The acquisition of Distributivity and its relationship with the Adjective of Comparison ’Different’

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Abstract

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How children learn to correctly interpret distributive sentences is not well understood. Consider the following sentence:

(Ex.) The boys are pushing a car.

This sentence can be interpreted as if the boys are pushing one car together (the collective interpretation), or as if they are pushing their own cars separately (the distributive interpretation). Generally adults prefer the collective interpretation and children prefer the distributive interpretation.

We did two studies. Study 1 focuses on the interpretation of definite plural noun phrases. We used a truth-value judgment task (TVJT) to study whether children’s accurate interpretation of ‘each’ relates to their interpretation of definite plurals and found a correlation between correctly rejecting collective readings with ‘each’ and correctly rejecting distributive readings with definite plurals.

Study 2 concerns the adjective of comparison (AOC) ‘different’. AOC’s are used two compare two elements: the current sentence and a sentence-external element. However, AOC’s can also compare sentences internally, without referring to any previously introduced element, which is called the sentence-internal reading. There is a long tradition of connecting the sentence-internal reading of AOCs with distributivity. We investigated whether the acquisition of the sentence-internal reading of ‘different’ is dependent on the development and acquisition of distributivity with a TVJT, again using definite plurals and the quantifier ‘each’. Contrary to our expectations we did not find a correlation between children who rejected the distributive interpretation with the definite plural ’de’ in Study 1 and understood the sentence-internal reading of the AOC ’different’ in Study 2. Further research is necessary to examine this relationship.
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Chapter 1

Introduction

A fundamental property of human language is its ability to refer to quantities of sub-
jects and objects, rather than only referring to specific subjects and objects. In English
and also in Dutch this can be achieved in various ways, such as using quantificational
expressions (each/every boy), numerical expressions (three boys) or plurals (the boys).
These expressions have the ability to give rise to different interpretations: How do we
consider the subjects in such sentences; as a group acting collectively or as individuals
acting separately? This possibility of multiple interpretations is called the phenomenon
of distributivity. Take for example the following three sentences:

(1) Each boy is pushing a car.
(2) Three boys are pushing a car.
(3) The boys are pushing a car.

These sentences can all be true if the boys pushed one car together in a joint action,
which is the collective interpretation (Figure 1a), or when each boy acted individually,
pushing his own car, which is the distributive interpretation (Figure 1b).

Figure 1: A. Collective Interpretation   B. Distributive Interpretation
Within the distributive interpretation we can further distinguish two types. Sentences (1), (2) and (3) can be true if each boy pushed a different car, so for each boy his own car. But it could also be true if all the boys pushed the same car, but one after the other. The first interpretation is called dependent distributivity, because which car is pushed depends on which boy we are talking about. This interpretation is shown in Figure 2a. The second reading is called independent distributivity, shown in Figure 2b. For the remainder of this thesis we focus on dependent distributivity rather than independent distributivity, because dependent distributivity is clearer and easier to depict.

![Figure 2: A. Dependent Distributivity B. Independent Distributivity](image)

Distributivity, evoked by quantified expressions, plurals or numerical expressions, is a widely examined phenomenon. Over the past two decades lots of research has been dedicated to the comprehension and acquisition of distributivity. How do children interpret and comprehend sentences including expressions that evoke distributivity? And how do these interpretations differ from the interpretations of adults?

This project consists of two studies, the first study concerns the acquisition of distributivity, examined by looking at the interpretations of the quantifier *iedere* 'each/every' and the definite plural *de* 'the'. The second study aims to find a relationship between distributivity and the adjective of comparison *andere* 'different'.

Study 1 concerning the acquisition of distributivity is based on the experiment of Pagliarini et al. (2012), and investigates the same hypothesis. Pagliarini et al. (2012)’s starting point is the fact that adults fully accept the collective interpretation of definite plural noun phrases like sentence (3), but they find distributive readings marginal, whereas children accept both interpretations. Their hypothesis is based on Dotlacil (2010)’s ideas about conversational implicature. They propose that the marginal status of the distributive interpretation in combination with definite plural noun phrases
follows from principles of conversational implicature, introduced in linguistics by Horn (1972).

In short, this means that adults are able to reason about an alternative (more informative) option, involving the quantifier ‘each’ and by doing that they are able to exclude the distributive interpretation. Children can’t reason about this alternative option yet (because of an incomplete lexical understanding of the quantifier ‘each’) and that’s the reason why children also accept the marginal distributive interpretation. A more detailed explanation of this hypothesis will be discussed in the next chapter.

Study 1 examines the interpretations of the Dutch quantifier _iedere_ ‘each’ and the definite plural _de_ ‘the’ in combination with the collective and distributive interpretation in a Truth-Value Judgment Task (TVJT). Which interpretations (distributive or collective) do children and adults accept? We make the following predictions:

- For the definite plural ‘the’ _de_, **adults** will reject the distributive interpretation, but accept the collective interpretation.

