Putting plural definites into context[1]

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Abstract. One of the main goals of theories of plural definites is to account for so-called 'non-maximal readings,' i.e. readings in which sentences like *Frank opened his presents* can be judged true even if Frank didn't open a few of his presents. Specifically, theories differ with respect to dealing with these cases in positive and negative contexts. The implicature approach, on the one hand, predicts an inherent asymmetry between positive and negative sentences: plural definites are predicted to straightforwardly allow for non-maximal readings in positive sentences but not in negative ones. The non-implicature approach, on the other hand, makes symmetric predictions: all else being equal, 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, more in line with the implicature approach. However, as previous studies did not control for potential contextual effects, we cannot rule out that context may have affected non-maximality in the two cases in different ways, thus giving rise to the observed asymmetry in a way that is compatible with both approaches. In this paper, we report on two experiments using a picture-sentence verification task, testing the effect of context on the non-maximality of plural definites in positive and negative sentences. More specifically, 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 is modulated by context, the effect size is much 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. We also sketch how the same experimental design can be extended to test related phenomena, where we find similar debates between implicature and non-implicature accounts.

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

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Contents

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1. Introduction

1.1. Two properties of plural definites

Sentences containing a plural definite expression like 'his presents,' exhibit two main properties. Firstly, while (1) tends to be interpreted akin to its universal counterpart in (2), surprisingly, its negation in (3) does not merely suggest the negation of (2), but rather something stronger, similar to the paraphrase in (4). Said differently, the predicate λx(**Frank opened**(x)) is understood to be about all presents in the positive case in (1) and the same is true of its negative counterpart λx(**Frank didn't open**(x)) in (3). This property is generally referred to as 'homogeneity' (Schwarzschild 1994; Löbner 2000; Breheny 2005; Gajewski 2005; Magri 2014 among many others).

(1) Frank opened his presents.

(2) Frank opened all of his presents.

(3) Frank didn't open his presents.

(4) Frank didn't open any of his presents.

The second property has to do with the fact that plural definites allow for exceptions in certain contexts. For example, in a context in which all we care about is whether Frank opened any presents at all – say because it was important that no present was open – (1) can be judged true even if Frank opened some but not all of his presents (Krifka 1996; Brisson 1998; Lasersohn 1999; Breheny 2005; Malamud 2012; Križ 2015 among many others). This second property is generally referred to as 'non-maximality.'

It is controversial how connected homogeneity and non-maximality are, but regardless, any theory of plural definites has to tell us where these two properties come from (see Malamud 2012; Križ 2016; Križ and Spector 2021; Sbardolini 2022; Magri 2014; Bar-Lev 2018, 2021 for discussion).

1.2. Two approaches

A variety of accounts on non-maximality and homogeneity have been proposed in the literature. For our purposes, we divide them into two main approaches: one approach involves implicatures and the other does not. Let us sketch them in turn.

1.2.1. 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 gist of the idea, consider a context in which the relevant presents are a, b and c. In such context, the literal meaning of (1) is analysed as in (5): Frank opened at least one of presents a, b and c.

(5) $\exists x \in \{a,b,c\}$(**Frank opened**(x)) $\qquad a \vee b \vee c$

(5) is obviously too weak to capture the 'maximal' interpretation of (1), but its negation immediately accounts for the reading of (2): Frank didn't open any of presents a, b and c.

(6) $\neg\exists x \in \{a,b,c\}$(**Frank opened**$(x)$) $\qquad \neg(a \vee b \vee c)$

In order to capture the positive case, the implicature approach argues that this basic existential semantics is strengthened by an implicature, here indicated as EXH. The details of how the implicature strengthening works are not crucial for our purposes and we refer the reader to Magri 2014; Bar-Lev 2021 for discussion. What matters for us is that the strengthened meaning corresponds to the maximal reading we are after indicated in (7): Frank opened all of presents a, b and c.

(7) $\text{EXH}(\exists x \in \{a,b,c\}(\textbf{Frank opened}(x)))=$
$\forall x \in \{a,b,c\}(\textbf{Frank opened}(x))) \qquad a \wedge b \wedge c$

In other words, under this approach, homogeneity is a by-product of the weak meaning of plural definites, which is strengthened by an implicature in positive cases, but not in negative ones, thereby giving rise to the pattern we saw above.

