Acquiring quantification
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Acquisition at the syntax-semantics interface

Children’s understanding of the Dutch floating quantifier allemaal*

4.1 Introduction

In the literature on children’s non-adult-like interpretation of quantified sentences discussed in chapter 2, it has been suggested that children differ from adults in their use of syntactic information to restrict the domain of a quantifier (Roeper and De Villiers, 1991; cf. Crain, Thornton, Boster, Conway, Lillo-Martin, and Woodams, 1996). Whereas adults restrict the domain to the noun phrase following the quantifier, children between four and six years of age impose an ‘over-exhaustive’ interpretation when they answer ‘no, not that one’ for a sentence like Are all cowboys riding a horse? for a picture displaying four horses of which three are ridden by a cowboy (the so-called extra object situation, see chapter 2). This has been called an ‘exhaustive pairing answer’ because the child seems to prefer a one-to-one relation between cowboys and horses, instead of only quantifying over the set of cowboys. Why do children ignore the syntax, which prescribes that the subject noun phrase is the domain of the quantifier, and also include the set denoted by the object? Or, to put it more precisely, why do children consider other sets as part of the quantifier domain than the set denoted by the noun phrase directly following the quantifier?

In this chapter, I take up these questions. Following up on the work by Roeper et al. (2006) that the existence of floating quantifiers in the input to the child might play a key role, I investigate children’s understanding of a floating quantifier.

Floating quantifiers are not followed by the noun phrase they quantify over, rather one needs to find the appropriate noun phrase in the sentence to determine its domain. Roeper et al. (2006) argue that it is this characteristic of floating quantifiers

that causes the child to include non-target noun phrases in the domain, also for non-floated quantifiers. Children would ignore the syntactic information provided by a quantified sentence and take the entire sentence to supply a possible quantifier domain. Roeper et al. predict that children restrict the domain of a floating quantifier in a similar way as for non-floating quantifiers.

In Dutch, the quantifier *allemaal* ‘all’ is such a floating quantifier. In fact, it can be used either as a floating or non-floating quantifier, with different meanings. The two uses are easily distinguishable (one is directly followed by a noun phrase, the other is not), and, hence, an ideal case to test children’s understanding of floating quantifiers versus non-floating quantifiers.

This chapter presents three experiments investigating children’s interpretation of the Dutch (floating) quantifier *allemaal*. The results show that not only do children include sets denoted by the object and/or the subject in the domain of floating *allemaal*, but additionally include visually represented sets. This mirrors children’s understanding of non-floating *allemaal*. This suggests that children differ from adults in their mapping of meaning to form and perform a shortcut to interpretation by over-relying on visual clues to restrict a quantifier domain. This supports the hypothesis identified in chapter 2 that acquiring quantification involves fine-tuning the interplay between syntax, semantics and pragmatics. This chapter proceeds as follows. In section 4.2, I discuss the acquisition literature on children’s interpretations of floating versus non-floating quantifiers. Section 4.3 continues with a discussion of the Dutch quantifier *allemaal*. After having formulated the main predictions in section 4.4, the three experiments testing these predictions are presented in section 4.5. I end this chapter with several conclusions about children’s understanding of floating quantifiers and the role of syntax in section 4.6.

4.2 (Floating) Quantification in child language

Floating quantifiers can occur at multiple positions in a clause, ‘away’ from their NP. Consider (1) in which *all* can occur both before and after *have*.

(1)  a. The boys should all have been playing outside with their toys  
    b. The boys should have been all playing outside with their toys

Floating quantifiers require an (appropriate) antecedent within the same clause, in a similar way as bound anaphora such as reflexives. Consider (2) and (3):

(2)  The boys_{i} I met yesterday when I was talking with the girls_{j} from next door  
     were ashamed of themselves_{i, +j}

(3)  The boys_{i} I met yesterday when I was talking with the girls_{i} from next door  
     were all_{i, +j} very nice

In (2) and (3), only *the boys* is a possible antecedent for the floating quantifier *all*, and not *the girls*. Just like reflexives must be c-commanded by their antecedent, floating
quantifiers must be c-commanded by their antecedent.

Floating quantifiers crucially differ from their non-floating counterparts in that they do not require their restriction to directly follow them (cf. (1)) and instead allow a noun phrase in the preceding part of the sentence to supply its domain. Roeper et al. (2006) argue that children carry this over to non-floating quantifiers: instead of restricting the quantifier domain to the noun phrase following the quantifier, they argue that the child also takes other noun phrases in the sentence to supply (part of) the quantifier domain. The child’s exhaustive pairing answer for *All cowboys are riding a horse* comes about as an effect of including another noun phrase in the quantifier domain than the one following the quantifier. As a result, children quantify over both the subject and the object.

