Children's Acquisition of Non-maximality in Plural Definite Sentences with Context

Flavia Naehrlich, Harmen de Weerd, Rineke Verbrugge, Angeliek van Hout

Background: Plural definite sentences allow for non-maximal readings: *'The townspeople are asleep.'* is true even if 'a few insomniacs are puttering around their houses'(Lasersohn, 1999). The question whether corresponding negative sentences such as *'The townspeople aren't asleep.'* behave analogously is not settled. Tieu et al. (2019) tested French preschoolers and found an asymmetry between positive and negative plural definite sentences. While adults rejected positive plural definite sentences in non-maximal scenarios, they accepted negative sentences at a rate over 25%. Children showed inverted response patterns: They consistently rejected negative sentences but accepted positive sentences at a rate over 30%. These results seem surprising but might be explained by a lack of contextual cues in the experimental setup rather than, as Bar-Lev (2021) argues, by a difficulty to access non-maximal readings in negative contexts. Theoretical accounts disagree whether non-maximal readings are derived in the same way for both positive and negative sentences (Križ, 2016; Križ and Spector, 2021) or are harder to access in negative sentences (Bar-Lev, 2021). However, they agree that the availability of non-maximal interpretations of plural definite sentences is context-dependent. In particular, non-maximal readings are available if they provide a sufficient answer to a Question Under Discussion (QUD). Augurzky et al.'s (2022) experimental findings on non-maximal readings in existential vs. universal contexts are oftentimes interpreted to indicate that there is, in fact, an asymmetry between positive and negative sentences. However, Augurzky et al. (2022) do not consider the processing difficulties that arise when participants have to assess the truth of negative sentences. Many studies (e.g., Wason, 1961; Kaup et al., 2006; Wang et al., 2021; Rück et al., 2021) could show that there is an interaction between truth-value and polarity: Correctly assessing the truth of positive sentences is easier than rejecting false positive sentences. In contrast, it is harder to correctly accept true negative sentences than rejecting false ones. This psychological effect might explain why previous experimental results on non-maximal interpretations of plural definite sentences (inconsistently) show an asymmetry between positive and negative sentences. That is, asymmetry-results might merely indicate processing difficulties arising from negation rather than limited availability of non-maximality readings in downward entailing environments. The psychological effect might be mitigated in the presence of context without vanishing altogether.

Our study: We wanted to see to what extent children access non-maximal readings of PDs if context is provided. Skordos et al. (2022) found that children's interpretation of quantifiers is more adult-like if target sentences are contextually embedded, which seems to allow them to accommodate the appropriate QUD. These findings indicate that children are able to interpret sentences under an accommodated QUD. In the setting of an animal delivery company, we used Dutch sentences with two contrasting Dutch verbs: translations of *'deliver'* and *'lose'*. Table 1 displays the four target conditions. The setup allowed us to compare positive and negative sentences with a parallel interpretation, depending on the accommodated QUD. We distinguish between (1) and (2).

(1)   **existential QUD:** Was *something* brought to the house?

(2)   **universal QUD:** Was *everything* brought to the house?

The existential QUD allows for non-maximal interpretations of *'didn't deliver'* *'lose'*, and disallows non-maximal interpretations of *'didn't lose'* and *'deliver'*. The universal QUD gives rise to the

opposite pattern (see Table 1). Because we provided context, we expected

(I) that we would detect more non-maximal readings than Tieu et al. (2019), and

(II) that we would find corresponding patterns of acceptance for positive and negative sentences that are interpreted under the same QUD.

Methods: 18 Dutch preschoolers (*mean age*=5;5 | range=4;5−6;9) and 20 adults participated in a Truth-Value Judgment Task (set-up inspired by Gualmini et al., 2008). In each trial, they saw four pictures portraying an animal attempting to deliver four food items (e.g., donuts) to a customer's house (see Figure 1). In critical conditions two items were lost and two delivered. After hearing a target sentence in Dutch with a PD such as *'the donuts'* (see Table 1) from a puppet, they had to judge whether the puppet assessed the story in the pictures correctly or incorrectly. The experiment consisted of two blocks with 6 items per condition, that is 24 target trials. In addition, we had 16 homogeneous control trials that would have allowed us to exclude participants, in case they would have answered two or more controls incorrectly.

Results: We analyze child and adult responses separately, before comparing them.