Finally, as suggested by Bar-Lev (2018, 2021) non-maximality can be assimilated to the contextual modulation of implicatures. In particular, while the strengthening above is obtained by quantifying over the alternatives in (8), in some context, some of the alternatives in (8) can be ignored or 'pruned.'

(8) $$\left\{\begin{array}{ll} \exists x \in \{a,b,c\}(\textbf{Frank opened}(x)) & (a \vee b \vee c) \\ \exists x \in \{a,b\}(\textbf{Frank opened}(x)) & (a \vee b) \\ \exists x \in \{b,c\}(\textbf{Frank opened}(x)) & (b \vee c) \\ \exists x \in \{a,c\}(\textbf{Frank opened}(x)) & (a \vee c) \\ \exists x \in \{a\}(\textbf{Frank opened}(x)) & a \\ \exists x \in \{b\}(\textbf{Frank opened}(x)) & b \\ \exists x \in \{c\}(\textbf{Frank opened}(x)) & c \end{array}\right\}$$

The strengthening over certain subsets of the alternatives gives rise to non-maximal readings. For instance, the strengthening of (1) over the alternatives in (9) gives rise to a meaning paraphrasable as Frank opened at least two of presents a, b, c; a meaning compatible with Frank not opening all of them.

(9) $$\left\{\begin{array}{ll} \exists x \in \{a,b,c\}(\textbf{Frank opened}(x)) & (a \vee b \vee c) \\ \exists x \in \{a,b\}(\textbf{Frank opened}(x)) & (a \vee b) \\ \exists x \in \{b,c\}(\textbf{Frank opened}(x)) & (b \vee c) \\ \exists x \in \{a,c\}(\textbf{Frank opened}(x)) & (a \vee c) \end{array}\right\}$$

In sum, the implicature approach captures the maximal reading in the positive case as an implicature, the strong reading under negation as part of the literal meaning of the sentence, while non-maximality comes from contextual modulation of the maximality implicature.

1.2.2. 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; see also Sbardolini 2022 for a recent different implementation). To briefly illustrate, we sketch the trivalent account within this approach. This account 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.
TRUE if Frank opened all of his presents
FALSE if Frank opened none of his presents
UNDEFINED otherwise

(11) Frank didn't open his presents.
FALSE if Frank opened all of his presents
TRUE if Frank opened none of his presents
UNDEFINED otherwise

In addition, when a sentence is associated with such a gap as its basic meaning, it can nonetheless be judged as 'effectively' true or false, depending on what is relevant in the context, thus accounting for non-maximality (Križ 2016).[2] To illustrate the idea, consider again a context in which Frank opened some but not all of his presents, and imagine further that all we care about is whether Frank opened any of his presents (let's call this an 'EXISTENTIAL' context from now on). We can think of this context as implicitly making salient the question in (12). This question partitions the context into a cell where Frank opened none of his presents, which corresponds to a negative answer to the question, and one in which he opened some or all of his presents, which would be a positive response.[3]

(12) Whether Frank opened any of his presents. $\{\{\forall, \exists \wedge \neg\forall\}, \{\neg\exists\}\}$

With this partition in mind, consider the sentence in (1) in a 'mixed' scenario in which Frank opened some but not all of the presents. As seen above, the sentence is associated with an undefined semantic value. But, given what is relevant in the context, the undefined value is 'grouped' together with the case in which he opened all of the presents, the case in which the sentence would be true. In other words, according to the partition associated with the EXISTENTIAL context, the two cases are indistinguishable. And when this is the case, according to this approach, a sentence with an undefined semantic value, can be nonetheless judged as effectively true. The same holds for when the implicit question partitions the context in such a way that the undefined case is grouped with the false case. The only difference is that in this case the sentence would be judged as effectively false rather than effectively true.

As a comparison, imagine now that the question under discussion in the context is whether Frank opened all of his presents (a 'UNIVERSAL' context). In this case, the mixed case is grouped with the false case, so, according to this approach, a sentence like (1) will be judged as effectively false.

(13) Whether Frank opened all of his presents. $\{\{\forall\}, \{\exists \wedge \neg\forall, \neg\exists\}\}$

The same holds for the negative case in (3) but in the opposite direction: in a mixed scenario, (3) would be judged as effectively true in a UNIVERSAL context and effectively false in an EXISTENTIAL one.

