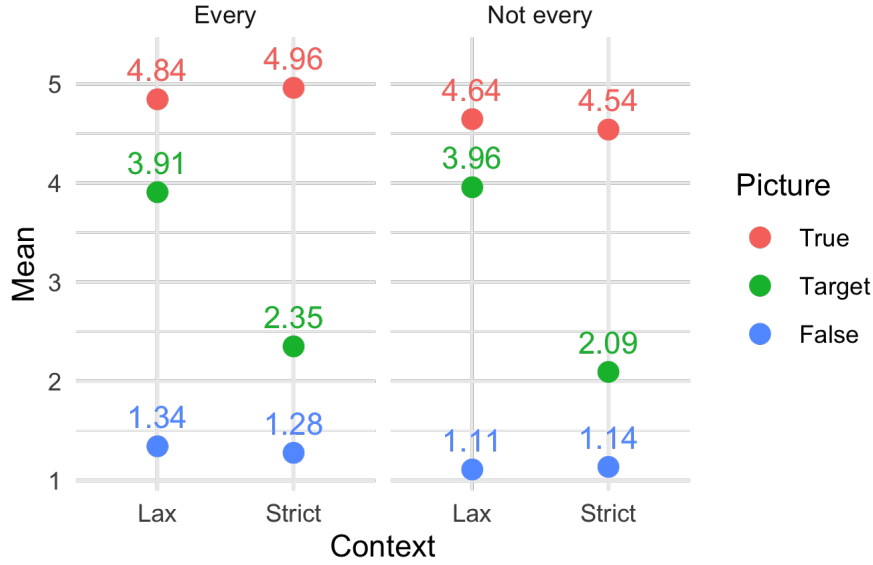


Figure 5: Mean acceptability ratings in Experiment 2. CONTEXT is recoded as LAX (favors non-maximality) or STRICT (favors maximality).

### 2.2.2. Results and discussion

Figure 5 shows the results of Experiment 2. As the figure indicates, some of the control conditions had less-than-perfect accuracy. An ordinal logistic mixed-effects model on the CONTROL-TRUE and CONTROL-FALSE conditions revealed effects of PICTURE and POLARITY, but crucially no effect of, or interaction with CONTEXT ( $\chi^2(3) = 0.46, p = .93$ ). This means that when analysing the mixed conditions, main effects of POLARITY may not be interpretable, but we can be confident that any effect of CONTEXT is specific to the TARGET conditions and not an overall artifact of the task.

The results in the Target condition were analysed as in Experiment 1. The cumulative logistic mixed-effects model revealed a simple effect of CONTEXT (LAX is more acceptable;  $\chi^2(1) = 89, p < .001$ ), no main effect of POLARITY (*every* is as acceptable as *not every* in mixed condition, but see caveat above;  $\chi^2(1) = .02, p = .90$ ), and, crucially, no significant interaction between CONTEXT and POLARITY ( $\chi^2(1) = 2.1, p = .15$ ).

As in Experiment 1, high performance in the CONTROL conditions shows that participants did not have difficulties with the experimental task. This time, in the TARGET conditions, we found no evidence for an interaction between CONTEXT and POLARITY. The EXISTENTIAL context made *every* more acceptable to the same extent that the UNIVERSAL context made *not every* more acceptable. Thus, non-maximal readings of the *not-every* sentences were found to be as context-dependent as with *every*-sentences. The symmetry in the contextual effect and the overall similar acceptance of the positive and negative quantifiers is very much in line with the non-implicature approach this time, but challenging for the implicature approach.

### 3. General discussion

To summarise the main findings, in Experiment 1, we found evidence for an asymmetric effect of our context manipulation for positive and negative sentences. This is in line with the implicature approach, but not straightforwardly predicted by the non-implicature approach. However, we observed an effect of context on *no*, which is not straightforwardly expected under the implicature approach. In Experiment 2, we observed a symmetric effect of CONTEXT for positive and negative sentences, which is more in line with the non-implicature approach and poses a challenge for the implicature approach. Thus, the results of our experiments pose issues for both approaches to plural definites. In the following, we sketch possible directions and amendments of each approach.

#### 3.1. Prospects for the implicature approach

There are two challenges to the implicature approach: (i) to account for the effect of context for negative sentences (both *no* and *not every*) and (ii) to account for why the case of *not every* gave rise to non-maximal reading as much as their positive counterpart and was equally sensitive to contextual effects, in contrast with *no*.