Note however, as pointed out above, that floating quantifiers do not randomly restrict their domains by means of the noun phrase available in the sentence. Floating quantifiers must be c-commanded by their antecedent. This, Roeper et al. (2006) argue, marks the difference between children’s and adults’ understanding of quantified sentences. Adults recognize the nature of a floating quantifier (it is not followed by ‘its’ noun phrase), and, first, look for a suitable domain and, second, restrict this search to the noun phrase c-commanding the floating quantifier. Children overgeneralize the first characteristic of floating quantifiers to their non-floated counterparts and ignore this second requirement.

The question arises what this means for children’s understanding of floating quantifiers. Roeper et al. suggest that, once children are able to distinguish floating quantifiers from non-floated ones, they will interpret quantified sentences adult-like. Before they make this distinction, they do not use syntax as a clue to restrict

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1This is supported by Roeper et al’s finding of three developmental stages in the acquisition of quantification. In the first, so-called ‘adverb stage’, children neither restrict the quantifier domain to the constituent following the quantifier nor even to other noun phrases in the sentence. Roeper et al. take this to mean that children treat quantifiers as adverbs in this stage. This explains why some children even answer ‘no, not that one’ for sentences like (i.) and a picture in which three horses are eating hay and one bunny is eating a carrot (i.e. the so-called *perfectionist* answers in Philip (1995), see chapter 2).

(i.) *Every horse is eating hay*

In the second so-called ‘each stage’ or floating quantification stage, Roeper et al. argue, children in particular disobey the syntactic conditions for restricting a quantifier domain and take the entire sentence to provide a suitable quantifier domain. This results in the exhaustive pairing answer. The floating quantification stage is followed by a final, adult stage, in which the child correctly makes a distinction between floating quantifiers like *all* and *each* and non-floated quantifiers like *every* (cf. *The boys should every have been playing outside*). In this sense, the existence of *every* would trigger children to distinguish domains available in the clause from domains that the syntax allows as appropriate (i.e. those noun phrases c-commanding the floating quantifier).

2Philip’s (1995) Event Quantification Account (EQA) makes a different claim. As he pointed out in Philip (2004), the EQA explicitly rejects the idea that children’s exhaustive pairing answers are related to their understanding of floating quantifiers. Moreover, Philip (2004) argues that the EQA rather claims that the exhaustive pairing answer is due to the “intrinsic semantic complexity of distributive universal quantification, which can consume too much of the allocated processing resources for the child to maintain an adult LF containing a determiner universal quantifier.” (Philip, 2004:8). Note
their domain.

Labelle and Valois (2002, 2003) provide support that children’s understanding of floating-quantified sentences indeed mirrors their understanding of non-floating quantifiers. Labelle and Valois examined children’s understanding of French quantifiers. In French, the domain of the quantifier beaucoup (a so-called quantifier at a distance, Obenauer, 1983, 1984) must be restricted by the object. This contrasts with floating quantifiers in French, like chacun, which only allow quantification over the subject. Consider (4) and (5) (examples from Labelle and Valois, 2003:1).

(4) a. [Les enfants]_i ont chacun_i reçu un ballon
   ‘The children each received a balloon’
b. *[Les enfants] ont chacun_i reçu les ballons_i
   ‘The children each received the balloons’

(5) a. *[Les enfants]_i ont beaucoup_i reçu un ballon
   ‘A lot of the children received a balloon’
b. [L’enfant] a beaucoup_i reçu de ballons_i
   ‘The children received a lot of balloons’

The data of Labelle and Valois (2003) show that whereas children correctly restrict the quantifier domain to the object in the case of the quantifier at a distance beaucoup, they allow the floating quantifier chacun to quantify over both subject and object. This mirrors their understanding of non-floated quantifiers and shows that children do not restrict the domain of floating quantifiers adult-like.

A similar conclusion can be drawn from the work of Brooks and Braine (1996) on children’s understanding of English each as in Each flower is in a vase. They show that children have trouble restricting the domain of each in extra-object situations. Brooks and Braine conclude that children ignore syntax:

We suspect that children initially learn to associate each with a “pairing” or one-to-one semantic feature without attending to the quantifier’s syntactic position (i.e., if the objects described by a sentence are in perfect one-to-one correspondence, children may grasp the pairing feature associated with each without attending to which NP is modified by each). Given the circumstance that a partial one-to-one correspondence occurs, however that children also give exhaustive pairing answer with all, which is not distributive. Moreover, if it is indeed the case that the distributivity features of universal quantifiers cause the child to interpret quantified statements differently than adults, this provides an additional reason to the one provided by Roeper et al. (2006) to look into children’s understanding of floating quantifiers; floating quantifiers are known for their distributive characteristics and even have been argued to carry a distributivity operator (Hoeksema, 1996).
children will initially make comprehension errors because they fail to attend to the syntactic position of each. (Brooks and Braine, 1996:247)

In sum, explaining why children take the domain of the quantifier too liberally, Roepet et al. (2006) argue that the child restricts the quantifier domain like adults do in the case of floating quantifiers by looking for a suitable noun phrase to restrict the domain all over the sentence. Children, however, do not limit the quantifier domain to the noun phrase following the quantifier, but rather ‘overuse’ the other noun phrases in the sentence. Children thus ignore the syntactic information to determine the quantifier domain. To leave this developmental stage, the child must realize that there is a difference in restricting the domain of a floating versus a non-floating quantifier. When do children realize the difference between floating quantifiers and non-floated quantifiers? From Roepet et al., it follows that this is not before the age of six (the age the over-exhaustive answers with non-floating quantifiers disappear). But is this indeed the case? The Dutch quantifier *allemaal* allows us to answer this question experimentally.