[2]What is relevant in the context is often modelled in terms of (explicit or implicit) Questions under Discussion. Križ (2016) suggests a related but different notion of 'current issue.' For our purposes, we can remain neutral about these details of the discussion and just characterise contexts in terms of the partitions they are associated with, as illustrated below.

[3]We represent the partition schematically as follows: $\forall$ is the cell corresponding to worlds in which all presents were open, $\exists \wedge \neg\forall$ the one where some but not all presents were open, and $\neg\exists$ where no presents were open.

	POSITIVE		NEGATIVE	
	EXI	UNI	EXI	UNI
IMPLICATURE	TRUE	FALSE	FALSE	FALSE
NON-IMPLICATURE	TRUE	FALSE	FALSE	TRUE

Table 1: Predictions of the two approaches for positive sentences like (1) and negative sentences like (3) in mixed scenarios (i.e., when Frank opened some but not all of his presents) across the two different contexts. Different predictions are highlighted in gray.

In sum, the non-implicature approach accounts for homogeneity as part of the trivalent semantics of sentences involving plural definites. In addition, non-maximality is also a by-product of contextual modulation, albeit in a different way than in the implicature approach.

1.3. Divergent predictions

The two approaches capture homogeneity and non-maximality, but, as discussed by Bar-Lev (2021) and Križ and Spector (2021), they make an important divergent prediction. On the one hand, the implicature approach predicts an inherent asymmetry between positive and negative sentences. Since non-maximality is linked to the mechanism for contextual modulation of implicatures, only positive sentences are predicted to allow for non-maximality.[4] On the other hand, the non-implicature approach is symmetric and does not predict any difference between positive and negative sentences regarding the availability of non-maximality. More concretely, the non-implicature approach predicts that in a mixed scenario when Frank opened some but not all of his presents, a sentence like (1) would be judged true in an EXISTENTIAL context and false in a UNIVERSAL one. Importantly, this approach predicts the same, albeit in the opposite direction, for its negative counterpart: (3) should be judged true in the UNIVERSAL context and false in the EXISTENTIAL one. On the other hand, the implicature approach makes the same predictions as the non-implicature approach for the positive case in (1) but predicts that (3) should be judged false regardless of what is relevant in the context. The predictions are summarised in Table 1.

Before moving on to our study, let us briefly summarise a previous study by Križ and Chemla (2015) and why we think its results are suggestive but not conclusive with respects to the predictions above.

2. A previous study: Križ & Chemla 2015

In a series of experiments, Križ and Chemla (2015) tested plural definites in a variety of different environments. In addition to the simple cases in (1) and (3), they tested quantified sentences like (14) and (15). The advantage of moving to quantified sentences like (14) and (15) is that, in the intended bound reading, they better control for the scope of the plural definite.

(14) Every boy opened his presents.

(15) No boy opened his presents.

Sentences like (14) and (15) were presented against visual contexts, representing mixed sce-

[4] More precisely, the prediction is that non-maximality through that mechanism can only arise in the positive case. We will come back to this point below.

	every		*no*		*not every*	
	EXI	UNI	EXI	UNI	EXI	UNI
IMPLICATURE	HIGH	LOW	LOW	LOW	LOW	LOW
NON-IMPLICATURE	HIGH	LOW	LOW	HIGH	LOW	HIGH

Table 2: Predictions of the two approaches for the three cases (*every*, *no*, and *not every*) in the two different contexts. Different predictions highlighted in gray.

narios (e.g. where some of the boys opened some but not all of their presents). In their results, they found evidence for non-maximal readings with (14) (across studies, only around 25% of completely false ratings in non-maximal contexts) but found fewer non-maximal readings with (15), more in line with the predictions of the implicature approach. However, as their study did not control for the role of context directly, it is possible that participants accommodated different contexts in the positive versus negative cases. This is in fact not unlikely, given previous findings suggesting that negative sentences generally require more contextual licensing (see Tian and Breheny 2018 and references therein). More concretely, participants could have accommodated an EXISTENTIAL context throughout – whether, for every boy, any of the presents was open – and this would have predicted true responses in the positive case of (14) and false in the negative case of (15) (see Table 1), thereby giving rise to the difference in responses they found, in a way that would be compatible with the non-implicature approach.

In sum, the results by Križ and Chemla (2015) might seem at first to be more in line with the prediction of the implicature approach, but as they did not include an explicit contextual manipulation, their results do not conclusively distinguish between the two approaches.

