DUTCH CHILDREN’S INTERPRETATION OF QUANTIFICATIONAL DETERMINERS: MUST THE UNIVERSAL PROPERTY OF CONSERVATIVITY BE LEARNED?

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Abstract: Conservativity has been proposed as a universal property of natural language determiners, so it is possible that children apply it to quantifier interpretations from a young age. Using a picture verification task and sentences using the conservative determiner all (all) and the non-conservative quantificational adverb alleen (only), we tested whether or not children interpreted quantifiers conservatively. We found evidence that children interpreted both all and alleen non-conservatively, leading to overwhelmingly incorrect responses for sentences with all, and overwhelmingly correct responses for alleen. We argue that conservativity is a principle of determiners that must be learned.

1. Introduction

In Generalized Quantifier Theory (e.g., Mostowski 1957; Barwise and Cooper 1981; Zwarts 1983), quantificational determiners are treated as operators that describe a relationship between two sets.

(1) All bears are fishing.
(2) Some bears are fishing.

In (1) and (2), the determiners All and Some describe relationships that hold between two sets. The first set (here: the set of bears) generally arises from the denotation of the N, and the second set (here: the set of fishing individuals) from the denotation of the VP. For convenience, we will refer to these two sets as Set A and Set B, respectively. Sentence (1)
is true iff all members of Set A (bears) also are members of Set B (fishers). Sentence (2) is true iff at least one member of Set A (bears) is also a member of Set B. Cross-linguistic research has found that natural language determiners seem to all share an interesting property: Verifying their truth values only requires examining the members of Set A. The members of Set B that are not in Set A are irrelevant for interpretation. Thus, for the interpretation of the sentences in (1) and (2), only bears and fishers that are bears are relevant. Fishers that are not bears can safely be ignored. This property of natural language determiners to ‘live on’ Set A is called **conservativity**.²

To see how conservativity restricts the interpretation of the determiner, consider Figure 1.

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² When we talk about conservativity in this paper, we mean Right-conservativity. This property, which holds for almost all natural language determiners, should be distinguished from Left-conservativity: the property to live on Set B. This latter property has been argued to hold for only (e.g., de Mey 1991).
**Figure 1.** For sentence (1), Set A is the group of three bears, and Set B is the group of fishers (in this picture the three bears as well as the mouse). The intersection of Set A and Set B only includes the three fishing bears.

To determine the truth value of sentence (1), we have to consider Set A of bears and the intersection of this Set A and the Set B of fishers. For sentence (1) to be true, the set of bears must be a subset of the set of fishers. As a consequence, sentence (1) can be paraphrased as *All bears are bears who are fishing.* Because of the property of conservativity, we do not have to consider members of Set B that are not in the intersection of the set of bears and the set of fishers. That is, individuals who are fishing but are not bears are irrelevant to the interpretation of sentence (1). Hence, in Figure 1 the fishing mouse has no bearing on whether (1) is true or false.
Typological investigations of determiners in numerous languages have yet to find a convincing example of a determiner that is not conservative (Barwise and Cooper 1981; Keenan and Stavi 1986). Thus, conservativity seems to be a universal property of natural language determiners. A major question then is how this property relates to the learnability of natural language determiners. Is the existence of a strong typological generalization evidence that the hypothesis space of possible determiner meanings is somehow restricted for children? Is conservativity part of the innate structure of language? By extension, will children begin by interpreting determiners conservatively and have trouble with interpretations that require non-conservativity?

In this paper we investigate the assumption that children initially interpret determiners conservatively and have trouble with non-conservative elements. For this reason, we compare Dutch children’s interpretation of the conservative quantificational determiner *al* ‘all’ with their interpretation of the non-conservative quantificational adverb *alleen* ‘only’.

2. **Previous work**

Existing work on children’s acquisition of quantificational determiners seems to suggest that they frequently consider members of Set B that are irrelevant to verification (e.g., Inhelder and Piaget 1958; Philip 1995; Hunter and Lidz 2013).
A well-known phenomenon in children’s interpretation of determiners is spreading. Spreading refers to the finding that children up to the age of 7:0 consider extra objects or individuals in their interpretation of a determiner that has scope over the subject of the sentence. For example, these children reject transitive sentence (3) as a description of a picture of three bears and an extra fishing rod. To justify their response, these children tend to refer to the extra fishing rod as not being included.