### 4.3 Quantifier flotation and the Dutch quantifier *allemaal*

In the case of the Dutch quantifier *allemaal*, the syntax does not only determine the quantifier domain, but also affects the kind of relation the quantifier establishes between its domain and the nuclear scope. This provides an ideal case to test children’s use of syntax to interpret a quantified sentence (see also Hollebrandse and Smits, 2006). Before turning to three experiments on children’s understanding of the Dutch floating quantifier *allemaal*, I first take a close look at the nature of the Dutch quantifier *allemaal*. Essentially, *allemaal* has two meanings: an exhaustive meaning and a existential meaning.

The quantifier *allemaal* in (6-b) is the floated counterpart of prenominal *alle* ‘all’ (cf. (6-a) and (6-b)).

(6) a. Alle jongens lachen
   All boys laugh
   ‘All boys are laughing’

b. De jongens lachen allemaal
   The boys laugh *allemaal*
   ‘The boys are all laughing’

*Allemaal* allows both quantification over the subject (exemplified in (6-b) and (7-a)) and quantification over the object (exemplified in (8-a)). It alternates with the more formal and archaic floated *alle* (Ax, 1977; Doetjes, 1997) which in a similar way allows the subject to be its domain (cf. (7-b)) as well as the object (cf. (8-b)).

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1The formal *alle* becomes *allen* if it is not followed by an overt noun phrase.
(7) a. De jongens dragen allemaal een koffer
   The boys carry *allemaal* a suitcase
   ‘The boys are all carrying a suitcase’
b. De jongens dragen allen een koffer
   The boys carry all a suitcase
   ‘All boys are all carrying a suitcase’

(8) a. De jongen draagt de koffers allemaal
   The boy carries the suitcase *allemaal*
   ‘The boy is carrying all the suitcase’
b. De jongen draagt de koffers allen
   The boy carries the suitcases all
   ‘The boy is carrying all the suitcases’

In addition, *allemaal* can be used prenominally in an existential sentence, in which it only allows a weak, existential reading (in the sense of Milsark, 1979) (cf. In’t Veld, 1990; Hollebrandse, 2002).

(9) Er vliegen allemaal papegaaien
   There fly *allemaal* parrots
   ‘There are flying many parrots’

The differences between floated and prenominal *allemaal* suggest that there are two distinct usages of *allemaal* in Dutch (cf. Hoeksema, 1996). Whereas the prenominally used *allemaal* has an intersective, non-exhaustive interpretation, its floated counterpart has an universal, exhaustive (i.e. non-intersective) interpretation (in the sense of Barwise and Cooper, 1981). So (9) is true if say four out of five parrots are flying, whereas (10) is crucially false in the same situation. Hollebrandse (2002) argues that the syntactic position of *allemaal* determines its interpretation as either exhaustive or non-exhaustive.

(10) De papegaaien vliegen allemaal
    The parrots fly *allemaal*
    ‘The parrots are all flying’

The Dutch quantifier *allemaal* is remarkable because it has two contrasting readings. According to Milsark (1979), quantifiers allow either an intersective reading (and are labeled *weak*) or a non-intersective reading (and are labeled *strong*) (cf. chapter 2). Quantifiers that allow both readings like *some* and *many* are called ambiguous. However, these latter quantifiers are ambiguous depending on the discourse context (they are non-floating quantifiers on both readings, cf. chapter 5). For *allemaal*, the

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4The Mandarin Chinese *dou* ‘all’ as cited from Dowty and Brodie (1984) by Bobaljik (2003) is similarly allowed in a floated position and not as a strong universal quantifier in a prenominal position.

5As Hoeksema points out, *allemaal* differs in this respect from its Afrikaans cognate *almal* which does allow an exhaustive reading when used prenominally. See Hoeksema (1996) and references therein.
4.4 Hypothesis and predictions

In this chapter, I hypothesize that children do not use syntactic information to restrict the quantifier domain (cf. Roeper et al., 2006, Brooks and Braine, 1996) of the Dutch floating quantifier *allemaal*.