3. The experiments

We report on two web-based experiments using picture-sentence verification. By comparing positive and negative cases, our experiments build on Križ and Chemla 2015, but crucially test contextual effects. In addition to our context manipulation, we also included a further negative quantifier, *not every boy/girl*, which had not been tested before. Experiment 1 compared *every* vs. *no* sentences, while Experiment 2 compared *every* vs. *not every* sentences.

In both experiments, we manipulated whether the context would make salient the question whether all presents were open, given an expectation in the context that all of them should be open (UNIVERSAL context) versus the question whether any presents were open, given the expectation in the context that no presents should be open (EXISTENTIAL context). Participants were instructed to judge on a five-point likert scale ranging from 'completely true' to 'completely false,' how well the target sentences described the scenarios shown in the picture.

The predictions of the two approaches with respect to our manipulation are summarised in Table 2: both approaches predicts that the positive case of *every* will be judged higher in the existential than in the universal context. The non-implicature approach predicts the same effect but in the opposite direction for the negative cases (*no* and *not every*), with higher ratings in the universal than in the existential contexts. Under the implicature approach the negative cases should receive low ratings in both contexts, as non-maximal readings are not possible in such contexts.

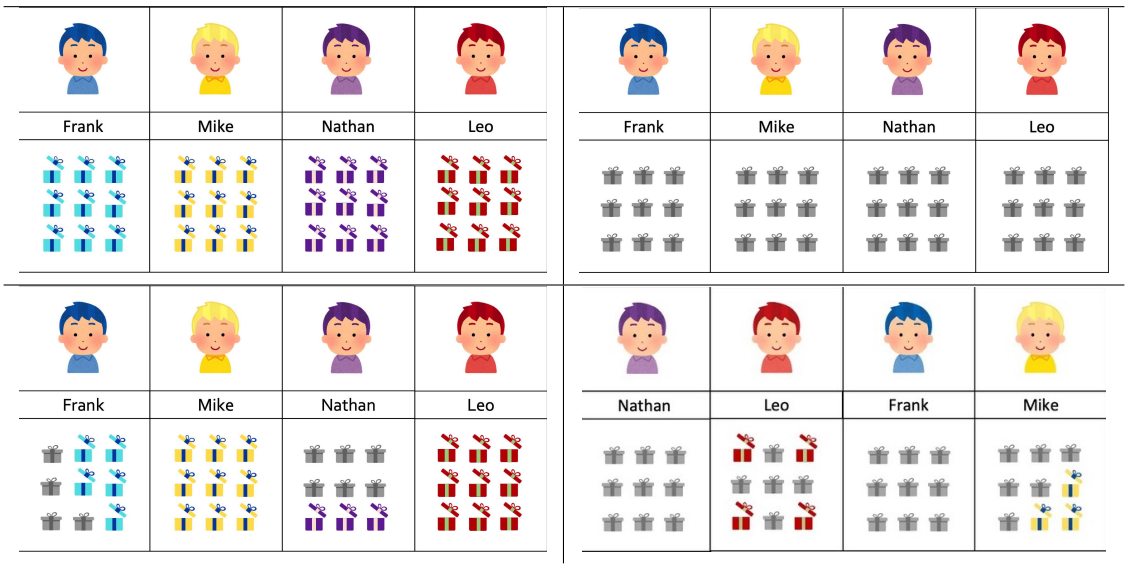

Figure 1: Pictures used in Experiment 1. The pictures on the top row are examples of the control conditions: The top left one was used as true control for *every boy opened his presents* and false control for *no boy opened is presents*, while it was the opposite for the top right picture. The two bottom pictures are examples of the target conditions: the bottom left picture was the target condition for *every* and the bottom right for *no*.

3.1. Experiment 1

3.1.1. Methods

In our first experiment, we compared positive and negative target sentences involving the quantifiers *every* and *no* with a plural definite in their scope. Sentences were accompanied by three types of pictures, and each of these pictures showed four boys/girls with nine presents each. The first two picture types served as control conditions and contained pictures in which all presents were either still closed (as indicated by grey colour), or had already been opened. These conditions allowed us to determine how many errors participants made. The third picture type consisted of mixed pictures, relative to which the truth-value of the sentence would change depending on whether it receives a non-maximal reading. As positive and negative sentences required different mixed scenarios, we included two variants of the mixed pictures. In the first variant, two of the four boys have already opened each of their nine presents, and the other two boys some but not all of their presents. In the second variant, two of the four boys haven't opened any of their presents, and the other two boys some but not all of their presents. Figure 1 shows example pictures used for each condition.