CHILDREN: Table 1 shows that the positive sentences yield mean acceptance rates over 50%. This is in line with prediction **I**. Model comparison with stepwise variable deletion resulted in the following best logistic linear mixed model: `response ∼ polarity+qud+(1+qud|ID)` and revealed a main effect of polarity ($p < .001$). As we can see in Figure 2a, positive sentences are preferred over negative ones. There was no main effect of QUD ($p \approx 0.607$). This simply indicates that there was no preference for either accommodating the existential or universal QUD. However, our best model, as reported above, features a random effect of QUD. This suggests that there is QUD-dependent individual variation. In order to see whether the individual response patterns align with prediction **II**, we performed a k-means cluster analysis to identify subgroups amongst the children. We found 4 distinct populations, the cluster means (centers) are reported in Table 2 (left). In order to perform the k-means analysis, we aggregated the responses per participant per condition (0-6 *'yes'*-responses). Based on the resulting centers, we interpreted the clusters as follows: Cluster A features individuals that accommodated an existential QUD, while Cluster B features individuals that accommodated a universal QUD. Cluster C seems to feature individuals that disregarded QUD and simply accepted all positive sentences while rejecting the negative sentences. Children in Cluster E seem to (dis-)like all sentences to the same extend. For these children, neither sentence polarity, nor qud-accommodating predicted to what extend non-maximal readings are available.

ADULTS: Table 1 shows relatively low mean acceptance rates across conditions, comparable with the means of previous studies. This contradicts prediction **I**. Model comparison with stepwise variable deletion resulted in the following best logistic linear mixed model: `response ∼ polarity+(1+polarity+qud|ID)`. We did not find a main effect of polarity ($p \approx 0.122$). In addition, as indicated by the model equation, we did not find an effect of QUD. However, our best model, as reported above, features a random effect of QUD as well as polarity. This suggests that there is individual variation regarding both QUD and polarity. In order to see whether the individual response patterns align with prediction **II**, we performed a k-means cluster analysis to identify subgroups amongst the adults. We found 5 distinct populations, the cluster means (centers) are reported in Table 2 (right). Based on the resulting centers, we interpreted the clusters as follows: Cluster A features individuals that accommodated an existential QUD, while Cluster B features

individuals that accommodated a universal QUD. Cluster C seems to feature individuals that disregarded QUD and simply accepted all positive sentences while rejecting the negative sentences. The individuals in Cluster D reject positive sentences and accept negative ones. Adults in Cluster E seem to reject plural definite sentences in non-homogeneous scenarios across conditions.

COMPARISON: Mixed model analysis of the combined data sets revealed a main-effect of participant-type ($p \approx 0.0136$) and polarity ($p < 0.001$). Figure 2 shows that children accept more sentences than adults and positive sentences are overall preferred over negative ones. Looking at the clusters from the k-means analysis suggests that there is a correspondence between child and adult groupings. Individual responses per group are depicted in Figure 3. There is no cluster of children that prefers negative sentences over positive ones whilst there is such a cluster for adults.

Discussion: Higher acceptance of positive sentences corroborates the findings of previous studies (e.g., Tieu et al., 2019). Individual patterns suggest that context does indeed help children to accommodate a QUD and access corresponding non-maximal readings. While pattern deliver+lose- is in line with a QUD such as *'Did the animals do something right?'*, pattern deliver-lose+ fits with QUD *'Did they do everything right?'* Future work that explicitly incorporates the QUD in the setup will allow us to investigate this further. Just like Augurzky et al. (2022), we find an asymmetry between positive and negative sentences but we can show that these findings are a result of individual patterns. Our findings indicate that previous studies that detected asymmetric interpretations (Tieu et al., 2019) might be caused by 1) children's struggles with interpreting negation or 2) a lack of context. Different contexts might be accommodated for positive or negative sentences if the experimental setup lacks contextual cues.

We found varying response patterns of children vs. adults. Children's limited processing abilities do not allow them to suppress the psychological effect that makes it hard to accept positive sentence while adults seem to be able to do. Nevertheless, some adults opt to answer based on sentence polarity. This appears to be a voluntarily chosen strategy, rather than a matter of availability of non-maximal interpretations.

(a) 4/4 items in cart   (b) 2/4 items are lost   (c) arrival with 2/4 items   (d) 2/4 items delivered
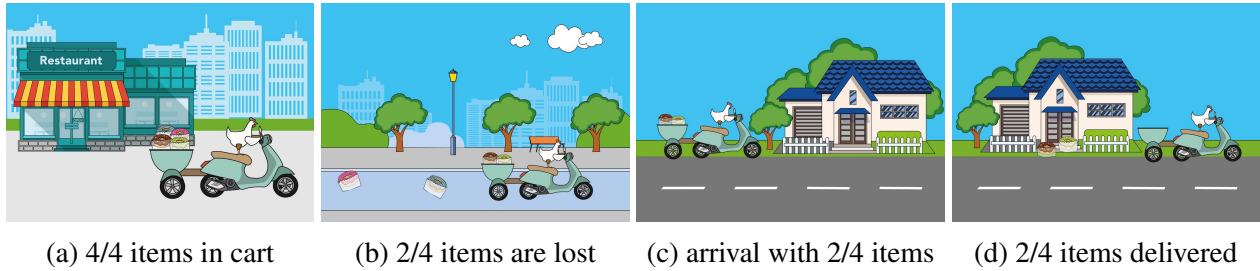
Figure 1: Example trial displaying the scenario in shown in target conditions. The chicken loses two of the overall four donuts on the way and delivers the remaining two successfully.