- For the quantifier ‘each’ _iedere_, **adults** will accept the distributive interpretation, but reject the collective interpretation.

- For both the definite plural ‘the’ _de_ and the quantifier ‘each’ _iedere_, **young children** will accept the distributive interpretation and the collective interpretation.

- Children who correctly reject the collective interpretation with the quantifier ‘each’ _iedere_, will also reject the distributive interpretation in combination with the definite plural ‘the’ _de_.

In summary, we expect that the acquisition of the quantifier ‘each’ _iedere_ will precede the rejection of the distributive interpretation in combination with the definite plural ‘the’ _de_. We expect a correlation between the rejection of the quantifier ‘each’ in the collective context and the rejection of the definite plural ‘the’ in the distributive context. In other words, children who understand ‘each’ will also find the distributive interpretation in combination with the definite plural ‘the’ marginal (the adult intuition). This prediction is based on principles of conversational implicature, following Dotlacil (2010).

We indeed found that children learn to reject the collective reading of the quantifier ‘each’ _iedere_ before they learn to reject the distributive reading of the definite plural ‘the’ _de_. We also found a significant correlation between the rejection of ‘each’ in the collective context and the rejection of ‘the’ in the distributive context. This correlation holds at the level of the individual child.
Unfortunately, not all results turned out to follow our predictions: the acceptance rates of the quantifier ‘each’ in the collective context and the definite plural ‘the’ in the distributive context both turned out to be higher as expected. These unexpected results will be discussed in detail in chapter 3.

The literature shows a long tradition of connecting the phenomenon of distributivity to at least some adjectives of comparison. Study 2 examines the relationship between distributivity and the Dutch adjective of comparison *andere* ‘different’. Adjectives of comparison (AOCs), e.g. *different, same* and *similar*, are used to compare two elements in language. Carlson (1987) is the first one to claim that distributivity forms the basis of the AOCs ‘different’ and ‘same’. He proposes that distributivity is necessary to interpret the AOC ‘different’. In Study 2 we will examine this proposal, by conducting a TVJT involving the Dutch quantifier *iedere* ‘each’ and the definite plural *de* in combination with the Dutch AOC *andere* ‘different’. Study 2 is conducted with the same participants as Study 1, this made it possible to perform a correlation test between the results of Study 1 and Study 2, to examine the proposal that the AOC ‘different’ is dependent on distributivity. We predict that children who acquired distributivity and thus showed the adult interpretation in Study 1, will also correctly interpret the AOC ‘different’.

We found no significant correlation between the results of Study 1 and Study 2. Our results do not provide clear evidence to the assumed relationship between distributivity and the AOC ‘different’, however they do show that the interpretation of the AOC ‘different’ relates to a distributive or collective preference. Further research is necessary to examine this relationship.

Study 2 is further introduced and discussed in chapter 7.

The following chapter provides more background covering previous research concerning the phenomenon of distributivity. Which directions of research can we distinguish and what kind of results, concerning the marginal distributive interpretation, do they provide?
Chapter 2

Study 1

The acquisition of distributivity

2.1 The ‘degraded’ status of the distributive reading

The word ‘distributivity’ indicates the application of a predicate to the members of a set. Take for example Sentence (4). Sentence (4) is distributive when it’s understood as a situation involving multiple boats. The predicate ‘wash’ applies to both Mark and John.

(4) Mark and John are washing a boat.

This in contrast to the situation which only entails one boat. As previously mentioned in the introduction, this interpretation is called the collective interpretation in which the predicate ‘wash’ applies to Mark and John together as a set.

Distributivity can be observed by the presence of distributive entailments. Sentence (5) shows the distributive entailment of sentence (4), by using a conjunction.

(5) Mark is washing a boat and John is washing a boat.

It’s commonly assumed that plural arguments (definite plural noun phrases, numerals and coordinations of proper names such as Mark and John etc.) can give rise to both the distributive and the collective interpretation, by using such entailments. However the distributive interpretation of these plural arguments is often judged as marginal or even unavailable. Dotlacil (2010) shows this contrast very clear by listing incompatible opinions about whether or not the distributive interpretation is available in combination with plural arguments. We will provide a short overview.

Lasersohn (1995), Landman (2000) and Winter (2000), among others assume that both interpretations are possible. This in contrast with Schwarzschild (1993), who claims that sentences like (4) do not allow, or only very marginally allow the distributive interpretation, in which Mark and John each wash a different boat. However he does soften his
claims in Schwarzschild (1996) with a new viewpoint claiming that the distributive interpretation is always possible, but requires the right context. Schwarzschild (1996) shares his viewpoint with Roberts (1987), who also claims that the distributive interpretation is hard to get with plural definites, but that it is possible in the right context. These claims makes definite plurals different from for example numerals, because numeral arguments like ‘three students’ can easily give rise to the distributive interpretation. Scha (1984) and Link (1991) on the other hand, find the distributive interpretation marginal. Scha (1984) states that the distributive interpretation is not possible in combination with definite plurals. Link (1991)’s claims are less strong in the sense that he proposes that definite plurals can give rise to the distributive interpretation, but that this interpretation is dispreferred. The collective reading is in his claims the preferred one. The claims of Scha (1984) and Link (1991) are followed by Williams (1991) and Moltmann (1992) who mark the distributive reading of definite plurals as unacceptable.