To test for contextual effects, we manipulated whether the context was EXISTENTIAL or UNIVERSAL, and we introduced a secondary task to ensure that participants would pay attention to the contextual manipulation. Both types of contexts were about particular rules in the boys' or girls' family, and it was introduced in detail in the practice session. In the UNIVERSAL context, the boys/girls were instructed by their parents to open their presents before their neighbours arrive, so that the apartment would be in an orderly state by then, with no present left to be opened. In the EXISTENTIAL context, in contrast, the boys/girls were instructed to wait until their grandparents arrived, so that they all could open their presents together. The secondary

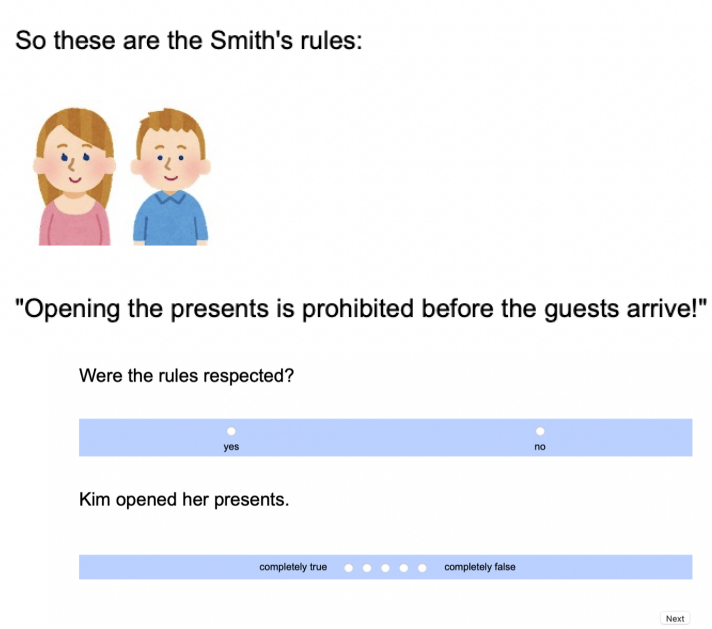

Figure 2: Example item from Experiment 1 of an EXISTENTIAL context.

task was to judge on each trial whether these rules ('Opening the presents is prohibited' or 'Opening the presents is required') were respected or not by clicking *yes* or *no*. Figure 2 shows an experimental display for one trial of the experiment. On the top of each display, participants were reminded of the family rule by showing 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). Below these two pictures, participants first had to judge via mouse click whether or not the family rules were respected, and then on a five-point Likert scale how well the target sentences described the scenarios shown in the picture. The experimental factors we manipulated were CONTEXT (existential, universal), TRUTH VALUE (mixed, true, false) and POLARITY (positive (*every*), negative (*no*)). CONTEXT was realized as a between-subjects factor, and the ordering of yes/no and true/false answers as well as the gender of the families' children (male, female) was counterbalanced. Each of the three pictures was presented with each sentence. The experimental sentences were spread over 8 lists. Each list contained 24 experimental items (half of them with the positive quantifier *every*), the other half with the negative quantifier *no*), with 6 items for each control condition and 2 items for the experimental mixed condition. The experimental items appeared in a randomized order for each participant. 192 native speakers of English were recruited from Prolific Academic and were paid 1.50 GBP for their participation. Seven were excluded for low accuracy on control items (error rate of at least 25%, with errors defined as responses above 3 to a false item or below 3 to a true item).

3.1.2. Results and discussion

Figure 3 shows 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 of mixed scenarios, while Strict contexts should lead to maximal interpretations. The mean accuracy of the unambiguously true and false cases