(3) All bears have a fishing rod.

This pattern of determiner interpretation in child language is often called spreading because of the idea that the determiner spreads over both the subject and the object in the sentence (Roeper and De Villiers 1993). Others (e.g., Philip 1995), call this the symmetric interpretation.

A possible explanation for the phenomenon of spreading is that young children treat the determiner *All* as non-conservative. They consider both Set A and Set B when trying to verify the truth of the sentence. Returning to example (1), this means that these children would also consider the fishing mouse when interpreting sentence (1).

Interestingly, not all expressions in natural languages relating two sets are conservative. The quantificational adverb *only* is such an example. To interpret the particle *only*, the members of Set B which are not in the intersection of Set A and Set B are
relevant: The existence of such members makes the sentence false. For example, for sentence (4) to be true, there should be no members in Set B (the set of fishers) which are not in Set A (the set of bears). That is, there should be no fishing mice or other fishing individuals other than bears.

(4) Only bears are fishing.

As a consequence, sentence (4) is false if presented as a description of the picture in Figure 1.

If children do not proceed from the assumption that determiners are conservative and instead assume that both sets should be considered, then we predict that they are able to correctly interpret sentences with only from a young age on. In fact, we predict that such children are better at only than at all, at least when focus does not play a role. The quantificational adverb only appears to introduce additional difficulties in comparison to true determiners: Only can appear in a number of different syntactic positions and associates with focus, giving rise to focus-dependent interpretations. For these reasons, the adverb only is not considered a true counterexample to the typological claim that all quantificational determiners are conservative. However, in sentence-initial position only functions very similarly to a determiner, and it has been argued to function semantically like a generalized quantifier (e.g., de Mey 1991). Its interpretation also requires considering the relation between two sets. Unlike true determiners, however, only is non-
conservative. It requires examining members of Set B that are not in the intersection of Set A and Set B to verify or reject the truth of its sentence.

Hunter and Lidz’s (2013) is the only experiment we are aware of that has directly tested the learnability of non-conservative determiners in children. In their experiment, 20 children (aged 4;5-5;6) were taught the meaning of a new determiner, *gleeb*. Half the children were taught a conservative interpretation of this determiner (equivalent to *Not every $X$ is $Y$*). The other half were taught a non-conservative interpretation (equivalent to *More than just $X$s are $Y$*). Children trained on the conservative determiner performed significantly better than chance on the five test trials than children trained on the non-conservative determiner, when the mean correct answers were considered. However, 80% of the children in the non-conservative group performed better than chance. This is still quite comparable to the 90% of the children in the conservative group performing better than chance.

These results suggest two things: Conservative determiners are easier to learn than non-conservative determiners, but non-conservative determiners are learnable, even after a very short training period. Are conservative determiners easier to learn because they are inherently simpler to verify, as they only require checking the members of Set $A$? Or are conservative determiners easier to learn because children’s experience with conservative determiners made it easier for them to assign a conservative meaning to the determiner? These questions remain unanswered in Hunter and Lidz’s study.
Our study seeks to extend our knowledge of children’s understanding of conservativity by comparing their interpretation of the conservative determiner *all* (Dutch *al*) to their interpretation of the quantificational adverb *only* (Dutch *alleen*). Conservativity may be a (near-)universal property of quantificational determiners because it is an innate restriction on quantifier interpretation. If so, conservativity should guide interpretation from an early age on. Hence, the interpretation of *all* is expected to be mastered early, whereas the interpretation of *only* is expected to be difficult. On the other hand, if conservativity must be learned, sentences with *all* are expected to be difficult for children, whereas sentences with *only* could be easier.