The point of Dotlacil (2010) to list all this literature, is to show that there is little agreement on the acceptability of the distributive reading. He states that many authors claim that the distributive reading is fully possible with any plural argument, but that on the other hand others claim that the distributive interpretation has some kind of special status, ranging from marginal to even ungrammatical and unacceptable. Dotlacil (2010) examines this contradictory literature about the distributive reading of plural arguments by focusing on four different experiments that concentrate on the interpretations of sentences with definite plural noun phrases. The results of these experiments all show that the distributive interpretation is marginal for many plural arguments, including universal quantifiers (each and every), indefinite numerals, definite plurals and coordinations of proper names. The discussed experiments were all conducted with adults to examine the ambiguous state of the different plural arguments. For example, Brooks and Braine (1996) conducted an experiment with 20 adults in which their preference for a distributive or collective interpretation was tested in combination with the following sentence types:

(6) a. Three NPs are verbing an NP
   b. All the NPs are verbing an NP
   c. Each NP is verbing an NP

If these sentences are indeed ambiguous, we should expect a 50% preference for the collective interpretation and a 50% preference for the distributive interpretation (note that there is no particular preference in this case, the participants randomly choose a picture, which results in a close to 50% preference-rate). However this is not the case, Brooks and Braine (1996) found quite different results. Participants preferred the collective interpretation with sentences like (6a) in 97.5% of the cases and (6b) in 83.3% of the
cases. When the sentence started with the quantifier 'each' (6c) participants strongly preferred the distributive interpretation with 99.2%. These results show us that the assumption that the three sentences (6a-c) are indeed ambiguous is highly unlikely.

Another experiment concerning the availability of the distributive interpretation in combination with plural arguments is conducted by Kaup et al. (2002). They tested the pronouns *sie* 'they' and *beide* 'both' in combination with a question resulting in either a distributive or collective answer. The results showed a strong preference for the collective interpretation in combination with the pronoun 'they' and a strong preference for the distributive interpretation in combination with the pronoun 'both'. The difference between the two preference rates turned out to be significant.

These results show us that the plural arguments 'they' and 'both' aren't ambiguous too. 'They' is preferred in combination with the collective interpretation and 'both' strongly prefers the distributive reading, like the quantifier 'each' from the experiment of Brooks and Braine (1996).

Dotlacil (2010) also discusses the experiment of Frazier et al. (1999). In their experiment the marginal status of the distributive interpretation was tested by an online task. They tested reading difficulties connected to the location of the quantifier 'each' and the adverb 'together,' by examining participants eye-movements. Note that the quantifier 'each' strongly prefers the distributive interpretation. The adverb 'together' on the other hand forces the collective interpretation. The markers 'each' and 'together' were either placed right after the subject or after the object shown in Sentence (7), directly from the materials of Frazier et al. (1999).

(7) a. Lynne and Patrick *each/together* saved $1000 to pay for their honeymoon.
   b. Lynne and Patrick saved $1000 *each/together* to pay for their honeymoon.

Note that Sentence (7a) and (7b) become disambiguated after the each/together is encountered. Frazier et al. (1999) hypothesized that the location of the markers 'each' and 'together' influenced the reading rate of the participants. In sentence (7b) the disambiguator each/together is placed later in the sentence than is the case in (7a). Following the hypothesis this would mean that sentence (7b) is more difficult to read than sentence (7a) due to the location of the disambiguator and should result in a slower reading rate. The results indeed show that the disambiguator placed right after the subject (7a) had no effect on the reading. However, when the disambiguator was placed after the object of the sentence, sentences with 'each' showed a slowdown compared with sentences with 'together'. The slowdown was detected at the region following the disambiguator and turned out to be significant. This slowdown is caused by the readers parsing preference, which is different form the interpretation that the quantifier 'each' triggers. The part
of the sentence before the disambiguator is most likely interpreted as a collective situation which is incompatible with the quantifier 'each', but compatible with the adverb 'together'. This difference explains the reading slowdown with the quantifier 'each' and the unaffected reading speed with the adverb 'together'. The results of Frazier et al. (1999) again show us that the collective interpretation is preferred over the distributive interpretation with plural arguments such as coordinations of proper names.

All the previously discussed experiments show us that the collective interpretation is preferred if the subject is either a numeral (three boys), the pronoun 'they', or a coordination of proper names. Dotlacil (2010) however states that the marginal status of the distributive interpretation is mild in the sense that the majority of participants still find the sentences grammatical and acceptable. And if the subject is a universal quantifier such as 'each' or a pronoun such as 'both', the distributive interpretation is strongly preferred over the collective interpretation.