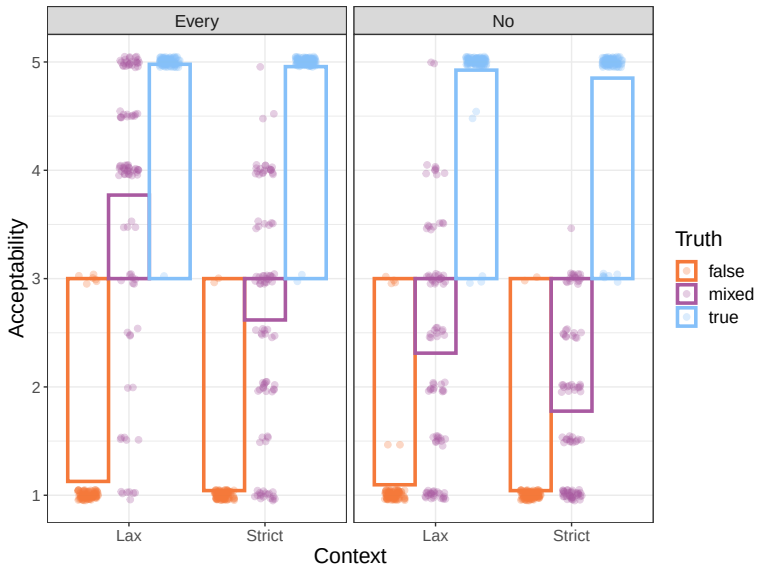

Figure 3: Acceptability ratings in Experiment 1. Context was recoded as Lax (favors non-maximality) or Strict (favors maximality).

was 98.3%. 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 controls in the model, floor and ceiling effects led to convergence issues in the ordinal logistic regression. Since performance on all controls is near-perfect, no information is lost from their non-inclusion. The model revealed significant main effects of CONTEXT ($\chi^2(1) = 49$; $p < .001$) and 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*; $\chi^2(1) = 11$; $p < .001$).

High performance in the control conditions shows that participants did not have any difficulties with the experimental task. In the mixed scenarios, positive quantifiers were rated high overall in Lax contexts, and low overall in Strict contexts. By contrast, sentences with negative quantifiers were rated low in both Lax and Strict contexts, albeit with a higher rating in Lax than Strict contexts.

The interaction between context and polarity poses a challenge for symmetric accounts, while straightforwardly consistent with the asymmetric implicature approach.

On the other hand, the presence of non-maximal readings for the negative condition is challenging for the implicature approach, at least in the version we presented above, where non-maximal readings in negative contexts should never arise. To meet this challege, the implicature approach could incorporate another route to non-maximality in negative contexts, and Bar-Lev 2021 in fact proposes such an additional mechanism.

In Experiment 2, we add another positive vs. negative comparison to broaden the testing of the predictions above.

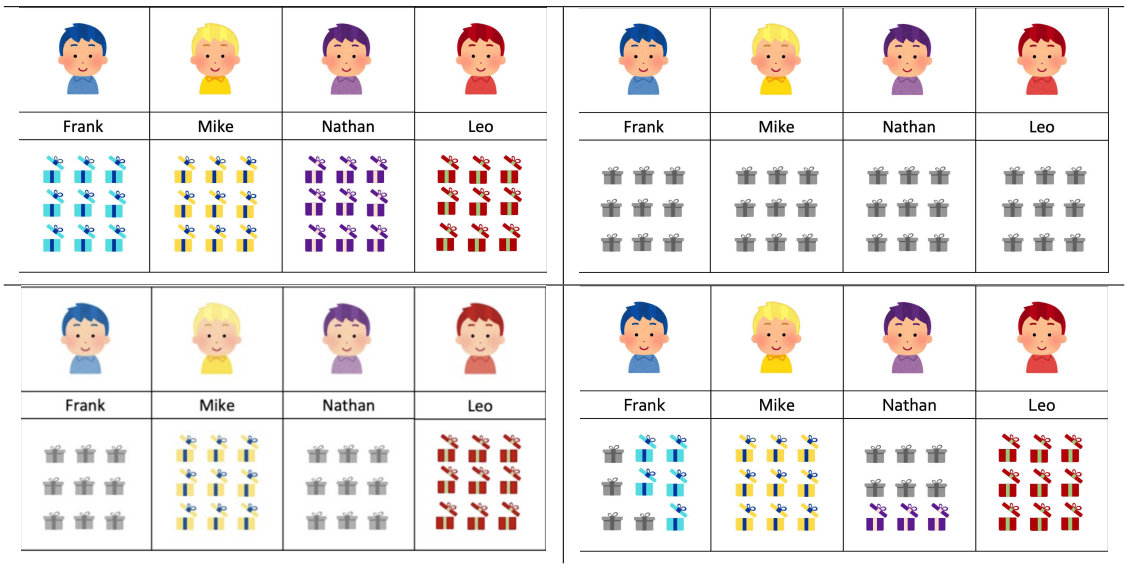

Figure 4: Pictures used in the different conditions of Experiment 2. The the top left one was used as true control for *every boy opened his presents* and false control for *not every boy opened his presents*. The top right picture served as false control for *every*. However, for the true control for *not every* we used the bottom left picture. The bottom right picture was associated with the mixed target condition for both *every* and *not every*.