(11) Hypothesis:
Children do not use the syntactic information to interpret a quantified sentence

Starting out from the literature reporting children giving exhaustive pairing answers for non-floating quantifiers, (11) makes two predictions. First, (11) predicts that children will show similar behavior for sentences with floating and non-floating quantifiers because they, by hypothesis, do not use the syntax to restrict their domain. Second, (11) predicts that children do not distinguish between *allemaal* quantifying over the subject or the object; in both cases, children allow the entire sentence to supply a quantifier domain since, again by hypothesis, they do not use syntax to determine the domain.

The question is what kind of information children use to restrict the quantifier domain instead. Is it the visual presence of the extra object (as already argued by Donaldson and Lloyd, 1974 and Bucci (1978); see chapter 3) or rather the experimental setup (as argued by Crain et al.) that causes children to give a non-adult-like answer? Moreover if children do not use syntax for interpreting a quantified sentence, does this mean that they do not distinguish between the two interpretations of *allemaal*, i.e. its exhaustive and non-exhaustive reading? Brooks and Braine (1996) show that children master the exhaustive reading of the universal quantifiers *each* and *all* and therefore argue that children have an adult quantifier system. Extending this to Dutch *allemaal* and given the hypothesis in (11), the third prediction follows that children only to allow exhaustive readings for *allemaal*. Three experiments address these predictions. After presenting these three experiments, I will return to the main hypothesis of this thesis outlined in chapter 3 that the acquisition of

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"Although they might historically be. Compare English *all sorts of, all manner of*, which has developed into some kind of elaborate indefinite, as evidence by their occurrence in existential sentences: *There were all sorts of problems with the new software* (Hoeksema, p.c.)."
quantification is a matter of establishing a target-like equilibrium between syntax, semantics and pragmatics and account for the results in terms of the OT framework introduced there.

The first experiment examines children’s understanding of floating quantifiers; do they restrict the domain of allemaal depending on the syntactic position of the quantifier? The second experiment addresses the question what kind of information children use to restrict a quantifier domain. By presenting children items containing both an extra object and an extra agent, this second experiment zooms in on the question what the role of the visual presence of the extra object and agent plays in children’s understanding of quantified sentences. The third experiment examines children’s usage of syntax to distinguish prenominal allemaal from floated allemaal.

4.5 Experiments

4.5.1 Experiment I: Quantifier scope

The first experiment aims to answer the question whether children use syntactic information to restrict the domain of allemaal.

4.5.1.1 Method

Participants Fifteen children of elementary school De Vensterschool, Paddepoel (Groningen, The Netherlands) were tested. The children varied in age from 4 to 6 (9 boys, 6 girls). Ten adults served as a control group.

Design All test items (twelve in total) contained the floating quantifier allemaal. The variables were Sentence Type and Picture Type, each containing two levels. The test sentences either contained quantification over the object (six items) or the subject (six items). Consider the pair in (12), illustrating quantification over the object and quantification over the subject respectively.

\[(12)\]
\[
\begin{align*}
a. & \quad \text{De jongens hebben de koffers allemaal vast} \\
& \quad \text{The boys have the suitcases all fixed} \\
& \quad \text{‘The boys are holding all the suitcases’}
\end{align*}
\[
\begin{align*}
b. & \quad \text{De jongens hebben allemaal de koffers vast} \\
& \quad \text{The boys have all the suitcases fixed} \\
& \quad \text{‘The boys are all holding the suitcases’}
\end{align*}
\]

The pictures accompanying these sentences contained either an extra object (3 items per sentence type) or an extra subject (3 items per sentence type). For example, (12-a) is false for figure 4.1 containing an extra object and true for figure 4.2 containing an extra agent. Conversely, (12-b) is true for 4.1 and false for 4.2.

In addition to these test items, there were three control items with subject quantification and three items with object quantification, accompanied by a picture
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Figure 4.1: Extra Object situation targeting a yes-answer for sentences with subject quantification and a no-answer for sentences with object quantification

Figure 4.2: Extra Subject situation targeting a no-answer for sentences with subject quantification and a yes-answer for sentences with object quantification

like figure 4.3. These control items targeted a yes-answer for both quantification over the object and subject and were added to the experiment to see if participants have an exhaustive reading for *allemaal*. Additionally, there were two control yes-fillers to check whether children were paying attention.

Figure 4.3: Control item eliciting a yes-answer for both sentences with subject and object quantification

**Procedure**  The children were tested using a Truth Value Judgment Task (Crain and Thornton, 1998). We presented children with pictures analogous to figure 4.1 and figure 4.2. They had to judge prerecorded test sentences and say whether or not these sentences matched the pictures that were shown to the child on a laptop screen.
Furthermore, every child was asked to explain each of her answers. We asked for explanations for both yes and no answers. This enabled us to determine the domain the child was quantifying over. The children’s answers were noted down during the experiment. When the child pointed at the denotation of the object to explain her answer, this was coded as object quantification. In a similar way, when the child pointed at the subject-denotation, the child was taken to quantify over the subject. This was done to investigate why children answered ‘yes’ or ‘no’.