Following Beghelli and Stowell (1997) this leads to the following three groups, distinguished by the level of acceptability of the distributive interpretation:

1. **Plural Arguments with universal distributive quantifiers**, such as 'each' and 'every' with which the distributive interpretation is strongly preferred.

2. **Plural Arguments with counting quantifiers**, such as 'all' and 'both' can occur with the collective interpretation and with the distributive interpretation.

3. **Group-denoting Plural Arguments**, such as numerals (three boys), definites (the boys) and coordinations of proper names (Mike and John) with which the distributive interpretation is strongly dispreferred.

### 2.2 Children’s interpretations

Although it has been found that adults find the distributive interpretation in combination with many plural arguments marginal, it turns out that children don’t have such intuitions. They are drawn to the distributive interpretation, rather than the collective interpretation. Syrett and Musolino (2013) for example found that children unlike adults prefer the distributive interpretation and that they are not aware of the lexical semantics of for example the quantifier 'each' and the adverb 'together', that both favor a particular interpretation. In a preference task with sentences like 'Two boys pushed a car', three and four year olds both preferred the distributive interpretation over the collective interpretation. However, they are able to access both interpretations. The experiment of Brooks and Braine (1996) showed that the collective preference emerges
in the course of development.

In another experiment Syrett and Musolino (2013) tested the performance of children evaluating the quantifier 'each'. Multiple studies have shown that children show non-adult-like interpretations of the quantifier 'each', more concreet they are able to interpret the quantifier 'each' collectively (Brooks and Braine, 1996; Brooks and Sekerina, 2006; Ferenz and Prasada, 2002; Musolino, 2009; Syrett and Musolino, 2013). Whereas adults find this marginal. The studies of for example Gil (1982) and Zimmermann (2002) showed that the (adult) distributive interpretation of sentences with plural arguments (such as the boys, three boys etc.) can be enforced by adding so called distributivity markers such as 'each', that lead to a strong distributive preference.

Syrett and Musolino (2013) tested in a preference task whether or not young children are able to use the lexical semantic information provided by the quantifier 'each' and the adverb 'together', to disambiguate the sentence and assign either the distributive or the collective interpretation. The results showed that children are prone to accept the test sentences in both interpretations no matter what the lexical item was. When children heard sentences containing the distributive quantifier 'each', they were not statistically more likely to accept them in the distributive than in the collective interpretation. However, they were slightly more likely to accept the sentences with the adverb 'together' in the collective interpretation than in the distributive interpretation (100% vs. 83.3%, p = 0.057). These results clearly suggest that lexical items such as 'each' and 'together' do not have the same interpretive force for children as they do for adults.

2.3 Conversational Implicature

The finding, that children are unaware of the lexical semantics of the quantifier 'each' forms the basis of Pagliarini et al. (2012) and our hypothesis concerning conversational implicature. Conversational implicatures, introduced by Horn (1972), are based on Grice’s maxim of quantity (Grice et al., 1975). This maxim entails that one has to make his contribution as informative as possible, but no more than required. Grice’s maxim of quantitiy also requires to be truthful: "Don’t say what you believe to be false, and don’t say anything without having evidence for it”. In other words if two sentences have a different status of informativeness, the speaker should utter the more informative sentence under the condition that this sentence is true. So, if the speaker chooses the less informative sentence, the listener can infer that the speaker has no evidence that the most informative sentence is true.

In summary, conversational implicatures concern situations in which the listener makes a comparison between what was said and what could have been said. By doing this, the listener can exclude a certain interpretation to avoid ambiguity. So both interpretations
are present, but in the actual conversation only one is considered.

Coming back to our hypothesis, we predicted that for sentences containing the definite plural 'the' such as, 'the boys are pushing a car', adults are able to reason about the more informative option using the distributive quantifier 'each'. By doing that they are able to infer that the distributive interpretation is not the right one.

In summary adults are able to reason like this: 'if the speaker had meant the distributive interpretation, he would have said 'each', 'each boy is pushing a car'; but he did not use 'each' so therefore I can infer that the collective interpretation is more appropriate'.

As previously mentioned, children have non-adult like intuitions of 'each'. They can interpret 'each' collectively, which means that 'each' does not serve as a distributive marker for children. Because of this children are not able to reason about it as a case of conversational implicature. The quantifier 'each' and the definite plural 'the' mean exactly the same to them, they are ambiguous. Therefore, the sentence with 'each' cannot serve as a more informative option excluding the distributive interpretation. We therefore predict that children, unlike adults, will accept the distributive interpretation in combination with the definite plural 'the'.

This background chapter served to give an overview of the literature concerning the interpretations of the quantifier 'each' and other plural arguments such as the definite plural 'the'. It showed that adults prefer the collective interpretation in combination with plural arguments like 'the' and the distributive interpretation with quantifiers like 'each'. Adults find the distributive interpretation of group-denoting plural arguments like definite plurals, numerals and coordinations of proper names marginal, which leads to an overall preference for the collective interpretation. However, the quantifier 'each' is found to serve as a strong distributive marker, resulting in a disappearance of the collective preference leading to a strong preference for the distributive interpretation.