3.2. Experiment 2

3.2.1. Methods

Overall, the experimental methods were identical to Experiment 1. However, in this study, we contrasted sentences involving the quantifiers *every* and *not every* instead of *every* and *no*. As a consequence, we only needed one type of mixed pictures in the current study, in which two boys opened all of their presents, and the other two boys opened none of them. Analogously to the positive sentence, the combination of this picture with the negative quantifier *not every* yields a sentence which is true under a non-maximal reading, but false under a maximal reading. Also, the control conditions for *not every* looked slightly different. The list of pictures is in Table 4. Each of the four pictures was presented with each sentence. The experimental sentences were spread over 8 lists. Each list contained 32 experimental items (half of them with the positive quantifier every, the other half with the negative quantifier not every), with 4 items for each control condition and 4 items for the experimental mixed condition. One of the basic motivations for this study was to test whether we would observe a different pattern as in our previous study. If so, such a finding couldn't be accounted for by either of the existing accounts in a straightforward manner. 192 native speakers of English were recruited from Prolific Academic and were paid 1.50 GBP for their participation. Ten were excluded for low accuracy on control items (error rate of at least 25%).

3.2.2. 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 'true' and 'false' conditions revealed effects of TRUTH and POLARITY, but crucially no effect of, or

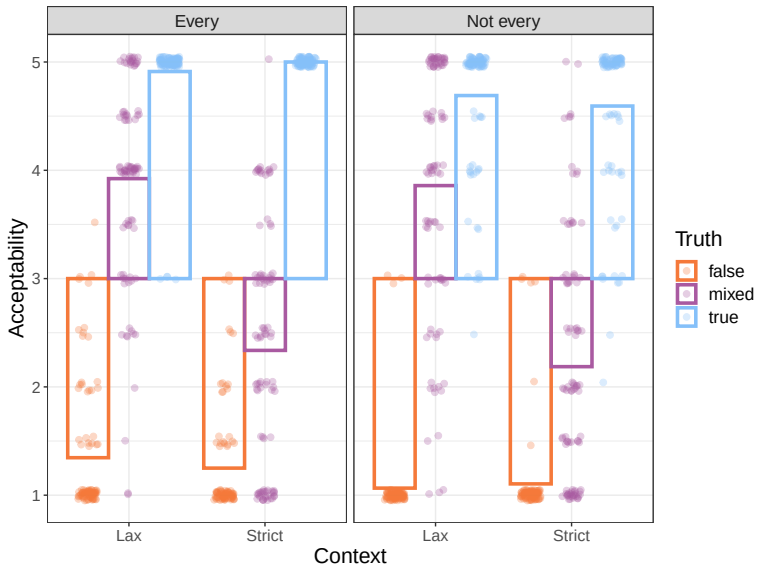

Figure 5: Acceptability ratings in Experiment 2.

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 mixed conditions and not an overall artifact of the task.

Mixed condition items were analysed as in Experiment 1. The model revealed a significant effect of CONTEXT (Lax context more accceptable overall; $\chi^2(1) = 89, p < .001$), no 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 ($\chi^2(1) = 2.1, p = .15$).

Again, high performance in the control conditions shows that participants did not have any difficulties with the experimental task. This time, in the mixed 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, while non-maximal readings were overall dispreferred for *no*, and showed limited sensitivity to context, 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 positive and negative cases is very much in line with the non-implicature approach this time, and challenging for the implicature approach.

4. General discussion

4.1. The challenges

In Experiment 1, we find evidence for an asymmetry between positive and negative cases. As discussed above, this is in line with the implicature approach. The results are, in contrast, more challenging for the non-implicature approach, which makes symmetric predictions. In Experiment 2, on the other hand, we find symmetric responses for both *every* and *not every*, more in line with the non-implicature approach. Overall the results of Experiment 1 are more or less straightforwardly explained under a version of the implicature approach, while the non-

implicature approach would require additional machinery to explain them. By contrast, the results of Experiment 2 are as expected by the non-implicature approach and challenging for the implicature approach. In the following, we sketch possible directions and amendments of each approach in order to account for our results.