4.5.1.2 Results

The data were analyzed with a $(2) \times (2) \times (2)$ repeated measures analysis of variance. The within-subject factors were Picture Type (Extra Agent Picture or Extra Object Picture) and Sentence Type (quantification over the subject or the object) and Age was the between-subject factor (child or adult). This revealed an interaction effect between Age, Picture Type and Sentence Type ($F(1,23) = 33.62, p < 0.001$), and an interaction effect between Sentence Type and Picture Type ($F(1,23) = 14.03, p = 0.001$). No main effects were found.

The adults answered as predicted (cf. figure 4.4); they answer significantly more often yes in the Extra Object condition than in the Extra Agent condition in the case of subject quantification ($t(9) = -2.714, p = 0.024$) and, conversely, they answer significantly more often yes in the Extra Agent condition than in the Extra Object condition in the case of object quantification ($t(9) = 3.934, p = 0.003$).

The children showed guessing behavior for all test items, as revealed by a two-tailed binomial test; the mean percentages yes-answers (displayed in figure 4.5) are not significantly different from what would be expected were they randomly guessing (see table 4.1). This means that children did not consistently either point at the extra object or the extra agent depending on the syntactic structure of the sentence, but rather applied a guessing strategy to restrict the quantifier domain.

<table>
<thead>
<tr>
<th>Picture Type</th>
<th>Sentence Type</th>
<th>Mean percentage</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra Agent</td>
<td>Subject Quantification</td>
<td>48.89*</td>
<td>39.57</td>
</tr>
<tr>
<td></td>
<td>Object Quantification</td>
<td>53.33**</td>
<td>39.44</td>
</tr>
<tr>
<td>Extra Object</td>
<td>Subject Quantification</td>
<td>60.00***</td>
<td>33.81</td>
</tr>
<tr>
<td></td>
<td>Object Quantification</td>
<td>42.22****</td>
<td>42.66</td>
</tr>
</tbody>
</table>

* $t(14) = -0.109, p = 0.915$; ** $t(14) = 0.327, p = 0.748$; *** $t(14) = 1.146, p = 0.271$; **** $t(14) = -0.706, p = 0.492$

Table 4.1: Mean percentages ‘yes’ answers children for both sentence types and both picture types and their difference from at chance behavior (all t-tests reveal no significant difference from 50%)
4.5.1.3 Discussion

The results show that children restrict the domain of a floating quantifier differently than adults. This supports the hypothesis in (11) that children do not use syntactic information to restrict the quantifier domain; children do not differentiate between sentences with subject and object quantification. Moreover, children point at the extra object and extra agent for sentences with floating quantifiers as they are reported in the literature to do for sentences with non-floating quantifiers. Finally, children seem to guess as to what restricts the domain of a floating quantifier.

4.5.2 Experiment II: Quantifier scope and extra agents and objects

The question arises whether children are not able to restrict the appropriate quantifier domain (i.e. they do not use the syntax) or whether they are rather intrigued by the extra object or agent in the picture. Donaldson and Lloyd (1974) and Bucci (1978) already argued that children's interpretations of quantified sentences are affected by visual information. In addition, Crain et al. (1996) and also Sugisaki and Isobe (2001) found that the exhaustive pairing answer disappears if more than one extra object is added. In line with these results, the results of experiment I confirms the idea that children allow the visual information to play a more important role
than the syntactic information to restrict a quantifier domain. But if it is indeed the mere visual presence of an extra object (or agent) that causes the child to include the object (or agent) in the quantifier domain, one predicts that children do not restrict the domain of a floating quantifier at chance if both an extra object and extra subject are displayed. In that case, there are two extra entities and, hence, adult domain restriction is predicted. The next experiment tests children’s understanding of quantification in such a situation.

If children apply a floating quantifier interpretation strategy to both floating and non-floating quantifiers (cf. Roeper et al. (2006) and the previous experiment) and restrict the domain of the quantifier by looking for a suitable domain in the entire sentence instead of the noun phrase that c-commands it, the question arises as to how children will interpret quantified sentences if the accompanying picture displays both an extra object and an extra agent. Having an extra agent and an extra object in the picture offers a way of testing how children determine the domain of a quantifier: do they restrict the quantifier by anything extra in the visual context or do they use syntactic information in such a case? The child’s explanation to the question whether the quantified sentences matches the picture or not will bring out this difference.

The previous experiment showed that children do not make a distinction between subject and object quantification with floated quantifiers in the Extra Object
4.5. Experiments

and Extra Agent situations. Children pointed at the extra object or the extra subject to explain why they found the sentence with a floated quantifier false. However, when an extra object and extra subject are displayed simultaneously children must choose which extra element they point to, thus revealing which domain they are quantifying over. If they point at the extra object in the case of object quantification and at the extra subject in the case of subject quantification, this would show that children do make a distinction between sentences with subject and object quantification. Alternatively, children could point at both the extra object and extra agent (due to quantifying over both object and subject), point at the extra agent in both conditions (due to a preference for subject quantification) or point at the extra object in both conditions (due to a preference for object quantification).