		verifying issue / QUD	
		existential	universal
Polarity	pos	ACCEPTANCE: 60.2% (adults: 32.5%) 'De kip heeft de donuts **bezorgd**.' *(The chicken **delivered** the donuts).*	MEAN ACCEPTANCE: 52.8% (ad: 36.7%) 'De kip heeft de donuts **verloren**.' *(The chicken **lost** the donuts.)*
	neg	ACCEPTANCE: 34.3% (adults: 15.0%) 'De kip heeft de donuts **niet verloren**.' *(The chicken **didn't lose** the donuts.)*	ACCEPTANCE: 22.2% (adults: 16.7%) 'De kip heeft de donuts **niet bezorgd**.' *(The chicken **didn't deliver** the donuts).*

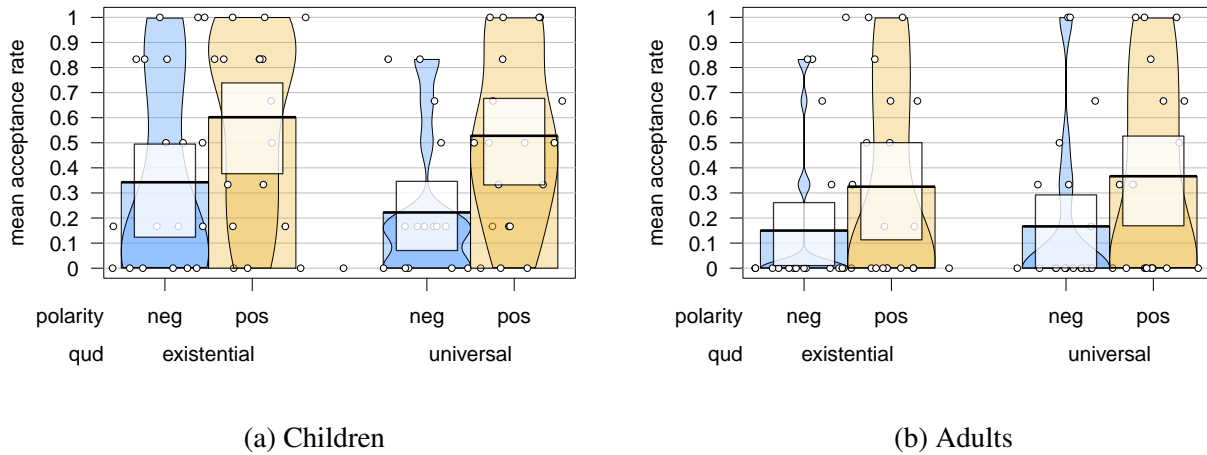Table 1: Mean acceptance rates and example sentences for the four target sentences.

(a) Children

(b) Adults

Figure 2: Mean acceptance rates per condition

	existential QUD		universal QUD				existential QUD		universal QUD	
	pos.lose	neg.deliver	pos.deliver	neg.lose			pos.lose	neg.deliver	pos.deliver	neg.lose
A	6.00	4.25	1.00	0.00		A	4.00	4.00	0.00	0.00
B	1.40	0.40	5.20	5.40		B	1.00	0.00	3.50	3.50
C	3.20	0.40	5.40	1.00		C	5.00	0.17	5.00	0.00
D	-	-	-	-		D	0.67	3.67	0.67	3.67
E	2.50	0.75	2.00	1.25		E	0.29	0.00	0.00	0.00