4.2. Prospects for the implicature approach

The challenge to the implicature approach is 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*. This is particularly problematic for this approach, given the independently justified assumption that implicatures do not arise in downward entailing contexts and the fact that both *no* and *not every* are downward entailing contexts.

How do we distinguish between the two? One possible way is to consider *not every* as 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. In particular, (16) suggests that some boys did open their presents. Once this implicature is added to the literal meaning the resulting overall environment is not downward entailing anymore, but rather it is non-monotonic.[5]

(16) EXH[Not every boy opened his presents].
⇝ *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 implicature would make the sentence equivalent to (17), thus true in a non-maximal situation. Finally, this mechanism would correctly not extend to *no*, thus predicting the difference between *not every* and *no*.[6]

(17) EXH[Not every boy$_x$ EXH[x opened his presents]].
⇝ *Not every boy opened all of his presents*
⇝ *some boys opened all of their presents*

This response for the implicature approach would capture our results, but makes an immediate prediction, which should be tested. Implicatures should 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 of the presents on their left and on their right, (while the others opened only one of the two), than (19) in a context in which all of the boys opened both of their presents. We leave testing this prediction for future research.

(18) Not every boy opened the present on their left or on their right.
? ⇝ *Not every boy opened one or the other but not both*
? ⇝ *Some boys opened one or the other but not both*

[5]For a similar assumption with respect to NPI licensing see Chierchia 2004, 2013.

[6]As mentioned above, Bar-Lev (2021) suggests a different additional mechanism for obtaining non-maximal reading, based on covers, and which would only apply to negative cases. This mechanism would be more restricted and less available that the one based on modulating implicatures, hence the asymmetry between *every* and *no*. This mechanism, however, is predicted to apply in the same limited way to *not every* and thus it does not capture the difference between the latter and *no*.

(19) No boy opened the present on his left or on his right.
? ⇝ *No boy opened one or the other but not both*

4.3. Prospects for the non-implicature approach

The challenge to the non-implicature approach is that the case of *no* gave rise to non-maximal readings much less than their positive counterpart. A possible response is to consider that the effect size of context manipulation in the positive and negative conditions could depend on how much effect our context manipulation can have on the prior associations of context and sentences, and that the positive and negative sentences could have different prior biases here. In other words, it could be that 'no' strongly biases EXISTENTIAL contexts, perhaps because of felicity conditions associated with negative sentences and understood questions under discussion. Due to this bias the contextual manipulation we used in our experiments had diminished effects for *no* than for *every*, thus giving rise to the asymmetry we observed in Experiment 1. Independent evidence for this hypothesis is yet to be raised, but a possible way of testing it is by testing sentences like non-monotonic quantifiers like (20), where we can compare non-maximality in the positive (i.e., *two of the boys opened their presents*) and negative parts (i.e., *none of the other boys opened their presents*) of the meaning, while keeping the prior bias associated with the sentence constant.

(20) Exactly two boys opened their presents.

In particular, we can test mixed scenarios for the positive part (when two of the boys opened some but not all of their presents and the others opened none), and mixed scenarios for the negative part (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.

5. Conclusion

We reported on two experiments using a picture-sentence verification task, testing the predictions of the implicature versus non-implicature approaches to plural definites. Target sentences involved embedded plural definites such as *Every/Not every/No boy opened his presents*. In our results we find evidence for an asymmetry between *every* and *no* sentences. This is more in line with the implicature approach, and more challenging for the non-implicature approach. On the other hand, we found the same effect of contextual manipulation in *every* and *not every*, as not predicted by the implicature approach, which would expect the latter to behave like *no* sentences, and more in line with the non-implicature approach. Taken together, our results are challenging for both approaches to plural definites. We discussed possible directions each approach can explore in order to account for our results.

Finally, a similar approach has been used or can be used to investigate similar debates between implicature and non-implicature accounts with other phenomena, such as free choice (Tieu et al. 2019), donkey pronouns (Sun et al. 2019) and counterfactuals (Marty et al. 2020).

All in all, comparing positive and negative sentences with the explicit contextual manipulation gives us a very effective way of intervening in these debates across similar phenomena.

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