4.5.2.1 Method

Participants Thirty-nine subjects (age range 4;1 to 6;7, 19 girls, 20 boys) from the after-school program of *De Boomhut* and elementary school *De Vrije School* (both located in Groningen, The Netherlands) were tested. In addition, seven adults were tested as a control group.

Materials The children were tested on their understanding of the difference between subject quantification (cf. (13), three items) and object quantification (cf. (14), three items), both targeting a no-answer for pictures presenting an extra object and an extra agent as in figures 4.6 and 4.7. Crucially, the reason why (13) and (14) are false differs; in the case of (13) and figure 4.6, it is because one girl does not ride a horse and in the case of (14) and figure 4.7, it is because one donkey is not being carried.⁷

(13) De meisjes rijden allemaal op een paard
The girls ride *allemaal* on a horse
‘The girls are all riding a horse’

(14) Een man draagt de ezels *allemaal*
A man carries the donkeys *allemaal*
‘A man is carrying all the donkeys’

Additionally, children were tested on control conditions for sentences with quantification over the subject (three items) and quantification over the object (three items). For these control conditions, pictures were shown displaying an exhaustive situation as in figure 4.8, without any extra objects or extra agents. The total number of items was twelve and the items were presented mixed with the test items and the

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⁷Some native speakers of Dutch might disagree and reject (14) due to a collective reading according to which there should be one man carrying all donkeys. Despite this different reason, the adult answer will still be ‘no’ which is most important for the current experiment.
three control no-items and three control yes-items items of the experiment presented in section 4.5.3.

**Procedure**  The children were tested using a Truth Value Judgment Task (Crain and Thornton, 1998). We presented children with pictures analogous to figure 4.6 and 4.7 on a laptop. They had to judge prerecorded test sentences and say whether or not these sentences matched the pictures. Furthermore, every child was asked to
explain each of her answers. As before, we asked for explanations for both yes- and no-answers.

### 4.5.2.2 Results

There were two subgroups of children. Ten of the total of thirty-nine children answered yes on the experimental condition on four or more than four out of the total of six test items. These children (who answered adult-like on the control conditions and control items) did not master the exhaustive property of *allemaal*.

The remaining twenty-nine children all gave no-answers on the test conditions which allowed me to look at their explanations in detail. Figure 4.9 shows the distribution of answer qualifications per sentence type. Adults answer as expected and explain their answers in terms of the target domain (subject or object depending on the condition). A chi-square analysis of the explanations of these twenty-nine children shows that the distribution of the children’s answers (either in terms of the subject, object, both object and subject, the world (e.g. *Robots do not hold balloons*) or non-interpretable c.q. ‘unknown’ terms) does not vary per sentence type ($\chi^2(4) = 3.608, p = 0.433$).

### 4.5.2.3 Discussion

This experiment aimed to answer the question whether children treat sentences with quantification over the subject differently from quantification over the object if they are faced with pictures displaying both an extra object and an extra subject. The results show that children do not make a distinction between sentences with *allemaal* quantifying over the subject and sentences with *allemaal* quantifying over the object. This suggests that children do not use syntactic information to restrict the quantifier domain (i.e. they do not take into account the c-commanding relation (or even subjacency) between the quantifier and its domain).

Do children also ignore the syntactic information provided by the sentence to distinguish between *allemaal* with a non-exhaustive reading (i.e. when it is used prenominally) and *allemaal* with an exhaustive reading (i.e. when it is used as a floating quantifier). The experiment presented in the next section addresses this question.

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8These children mirror the behavior of children giving so-called underexhaustive answers on tasks with non-floating quantifiers and do not take *allemaal* as an exhaustive quantifier. Hollebrandse (p.c.) suggests that children giving under-exhaustive answers might point at the existence of a pre-quantificational stage, marking a developmental stage between target-like understanding of cardinal items and non-target-like understanding of quantifiers. In this stage, children do not yet quantify, but rather just check whether the denotation of the quantifier domain is present in the test item. This explains their yes-answer on experimental conditions like the extra-object situation and a sentence containing quantification over the subject. The answers of the ten children found in this experiment, present additional evidence for such a pre-quantificational stage.
4.5.3 Experiment III: Quantifier position and interpretation

The results of the previous experiment lead to the next question. Recall from section 4.3 that *allemaal* has an intersective or non-intersective reading depending on its syntactic position. Consider again (9), repeated here as (15), in which *allemaal* is a floating quantifier and receives an exhaustive reading and (10), repeated here as (16), in which *allemaal* is used in an existential *there*-sentence and only allows a non-exhaustive interpretation.