3. **Experiment**

3.1 **Participants**

Forty-five Dutch children between 4 and 6 (mean age 5;4; range: 4;4 – 6;3) participated in the experiment. Additionally, we tested twenty adult native speakers of Dutch (mean age 25.5, range: 18 – 62).

3.2 **Materials and design**

All participants were tested on a sentence-picture verification task in a 2x2 design, contrasting the factors Quantifier (*al* ‘all’ vs. *alleen* ‘only’) and Picture (Set A+ vs. Set A-).
Test sentences were either universally quantified sentences of the form *all the A B* (5a) or sentences with the quantificational adverb *only* of the form *only the A B* (5b).

(5) a. Al de beren vissen.
all the bears fish
“All the bears are fishing.”

b. Alleen de beren vissen.
only the bears fish
“Only the bears are fishing.”

Participants were asked to verify these two types of test sentences with two types of pictures, see Figure 2.

*Figure 2. Examples of the Set A+ picture (left) and the Set A- picture (right)*
The picture on the left in Figure 2 is an example of a Set A+ picture. Set A+ pictures show all Set A characters (for example, all bears in the example sentences in (5)) performing the action denoted by the intransitive verb, plus an additional character performing the same action. In Figure 2 (left), the action is fishing and the additional character is the mouse.

The picture on the right is an example of a Set A- picture. Set A- pictures show only some of the members of Set A performing the action denoted by the intransitive verb. Crucially, one member of Set A is not performing this action. In Figure 2 (right), the relevant action is dancing, but one of the rabbits is not dancing. Note that this picture also contains an additional character (the panda) to maximize the similarity between the two picture types.

All test sentences are intransitive sentences. We chose to use the forms *al de* ‘all the’ and *alleen de* ‘only the’, with the quantificational determiner or adverb being followed by a definite determiner, to restrict interpretation to the situation shown in the picture and to avoid any interference with world knowledge. Leaving the determiner out, as in (6), results in a generic statement. This could lead participants to reject the sentence on the basis of the fact that in the actual world other individuals in addition to bears can fish.

(6) Alleen beren vissen.

Only bears fish

“Only bears are fishing.”
We included 8 test trials of each sentence, extended with 8 filler items. The test session started with 3 practice items. After each trial, we ask the children to justify their responses.

Testing an adult group on the same task yielded confirmation for the target interpretations. For adults, the *all*-sentences are true descriptions of Set A+ pictures (e.g., Figure 2, left), whereas the *only*-sentences are false descriptions of these pictures. For Set A- pictures, the opposite holds: the *all*-sentences are false and the *only*-sentences are true for these pictures.

If children proceed from the assumption that all determiners are conservative, we expect them to give target responses for *all*-sentences with Set A+ pictures. Furthermore, if they apply the same assumption to *only*, we expect these children to also accept *only*-sentences with Set A+ pictures, resulting in non-target responses. On the other hand, if children still have to learn that determiners are conservative, we expect them to make errors with *all*-sentences. In particular, we expect them to reject *all*-sentences with Set A+ pictures, because of the presence of the additional character. At the same time, we expect them to correctly reject *only*-sentences with these pictures.

Whereas Set A+ pictures show one additional animal performing the relevant action, the Set A- pictures show one animal too few performing the relevant action. As such, they test the exhaustivity requirement of *all*. If children master the exhaustivity requirement of *all*, they are predicted to reject *all*-sentences with Set A- pictures. If one rabbit does not

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*The adults only made 18 errors in total with test items, and the distribution of the errors over the four conditions was not significant (Fisher’s Exact Test, p-value = 0.25).*
dance, then children should reject the statement that all rabbits dance. Finally, if children do not make a distinction between the determiner *all* and the adverb *only*, we expect them to also reject the *only*-sentences for Set A- pictures.

### 3.3 Procedure

Using a laptop, participants were presented with one picture at a time while a pre-recorded sentence was played. Participants were instructed to verify whether the sentence matched the picture, and were then asked to explain their answer.

### 4. Results

In this section children’s results are presented for both accuracy and justifications.