Children on the other hand show a strong overall distributive preference, even with the group-denoting plural arguments defined by Beghelli and Stowell (1997), which are strongly dispreferred by adults in combination with the distributive interpretation. The difference in interpretation preference between adults and children is proposed to be caused by principles of conversational implicature. This hypothesis is following Dotlacil (2010) and Pagliarini et al. (2012). The next chapter involves experiment 1 of Study 1, examining the interpretations of the quantifier 'each' and the definite plural 'the', based on the hypothesis concerning conversational implicatures.
Chapter 3

Experiment 1 - The interpretations of ’The’ and ’Each’

It has been found that adults fully accept the collective interpretation of definite plural noun phrases, but they find the distributive interpretation marginal (Frazier et al., 1999; Kaup et al., 2002). Crucially is, that this is the case even when both interpretations are equally possible, as shown in the eye-tracking experiment of Frazier et al. (1999). Children on the other hand are drawn to the distributive interpretation, rather than the collective interpretation (Syrett and Musolino, 2013). This difference leads to the following questions:

1. Why is the distributive interpretation of definite plural noun phrases degraded?

2. How do children develop these adult like intuitions?

We hypothesize that the degraded status of the distributive interpretation follows from principles of conversation, previously introduced in the background section (Dotlacil, 2010). Following this hypothesis, the collective interpretation is excluded by conversational implicature. This means that both interpretations are available, but the distributive interpretation is excluded in actual conversation.

Adults are able to reason about a more informative option using ’each’, as suggested by Dotlacil (2010). For adults, the universal quantifier ’each’ excludes the collective reading, since it is a very strong marker for the distributive interpretation (Vendler, 1967). The literature shows that children do not treat the quantifier ’each’ as such a strong distributive marker. Brooks and Braine (1996) and Syrett and Musolino (2013) both found that children allow collective readings of the quantifier ’each’. They accept both interpretations, whereas adults reject the collective interpretation in combination with the quantifier ’each’ and show a clear preference for the distributive interpretation (Brooks and Braine, 1996). This finding that children are not yet aware of the lexical
Chapter 3. Experiment 1 - the quantifier 'each' and the definite plural 'the'

Semantics of the quantifier 'each', leads to the prediction that children will accept the distributive interpretation in combination with definite plural noun-phrases. Children are not yet able to exclude the distributive interpretation, because they can’t reason about the more informative option with 'each'. A sentence with the quantifier ‘each’ (which is a marker for distributivity to adults), means exactly the same to them as a definite plural noun phrase. They are ambiguous. So, when children have not yet learnt the lexical semantics of the quantifier 'each’, they will accept the 'degraded’ distributive interpretation.

This hypothesis leads to the following two predictions:

In language development:

1. The rate of rejection of the quantifier ‘each’ in the collective context will correlate positively with the rate of rejection of the plural definite ‘the’ in the distributive context.

2. This correlation will hold at the level of the individual child.

We examined these predictions, by using a Truth-Value Judgment Task (TVJT) with two factors: PICTURE and SENTENCE. The picture was either collective or distributive and the sentences started either with ‘the’ or ‘each’.

The experiment is conducted in Dutch, with the Dutch quantifier *iedere* and the Dutch definite plural *de*. A similar experiment is conducted by Pagliarini et al. (2012) in Italian, using the quantifier *ciascun* and the definite plural *i/le*. We replicated this experiment, with a couple of adjustments besides the difference in the examined language.

The first difference concerns the ages of the participants. Pagliarini et al. (2012) tested children from 4 to 13 years old. We decided to start at age 5 and stop at age 9, because from experience with previous research we noticed that 4 year old children have difficulty to remain focused. Another reason is that they say ‘yes’ to almost everything, even if the experiment is designed to avoid the so-called ‘yes’ bias. We stopped at age 9, because at that age children already showed adult interpretations.

Another difference lies in the verbs that were used. Pagliarini et al. (2012) used the following 6 verbs: *dipingere* ‘paint’, *portare* ‘carry’, *mangiare* ‘eat’, *construire* ‘build’, *sollevare* ‘lift’ and *riparare* ‘repair’. We decided to change 4 of those verbs, only keeping ‘carry’ *dragen* and ‘build’ *bouwen*. The other verbs were replaced by *vasthouden* ‘hold’, *duwen* ‘push’, *trekken* ‘pull’ and *wassen* ‘wash’. The detailed explanation for this replacement will be provided in the discussion section of this chapter.

In contrast to our experiment, Pagliarini et al. (2012) used a TVJT with a picture presented on a computer screen and a puppet manipulated by one of the experimentors that uttered the target sentences. The children were asked to judge the sentence as a correct or incorrect description of the picture by giving the puppet either a golden or
a green coin. We decided to leave the puppet and the coin out of our procedure. The reason for this adjustment is that we told the children that they had to help us with checking our computer, because we thought that there might be something wrong with it. The children were instructed to tell us whether the computer was wrong or right and in this context the addition of the puppet made no sense.