(15) De ezels huilen allemaal
     the donkeys cry *allemaal*
     ‘The donkeys are all crying’

(16) Er huilen allemaal ezels
     there cry *allemaal* donkeys
     ‘There are many donkeys crying’

If children do not take into account the syntax to restrict a quantifier domain as the results of experiment 1 and 2 suggest, they are predicted not to differentiate these two meanings of *allemaal*. 
4.5.3.1 Method

Participants The same participants were tested as in experiment 2. See section 4.5.2.1.

Materials Both children and adults were tested on sentences with exhaustive allemaal like (15) (3 items) and sentences with non-exhaustive allemaal like (16) (6 items). To control for exhaustive interpretations, non-floated alle as in (17) was used in three extra-agent situations. All test items were accompanied by a picture with an Extra Agent like the one in figure 4.10. Intransitive sentences were used to rule out a possible effect of the object at the children’s interpretation.

(17) Alle ezels huilen
all donkeys cry
‘All donkeys are crying’

Figure 4.10: The donkeys are all crying?

In addition to the test items, three control no-items and three control yes-items were included. The control no-items were plural sentences accompanied by pictures in which only one object was performing an action (e.g. one donkey was crying). The control yes-items were sentences containing alle ‘all’ accompanied by pictures in which all the objects were performing an action (e.g. all donkeys were crying). The total of sentences was eighteen. The items were mixed with the items of the experiment discussed in section 4.5.2.1.

Procedure The same procedure was used as in experiment 2. See section 4.5.2.1.

4.5.3.2 Results

The mean percentages of yes-answers are displayed in figure 4.11 for items containing the exhaustive allemaal, prenominal alle and the items containing non-exhaustive allemaal for both children and adults. Overall, children overwhelmingly answer ‘no, not that one’ for all three sentence types and e.g. point at the donkey that is not crying. They do this even for sentences with non-exhaustive allemaal as in (16) with respect to figure 4.10. In contrast, the adults answered as expected; they accept
a sentence with non-exhaustive *allemaal* in such cases (with the exception of one adult) and answer as expected in 0% of the cases ‘yes’ with exhaustive *allemaal* or non-exhaustive *alle*). Both children and adults answered adult-like on the control items.

Since the three items with *alle* were only added to the experiment to control for exhaustive interpretations (and children show adult behavior on these items, 15.38% versus 0.00%, $t(44) = 1.325, p = 0.192$) and the focus of the experiment is children’s understanding of the two interpretations of *allemaal*, prenominal *alle* was left out from further analysis of the data.

The data were analyzed with a (2) x (2) repeated measures analysis of variance. Sentence type (floated *allemaal* versus prenominal *allemaal*) was chosen as within-subjects variable, Age (adults and children) was chosen as between-subject variable. This revealed an interaction effect between Sentence Type and Age ($F(1,44) = 113.49, p < 0.001$) and a main effect of Sentence Type ($F(1,44) = 113.49, p < 0.001$). In addition, a main effect was found for Age ($F(1,44) = 7.392, p = 0.009$). T-tests revealed that children differ significantly from adults in their interpretation of non-exhaustive *allemaal* ($t(44) = -6.03, p < .001$). For exhaustive *allemaal*, no significant difference between children and adults was found ($p > 0.05$).

Figure 4.12 illustrates the individual results in a subject analysis. Dots represent children’s individual interpretations of floated *allemaal* (on the x-axis) versus
4.5. Experiments

prenominal *allemaal* (on the y-axis).

![Graph showing mean percentage yes-answers for sentences with non-exhaustive *allemaal*](image)

**Figure 4.12:** Mean given yes-answer for exhaustive *allemaal* ‘all’ versus non-exhaustive *allemaal* ‘a lot of’ per child

To answer the question whether children interpreted the items with *alle* differently than the items with floated *allemaal*, an item analysis was performed. This revealed no difference between the items with prenominal *alle* and floated *allemaal* (Cronbach’s alpha = 0.843). This means that floated *allemaal* and the prenominal *alle* are interpreted the same; both exhaustively. An analysis using Pearson’s correlation coefficient then showed that there was a significant positive correlation between children’s interpretations of floated *allemaal*prenominal *alle* and their interpretations of non-exhaustive *allemaal* ($r(37) = 0.843$, $p < 0.001; r^2 = 0.711$). Children who more often answered yes for floated *allemaal*/prenominal *alle* also significantly more often answered yes for prenominal *allemaal*. Such an effect is not found for adults.

4.5.3.3 Discussion

The results of the third experiment show that children’s interpretations of non-exhaustive *allemaal* differ from adults’ interpretations; children, but not adults, only allow an exhaustive reading of *allemaal*. The children are adult-like for floated *allemaal*. This means that children allow an exhaustive reading for *allemaal*, independent of its position. Children ignore the syntactic position of *allemaal* in sentences with the floated *allemaal* and the sentences with non-exhaustive *allemaal*. 
For children, both positions of *allemaal* have an exclusively exhaustive reading. Adults only give this reading for floated *allemaal*.