#### 4.1 Accuracy

Participants were asked to verify two types of sentences with two types of pictures. The children overwhelmingly rejected all sentences. With Set A+ pictures (e.g., the picture with the extra mouse in Figure 2, left), children incorrectly rejected the *all*-sentences. However, they also correctly rejected the *only*-sentences. These results are exactly what we would expect if children are not treating *all* and *only* as conservative. For the Set A- pictures (e.g., the picture with the non-dancing rabbit in Figure 2, right), the children correctly rejected the *all*-sentences, but also incorrectly rejected the *only*-sentences. Figure 3 gives the results.
We analyzed the results using mixed effect linear models, using *Quantifier* and *Picture* as predictors, and target interpretation as the response variable. We found a significant effect for both *Quantifier* and *Picture*, and a significant interaction (see Table 1). Whereas adults accepted *all* with Set A+ pictures and rejected *only* with these pictures, children rejected both *all* and *only* with these pictures. Also, whereas adults rejected *all* with Set A- pictures and accepted *only* with these pictures, children rejected *all* and *only* with these pictures. This indicates that children respond quite differently than adults.
Table 1. Fixed effects of the maximally best fitting logistic mixed-effects model

Formula

response ~ quantifier * picture + (1 + condition | participant)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Estimate</th>
<th>SE</th>
<th>z-value</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Intercept</td>
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</tr>
<tr>
<td>Quantifier(^i)</td>
<td>-3.0338</td>
<td>0.2820</td>
<td>-10.756</td>
<td>&lt;2e-16</td>
</tr>
<tr>
<td>Picture(^ii)</td>
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<td>0.2723</td>
<td>-10.677</td>
<td>&lt;2e-16</td>
</tr>
<tr>
<td>Quantifier:picture</td>
<td>5.9513</td>
<td>0.3953</td>
<td>15.057</td>
<td>&lt;2e-16</td>
</tr>
</tbody>
</table>

\(^i\)Contrasts used for Quantifier: Only(0), All (1)

\(^ii\)Contrasts used for Picture: Set A+ (0), Set A– (1)

4.2 Justification

The accuracy responses indicated that the children tended to reject all sentence types for all pictures presented to them. So do they fail to distinguish between situations with an extra entity that is irrelevant due to conservativity (Set A+ situations) and under-exhaustive situations (Set A- situations)? And do they fail to distinguish between the quantificational determiner *all* and the quantificational adverb *only*? To answer these questions, we analyzed the children’s justifications.
We first present the justifications for the Set A+ pictures. As expected, given previous research on spreading, children incorrectly rejected *all*-sentences with Set A+ pictures. In their justifications (see Figure 4), they refer to the part of Set B which is not in the intersection of Sets A and B. This is exactly what we would expect if children interpret the determiner *all* non-conservatively. For the *only*-sentences, children also refer to Set B. In this case however, this corresponds to the appropriate explanation.

![Figure 4. Justification scores in percentage of reference to a particular set](image)

Turning to the Set A- picture, we see mixed results. Children refer to the member of Set A which is not in the intersection of Sets A and B (e.g., the non-dancing rabbit in Figure 2, right), but also to the member of set B which is not in the intersection (the panda).
Children sometimes even refer to both of these individuals in their justification. However, because Set A- pictures have no Set B members that are not also a member of Set A (e.g., in Figure 2 there is no dancer that is not a rabbit), these results do not directly bear on children’s tendency to interpret quantificational determiners as conservative or non-conservative. The references to the non-dancing rabbit from Set A with all-sentences merely indicate that the children have detected the violation of the exhaustivity requirement for all. In contrast, references to the non-dancing rabbit with only-sentences indicate problems in understanding alleen ‘only’, but these problems do not seem to be related to conservativity.

Summarizing the data, we find that children give non-adult-like responses with all-sentences and Set A+ pictures and with only-sentences and Set A- pictures. Although they appear to give the same responses for all sentence-picture pairs, their justifications show that they distinguish between situations with an extra entity that is irrelevant due to conservativity and under-exhaustive situations. On the other hand, they do not seem to distinguish between all and only.