In summary, the goal of experiment 1 is to examine children’s interpretations of the universal quantifier *iedere* ‘each’ and the definite plural *de* ‘the’, by using a Truth-Value Judgment Task (TVJT). We hypothesize that the rejection of the quantifier *iedere* in the collective context will correlate positively with the rejection of the definite plural *de* in the distributive context. To make an even more stronger claim, we expect that this prediction will hold at the level of the individual child, which means that children who reject ‘each’ in the collective context will also reject ‘the’ in the distributive context.

3.1 Method

3.1.1 Participants

114 Dutch children aged between 5 and 9 years old and 40 Dutch adults participated in experiment 1 of study 1. The participants were divided into 6 different age-groups. The main features of these groups are summarized in Table 1. All children were recruited from the same primary school in Groningen. Adults were recruited through a website and were mainly students of the Faculty of Mathematics and Natural Sciences. The children were tested individually by the experimenter, in a quiet classroom at their school. The adults performed the experiment online, without the experimenter being present. They did not receive any compensation.

<table>
<thead>
<tr>
<th>Age-Group</th>
<th>Number of Participants</th>
<th>Group Mean Age (with SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Adults</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>86</td>
</tr>
</tbody>
</table>
Chapter 3. Experiment 1 - the quantifier ‘each’ and the definite plural ‘the’

3.1.2 Materials

For experiment 1 a Truth-value Judgment Task (TVJT) in a 2x2 design was used. The 2x2 design consisted of the factors PICTURE (collective vs. distributive) and SENTENCE (de ‘the’ vs. iedere ‘each’).

3.1.2.1 Picture

Figure 3:

A. Distributive Interpretation

B. Collective Interpretation

Figure 3a shows the distributive interpretation (each boy is building his own snowman) and Figure 3b shows the collective interpretation (the boys are building one snowman together).

3.1.2.2 Sentence

(8) **Iedere** jongen bouwt een sneeuwpop.
    **Each** boy build.3Psing.PRES a snowman.
    **Each** boy is building a snowman.

(9) **De** jongens bouwen een sneeuwpop.
    **The** boy.PL build.3PPl.PRES a snowman.
    **The** boys are building a snowman.

Experiment 1 contains two types of sentences: one with the quantifier *iedere* ‘each’ (Sentence 8) and one with the plural definite *de* ‘the’ (Sentence 9). The sentences are all of the form Subject-Verb-Indefinite Object.
3.1.2.3 Conditions

The 2x2 design of experiment 1 results in four conditions. In each condition participants are asked to verify a Dutch transitive sentence in the context of a picture, by answering ‘yes’ or ‘no’.

The four possible conditions:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Sentence</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>iedere</em> ‘Each’</td>
<td>Distributive picture.</td>
</tr>
<tr>
<td>2</td>
<td><em>iedere</em> ‘Each’</td>
<td>Collective picture.</td>
</tr>
<tr>
<td>3</td>
<td>Plural definite <em>de</em> ‘The’</td>
<td>Distributive picture.</td>
</tr>
<tr>
<td>4</td>
<td>Plural definite <em>de</em> ‘The’</td>
<td>Collective picture.</td>
</tr>
</tbody>
</table>

In Conditions 1 and 2, the sentence contains a distributive NP subject: the distributive quantifier *iedere* ‘each’ (sentence 8). In Conditions 3 and 4, the sentence contains a non-quantificational NP subject: the definite plural *de* ‘the’ (sentence 9).

In condition 1 participants have to verify a sentence with *iedere* in the context of a picture depicting a distributive situation (Figure 3a). A ‘yes’ answer to this condition is interpreted as an acceptance of the distributive interpretation of the distributive quantifier *iedere*. For condition 2 participants have to verify a sentence with *iedere* in the context of a picture depicting a collective situation (Figure 3b). A ‘yes’ answer to this condition is interpreted as an acceptance of the collective interpretation of the distributive quantifier *iedere*. For Condition 3 a sentence with *de* has to be verified in the context of a distributive picture (Figure 3a). A ‘yes’ answer to Condition 3 is interpreted as an acceptance of the distributive interpretation of the definite plural *de*. In the fourth and last condition 4 a sentence with *de* has to be verified in the context of a collective picture (Figure 3b). A ‘yes’ answer to Condition 4 is interpreted as an acceptance of the collective interpretation of the definite plural *de*. We will refer to the different conditions in the following way: ‘each-dis’, ‘each-col’, ‘the-dis’, ‘the-col’.