### 4.6 General discussion and conclusions

The three experiments presented in this chapter aimed to test the prediction that followed from the work by Roeper et al. (2006) who argued that, at a stage at which children do not yet recognize the difference between floating quantifiers and non-floating quantifiers, they resort to a floating quantification strategy for determining the domain of the quantifier. Floating quantifiers allow the entire clause to provide their suitable domain (within the boundaries of c-command), in contrast to non-floating quantifiers for which the noun phrase following the quantifier provides the domain. Roeper et al. hypothesize that children do not use the syntax to interpret a quantified sentence. Instead, they would take any NP in the clause to provide the domain, which results in exhaustive-pairing interpretations. This led to the main hypothesis in (11), repeated here as (18).

(18) **Hypothesis:**
Children initially do not use the syntactic information to interpret a quantified sentence

Three predictions followed from this hypothesis which were tested in three experiments. First, children were predicted to give exhaustive pairing answers for sentences with floating quantifiers; since children’s exhaustive pairing answers for sentences with non-floating quantifiers are hypothesized to be due to not using syntax to restrict a quantifier domain (cf. Roeper et al., 2006), children are predicted to ignore the syntax in a similar way if sentences with floating quantifiers are at issue. The results of experiment 1 support this prediction. They show that children give similar non-adult like answers for sentences with floating quantifiers as with non-floated ones. This suggests that children’s search for a suitable domain of a floating quantifier is not limited to those noun phrases that are in a c-commanding relation with the quantifier.

Second, children were predicted to use a different clue than syntax to restrict a quantifier domain. Because children’s interpretations of quantified sentences are known to be affected by visual information (i.e. the extra object in the extra object condition), children are predicted to restrict the domain of a floating quantifier at chance if both an extra object and extra subject are displayed. In that case, there is no ‘extra’ entity that is visually more prominent than the other displayed entities and, hence, adult domain restricted is predicted. The second experiment tested children’s understanding of quantification in such situations. The results revealed that children do not make a distinction between sentences with quantification over the subject and sentences with quantification over the object in such a situation. In both cases, children answered similarly and either point at the subject, object, both
subject or object or gave an answer in terms of their world-knowledge.

This led to a third prediction regarding children’s understanding of the peculiarities of the Dutch quantifier *allemaal*. This quantifier gets an intersective, non-exhaustive reading when it used prenominally or a non-intersective, exhaustive reading if it used as a floating quantifier. To keep these two interpretations apart, it is crucial to take into account the syntactic environment the quantifier occurs in. The third experiment presented above addressed children’s understanding of the two usages of the Dutch quantifier *allemaal*. The results showed that they only allow an exhaustive reading for *allemaal*, regardless of the syntactic environment the quantifier occurs in. This means that children do not use the syntactic position of the quantifier to determine what kind of relation the quantifier establishes between its domain and nuclear scope (i.e. an exhaustive and non-exhaustive reading).

In sum, the results presented in this chapter show that children do not use syntax to restrict a quantifier domain. The results support the hypothesis identified in chapter 3 that the acquisition of an adult-like understanding of quantified sentences involves the fine-tuning of the interaction between syntax, semantics and pragmatics. Children differ from adults in their mapping of meaning to form by giving different weight than adults to the clues to restrict a quantifier domain; whereas adults use syntax in all experiments reported in this chapter, children clearly do not.

If children use other clues than syntax to restrict a quantifier domain, what are these other clues? Crucially, in all experiments in this chapter the visual information competed with the syntactic information; in experiment 1, an extra agent or object was displayed an hence, a visually prominent item was present, in experiment 2, an extra agent or extra object might have distracted the child and in experiment 3, an extra agent again was a visually prominent item. In this respect, the results present experimental evidence that children do not use syntactic information when the visual contexts competes with this syntactic information. This confirms the hypothesis outlined in 3 that children rank visual information higher than syntactic information. Clearly, more experimental data is needed to address the effect of visually prominent items in more detail.

Crucially, the question needs to be answered whether children are also able to answer target-like if such a visually prominent item is not present (anymore) in the stimulus. Drozd and Van Loosbroek (2006) present experimental evidence that suggests this might indeed be the case. When the child is first pointed at certain sets in the picture, children gave adult-like answer for quantified sentences. In relation to this question, the question arises how children interpret quantifiers whose domain is context dependent. And do children also become adult-like if the test items are embedded in a particular discourse context (cf. also Drozd, 2001, cf. Hollebrandse, 2004)? If it is indeed the discourse context that children use to restrict a quantifier domain, what kind of information do children use from this context to restrict a quantifier domain? These two questions will be respectively addressed in the next two chapters.