5. Discussion and Conclusion

This paper set out to investigate whether Dutch children’s interpretations of the quantificational determiner al ‘all’ and the quantificational adverb alleen ‘only’ obey the property of conservativity.
Children’s responses with Set A+ pictures (depicting an extra entity) in combination with their justifications of the responses suggest that children interpret the determiner *all* non-conservatively. With the adverb *only*, which requires a non-conservative interpretation, their responses are target-like.

The responses with Set A- pictures are more complex. They show that children can correctly interpret the determiner *all*, including the exhaustivity requirement, but this is not evidence for or against the hypothesis that they treat *all* as conservative. This is because Set A- pictures in our study did not depict members of Set B that are not in the intersection of Set A and Set B. To test if children interpret determiners non-conservatively, there must be a potential non-conservative interpretation. Hence, in contrast to the Set A+ pictures the Set A- pictures do not bear on the issue of conservativity.

On the basis of children’s responses with *all*, we like to conclude that children interpret this determiner non-conservatively. A possible objection to this conclusion is that the determiner in the experiment contained the definite article *de* ‘the’ and therefore the acquisition of the meaning of this article may have interfered. However, in an unpublished follow-up study in which we used the determiner *alle* ‘all’ instead of *al de* ‘all the’ we obtained similar results. Hence, we believe we can conclude that children’s incorrect interpretation of *al de* ‘all the’ is due to their failure to interpret the quantificational determiner conservatively.
Given that our results for the all-sentences in combination with the Set A-pictures are consistent with previous results, we believe the results for the only-sentences point to a problem with the interpretation of only. We suspect that the problem may lie in our decision to use a definite determiner in between the adverb and the noun. Recall that all test sentences were of the form all the A B or only the A B. Consider the following item consisting of an only-sentence, repeated here in (7), with the Set A-picture in Figure 5.

(7) Alleen de konijnen dansen.
only the rabbits dance

“Only the rabbits are dancing.”

Figure 5. Set A-picture
Definite determiners are interpreted as being maximal, meaning that all relevant individuals have to be included in the event. Therefore, for the sentence *The rabbits are dancing* to be true, all the rabbits in the picture must be dancing. However, in the *only*-sentence *Only the rabbits are dancing* a maximal interpretation of the definite article seems to conflict with the non-dancing rabbit. An informal survey of native speakers confirms that even adults find this sentence slightly odd as a description of the picture in Figure 5, although they still consistently judge the sentence as correctly matching the picture.

Recall that we purposefully used the determiner to avoid suggesting a generic statement. We were concerned that children might reject sentences without the definite article, providing justifications such as that their dog can dance (for the combination of sentence (7) and the picture in Figure 5). However, rerunning the experiment without the definite article would give us more information about whether or not the results of *only* with Set A- pictures are due to the article or to a misunderstanding of *only*. If children would still make errors with *only* in test sentences without the definite article, this might suggest that they confuse *alleen* ‘only’ with *al* ‘all’.

Comparing our results to Hunter and Lidz’s (2013), we found that children had trouble making conservative interpretations even for quantificational expressions with which they surely must have had extensive experience. This seems to contradict Hunter
and Lidz’s result that non-conservative determiners are harder to learn than conservative determiners.

Hunter and Lidz (2013) make one additional argument in their conclusion: They argue that, if non-conservative natural language determiners are difficult to learn and unattested typologically, then natural language semantic theories should rule out non-conservative relations. Certainly, given our results we disagree with this proposal. Even if all pure quantificational determiners are conservative, the most natural way to model the meaning of only is as a relationship between two sets. Further, while non-conservative quantifiers may not be lexicalized as determiners, there are frequently used in paraphrases to express non-conservative meanings, such as someone besides DP, as in Someone besides the bears is fishing. This sentence would be true for the Set A+ picture but false for the Set A- picture. This non-conservative meaning is easily interpretable by adults, yet requires examining members of Set B that are not in Set A. A semantic theory of natural language that can uniformly handle conservative as well as non-conservative quantification would seem to be at an advantage over one that proposes two mechanisms for such similar relations.

6. References


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