3.1.3 Design and Procedure

Participants were presented 24 experimental items in total, 6 sentence-picture pairs for each condition. The following 6 verbs were used: *vasthouden, dragen, duwen, trekken, wassen, and bouwen* (in English: ‘hold’, ‘carry’, ‘push’, ‘pull’, ‘wash’ and ‘build’). The subjects of the items were girls, boys, monkeys or dogs and every item contained a different object. The experiment also included 12 control items, of whom 8 were false and 4 were true. More false than true controls were chosen to prevent children’s yes-bias. Children generally avoid saying that something is wrong, so letting them answer ‘no’ to relatively easy control items will show them that it’s also possible to answer ‘no’.
The controls were constructed using the same four subjects as for the items but with three different verbs: staan op, zitten op and spelen met (in English: ‘sit on’, ‘stand on’ and ‘play with’). Every subject performed each action/verb, resulting in 12 controls. See Figure 4 for an example with the following sentences, from which one is true and two are false: A. The monkey is standing on the rock. B. The monkey is sitting on the bike. C. The monkey is playing with a computer.

The 12 control items and the 24 experimental items resulted in a total of 36 items. Four different versions of the experiment were developed in which experimental and control items were presented in random order. Participants were assigned randomly to one of the four versions. The experiment started with three practice items, to introduce the verbs and the subjects and to warm up the participants. The pictures were displayed on a laptop screen. The participants were presented with one picture at a time, while a recorded sentence was played. They were instructed to verify whether the sentence matched the picture, by saying ‘yes’ or ‘no’.

### 3.2 Results

All 154 participants were able to complete the experiment. Participants answered incorrectly to control items 1.5% of the time. These incorrect answers were mainly due to overthinking, an example of an explanation that some of the children gave: 'No that monkey is not standing on a rock, it is standing on a stone' (Figure 4a).

Figure 5 and Table 2 report the mean proportion of ‘yes’ answers for each group and for each condition. Looking at the descriptive statistics, it can be seen that children consistently accept the Each-Dis Condition (the distributive interpretation of the quantifier iedere) and the The-Col Condition (the collective interpretation of the plural definite de) from the age of 5 years old (Figure 5a).
Chapter 3. Experiment 1 - the quantifier 'each' and the definite plural 'the'

Figure 5: Proportion of 'yes' Responses per Age Group for (A) the Conditions Each - Dis and The - Col. (B) the Conditions Each - Col and The - Dis. The last column of each Condition shows the prediction.
Table 2: Mean Proportion of ‘Yes’ Responses for each Group and for each Condition

<table>
<thead>
<tr>
<th>Age-Group</th>
<th>Proportion of ‘yes’ Responses (with SD)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Each-Dis</td>
<td>Each-Col</td>
<td>The-Dis</td>
<td>The-Col</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>100 (0)</td>
<td>76.2 (42.7)</td>
<td>98.8 (10.9)</td>
<td>97.6 (15.3)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>100 (0)</td>
<td>72.5 (44.8)</td>
<td>97.5 (15.7)</td>
<td>96.7 (18.0)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>100 (0)</td>
<td>63.8 (48.2)</td>
<td>94.2 (23.5)</td>
<td>98.6 (11.2)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>100 (0)</td>
<td>50.7 (50.2)</td>
<td>92.0 (27.1)</td>
<td>99.3 (8.5)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>99.2 (9.1)</td>
<td>35.0 (47.9)</td>
<td>90.0 (9.1)</td>
<td>100 (0)</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>99.6 (6.5)</td>
<td>36.3 (48.2)</td>
<td>52.5 (50.0)</td>
<td>100 (0)</td>
<td></td>
</tr>
</tbody>
</table>

The results of the Each-Col Condition (Figure 5b) suggest that 5 and 6-year-old children also accept the collective interpretation of the quantifier *iedere*. However, starting at age 7, children start rejecting this interpretation, gradually moving toward the adult interpretation, which is reached at the age of 9.

The results of the The-Dis Condition (Figure 5b) show that children from the age of 5 years old accept the distributive interpretation of the plural definite *de*. They start rejecting this condition around the age of 8/9 years old. They do not seem to have reached the adult interpretation, as was the case for the Each-Col Condition. Adults accept the The-Dis Condition around half of the times. Which is higher as expected.

To summarize, the descriptive statistics show us that the acquisition of the quantifier *iedere* precedes the acquisition of the meaning of the definite plural *de*.

Table 3: Fixed effects of the maximally best fitting logistic mixed-effects model, with Condition Each - Dis as reference variable