Bar-Lev (2021) acknowledges the first challenge based on introspective judgments, and suggests that non-maximal readings in negative sentences should be explained by a different mechanism than pruning of alternatives, which has to do with (non-trivial) covers and only has truth-conditionally detectable effects in non-positive contexts. Putting aside the details (the interested reader is referred to Bar-Lev 2021), on the assumption that the availability of this mechanism is context-sensitive (as Bar-Lev 2021 in fact assumes), the effect of context on the availability of non-maximal readings can be explained.

In addition, if we also assume that the additional mechanism in question is more restricted and less available than pruning of alternatives, we could explain the asymmetry between *every* and *no*, but the symmetric results of Experiment 2 would still remain to be puzzling, given that *not every* would be predicted to pattern with *no*.

In order to explain the difference between the two negative quantifiers, *no* and *not every*, we suggest the possibility that *not every* is not ‘genuinely downward entailing.’ That is, when evaluating whether a sentence is downward entailing, for the purpose of the distribution of implicatures, we should also take into account the implicatures the sentence can give rise to.<sup>2</sup> In fact, (16) does very robustly suggest that some boys did open their presents. Once this implicature is added to the literal meaning the resulting overall environment is not downward entailing, but non-monotonic.

- (16) EXH[Not every boy opened his presents].  
 $\leadsto$  *some boys opened their presents.*

If we add the assumption that implicatures can appear more easily in non-monotonic contexts, it would give the implicature approach another route to non-maximality through an embedded implicature. This embedded implicature would make the sentence equivalent to (17), thus true

<sup>2</sup>Compare the so-called ‘intervention effects’ of universal quantifiers for NPI licensing in sentences like *\*I didn’t give every boy any present*, which are considered to be due to indirect scalar implicatures turning the positions of NPIs non-monotonic (Chierchia 2004, 2013).

in a non-maximal situation. Finally, this mechanism would correctly not extend to *no*, thus predicting the difference between *not every* and *no*.

- (17) EXH[Not every boy<sub>x</sub> EXH[*x* opened his presents]].  
 $\leadsto$  *not every boy opened all of his presents*  
 $\leadsto$  *Some boys opened all of their presents*

This response for the implicature approach would capture our results, but makes an immediate prediction that implicatures should generally arise more easily in the scope of *not every* than that of *no*. For instance, (18) should more easily be read with the indicated implicatures than (19). Said differently, (18) should be accepted more easily in a context in which some of the boys opened both presents, (while the others opened only one of the two), than (19) in a context in which all the boys opened both.

- (18) Not every boy opened the present on their left or on their right.  
 $? \leadsto$  *not every boy opened one or the other but not both*  
 $? \leadsto$  *some boys opened one or the other but not both*
- (19) No boy opened the present on his left or on his right.  
 $? \leadsto$  *no boy opened one or the other but not both*

We leave this as an open question for future research, but it should be remarked that provided that something like Bar-Lev's (2021) is necessary for the implicature approach and it will affect the interpretation of definite plurals under *not every*, meaning there will be two ways of getting non-maximal readings under *not every*, the symmetric results between *every* and *not every*, under the current hypothesis, should not carry over to the case of regular scalar implicatures.

### 3.2. Prospects for the non-implicature approach

The main challenge to the non-implicature approach is that *no* gave rise to non-maximal readings much less than both *every* and *not every*. A possible response is to assume that the effect size of context manipulation negatively correlates with the strengths of prior associations between context and sentences, and that sentences with *no* come with stronger prior associations with contexts that disallow non-maximal readings than sentences containing *every* or *not every*.

Certainly, independent evidence for the prior associations needs to be raised, which we leave for future research but we would like to mention that sentences with non-monotonic quantifiers like (20) offer possible testing grounds.

- (20) Exactly two boys opened their presents.

For such sentences, we can separately test the availability of non-maximal readings in the positive part of the meaning (i.e., *two of the boys opened their presents*) and the negative part of the meaning (i.e., *none of the other boys opened their presents*), while keeping the prior bias associated with the sentence constant, by assessing judgments against mixed scenarios for the positive part of the meaning (Two of the boys opened some but not all of their presents and the others opened none), and mixed scenarios for the negative part of the meaning (Two boys opened all of their presents and two opened some but not all). If the asymmetry we found in Experiment 1 is specific to *no*, we should find symmetric behaviour here. We also leave this to future research.

#### 4. Conclusion

We reported on two experiments using a picture-sentence truth-value judgment task, testing the predictions of the implicature versus non-implicature approaches to plural definites. Our results provided evidence for an asymmetry between plural definites in the scope of *every* and *no* sentences but a symmetry between plural definites in the scope of *every* and *not every*. We argued that taken together, these results are challenging for both approaches to non-maximal readings of plural definites. We discussed possible directions each approach can explore in order to account for our results.