Table 2: K-means analysis, cluster means: children (left) and adults (right)
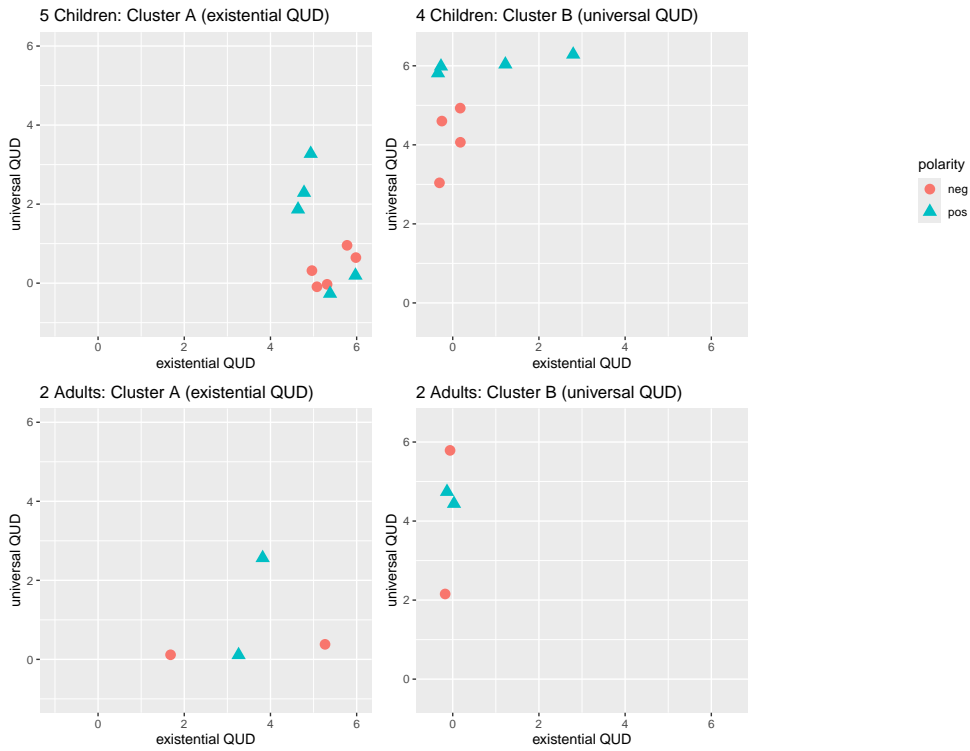
(a) Clusters of individuals that are sensitive to QUD.
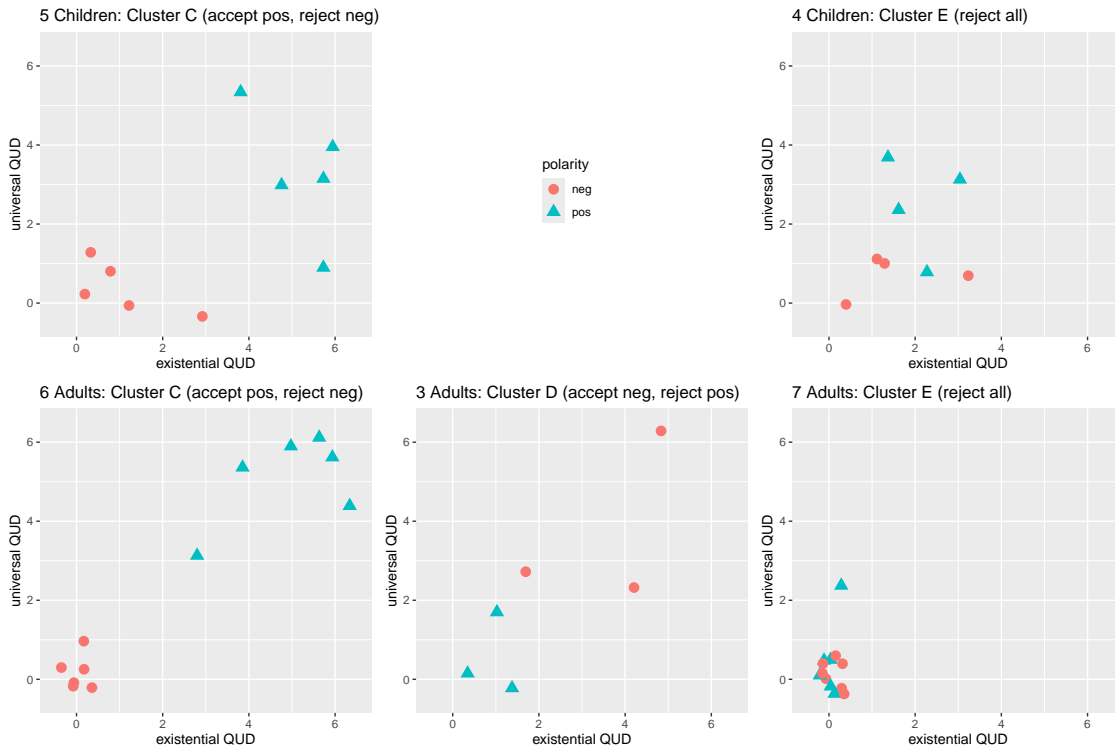
(b) Clusters of individuals that are sensitive to polarity.

Figure 3: Individual patterns.

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