Lastly, we would like to remark that there are similar debates in the current theoretical literature between implicature and non-implicature accounts concerning other empirical domains, such as free choice inferences (Tieu et al. 2019), strong vs. weak donkey pronouns (Sun et al. 2020), and counterfactual conditionals (Marty et al. 2020), and for these cases too, comparing positive and negative sentences with the explicit contextual manipulation will be informative in adjudicating between theoretical options.

#### References

- Bar-Lev, M. (2018). *Free choice, homogeneity and innocent inclusion*. Ph. D. thesis, The Hebrew University of Jerusalem.
- Bar-Lev, M. (2021). An implicature account of homogeneity and non-maximality. *Linguistics and Philosophy* 44(5), 1045–1097.
- Breheny, R. (2005). Exhaustivity, homogeneity, and definiteness. In P. Dekker and M. Franke (Eds.), *Proceedings of the Amsterdam Colloquium 2005*, pp. 59–64.
- Brisson, C. (1998). *Distributivity, Maximality, and Floating Quantifiers*. Ph. D. thesis, Rutgers University.
- Chierchia, G. (2004). Scalar implicatures, polarity phenomena, and the syntax/pragmatics interface. In A. Belletti (Ed.), *Structures and Beyond: The Cartography of Syntactic Structures*, Volume 3, pp. 39–103. Oxford: Oxford University Press.
- Chierchia, G. (2013). *Logic in Grammar: Polarity, Free Choice, and Intervention*. Oxford University Press.
- Christensen, R. H. B. (2022). ordinal—regression models for ordinal data. R package version 2022.11-16.
- Gajewski, J. R. (2005). *Neg-Raising: Polarity and Presupposition*. Ph. D. thesis, Massachusetts Institute of Technology, Cambridge, MA.
- Krifka, M. (1996). Pragmatic strengthening in plural predications and donkey sentences. In T. Galloway and J. Spence (Eds.), *Proceedings of SALT VI*, Ithaca, NY, pp. 136–153. CLC Publications.
- Križ, M. (2015). *Aspects of homogeneity in the semantics of natural language*. Ph. D. thesis, University of Vienna.
- Križ, M. (2016). Homogeneity, maximality, and *all*. *Journal of Semantics* 33, 493–539.
- Križ, M. and E. Chemla (2015). Two methods to find truth value gaps and their application to the projection problem of homogeneity. *Natural Language Semantics* 23, 205–248.
- Križ, M. and B. Spector (2021). Interpreting plural predication: homogeneity and non-maximality. *Linguistics & Philosophy* 44(5), 1131–1178.
- Lasnik, P. (1999). Pragmatic halos. *Language* 75(3), 522–551.

- Löbner, S. (2000). Polarity in natural language: Predication, quantification and negation in particular and characterizing sentences. *Linguistics and Philosophy* 23(3), 213–308.
- Magri, G. (2014). An account for the homogeneity effects triggered by plural definites and conjunction based on double strengthening. In S. Pistoia-Reda (Ed.), *Pragmatics, Semantics and the Case of Scalar Implicatures*, pp. 99–145. Springer.
- Malamud, S. A. (2012). The meaning of plural definites: A decision-theoretic approach. *Semantics and Pragmatics* 5, 1–58.
- Marty, P., J. Romoli, and P. Santorio (2020). Counterfactuals and Undefinedness: homogeneity vs supervaluations. In J. Rhyne, K. Lamp, N. Dreier, and C. Kwon (Eds.), *Proceedings of SALT 30*, pp. 603–623.
- Schwarzschild, R. (1994). Plurals, presuppositions and the sources of distributivity. *Natural Language Semantics* 2(3), 201–248.
- Sun, C., R. Breheny, and D. Rothschild (2020). Exploring the existential/universal ambiguity in singular donkey sentences. In M. Franke, N. Kompa, M. Liu, J. L. Mueller, and J. Schwab (Eds.), *Proceedings of Sinn und Bedeutung 24*, Volume 2, pp. 289–305.
- Tian, Y. and R. Breheny (2019). Negation. In C. Cummins and N. Katsos (Eds.), *The Oxford Handbook of Experimental Semantics and Pragmatics*, pp. 195–207. Oxford University Press.
- Tieu, L., C. Bill, and J. Romoli (2019). Homogeneity or implicature: an experimental study of free choice. In K. Blake, F. Davis, K. Lamp, and J. Rhyne (Eds.), *Proceedings of SALT 29*, pp. 706–726.
- Tieu, L., M. Križ, and E. Chemla (2019). Children’s acquisition of homogeneity in plural definite descriptions. *Frontiers in Psychology* 10, 2329.