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Estimate</th>
<th>SE</th>
<th>z-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.56096</td>
<td>1.14814</td>
<td>6.585</td>
<td>4.54e-11</td>
</tr>
<tr>
<td>Each - Col</td>
<td>-6.33852</td>
<td>1.08957</td>
<td>-5.817</td>
<td>5.98e-09</td>
</tr>
<tr>
<td>The - Dis</td>
<td>-2.12865</td>
<td>1.14619</td>
<td>-1.857</td>
<td>0.063289</td>
</tr>
<tr>
<td>The - Col</td>
<td>-1.78072</td>
<td>1.04237</td>
<td>-1.708</td>
<td>0.087573</td>
</tr>
<tr>
<td>Age</td>
<td>0.09626</td>
<td>0.09475</td>
<td>1.016</td>
<td>0.309652</td>
</tr>
<tr>
<td>Each - Col: Age</td>
<td>-0.20730</td>
<td>0.09218</td>
<td>-2.249</td>
<td>0.024525</td>
</tr>
<tr>
<td>The - Dis: Age</td>
<td>-0.35670</td>
<td>0.09176</td>
<td>-3.887</td>
<td>0.000101</td>
</tr>
<tr>
<td>The - Col: Age</td>
<td>0.10447</td>
<td>0.12659</td>
<td>0.825</td>
<td>0.409257</td>
</tr>
</tbody>
</table>
Chapter 3. *Experiment 1 - the quantifier ‘each’ and the definite plural ‘the’*

The results were analyzed using mixed-effect linear models. The dependent variable was the response (0 for a ‘no’ answer rejecting an item, 1 for a ‘yes’ answer accepting an item). The predictors were: CONDITION, AGE, and the interaction of the two. We also included two random effects for the intercept: PARTICIPANTS and VERBS, and one random effect for the slope of the VERBS: CONDITION.

In the resulting model (Table 3.), CONDITION EACH-Col turned out to be a significant predictor ($z=-5.8$, $p<0.001$). Furthermore, two interactions were significant: AGE with EACH-Col ($z=-2.2$, $p<0.01$) and AGE with THE-Dis ($z=-3.9$, $p<0.001$). Other conditions and their interactions with AGE were not significant.

The results show us that Condition Each-Col (the quantifier *iedere* in the collective context) is rejected more than the other conditions. Furthermore, with higher age, both Conditions Each-Col and The-Dis (plural definite *de* in the distributive context) become less accepted. The other two Conditions, Each-Dis and The-Col, remain stable and fully accepted throughout all groups. To conclude, the descriptive statistics of Table 2. and Figure 5. and the results of the mixed effect linear model (Table 3.) show us that almost all conditions start as being fully accepted. Condition Each-Col is the first condition that children start to reject, beginning at age 5. This is followed by Condition The-Dis, as expected. Conditions Each-Dis and The-Col remain stable and adult like, even at age 5 there is no significant difference with the adults.

![Figure 6: Correlation between the acceptance rates of Condition Each-Col and The-Dis: The triangles represent the individual children](image)

We were not only interested in the acceptance rates of the four conditions, but we also wanted to examine the role that the quantifier *iedere* in the collective context (Condition
Each-Col) plays in the acceptance of the plural definite *de* in the distributive context (The-Dis). To repeat our prediction: it’s expected that the rejection of Condition The-Dis should positively correlate with the rejection of Condition Each-Col. Second, this correlation will hold at the level of the individual child.

The first prediction is already shown in the descriptive statistics and the results of the mixed effect linear model. To examine the second part of the hypothesis, we have to examine the correlation between each child’s acceptance of Condition The-Dis and his or her acceptance of Condition Each-Col. We defined ‘acceptance’ as the number of items that a child accepted in a condition. The correlation between the proportion of items accepted in Condition Each-Col and the proportion of items accepted in Condition The-Dis was measured using Spearman’s rank correlation. A significant positive correlation was found between the two conditions ($\rho=0.3$, $p<0.001$). None of the other conditions correlated significantly with Condition Each-Col.

Figure 6. shows the correlation between Condition Each-Col and The-Dis, by showing how many times each child accepted Condition Each-Col (x-axis) and Condition The-Dis (y-axis). The most important thing that has to be noticed, there are no data points in the upper left corner of the graph. Datapoints in that region would mean children that reject Condition Each-Col, but accept condition The-Dis and following the hypothesis, that combination should be impossible. This means that the results support our hypothesis.

### 3.3 Discussion

Since we replicated the experiment of Pagliarini et al. (2012), we will first compare our results to theirs. Then we will discuss a possible effect of the verbs and finally the difference between the quantifiers *iedere* and *elke* is examined.

#### 3.3.1 Comparison with Pagliarini et al. (2012)

Pagliarini et al. (2012) tested 189 children aged between 4 and 13 years old and 97 adults. The descriptive statistics of their experiment are shown in Table 4. The results suggest that children consistently accept the conditions Each-Dis and The-Col, from the age of 4 years old. This is similar to our results; we also found a consistent acceptance in these two conditions. Furthermore, the results of Pagliarini et al. (2012) show that Condition Each-Col is accepted at an age of 4 and 5 years old. From 6 years old, this condition is starting to be rejected, gradually moving toward the adult interpretation, which is reached at the age of 11. In our results, condition Each-Col is accepted till the age of 6 years old and from the age of 7 years old, children start rejecting it. The adult interpretation is reached at the age of 9 years old.

So the Dutch children of our experiment reached the adult interpretation faster than
the Italian children of Pagliarini et al. (2012).

Table 4: Results Pagliarini et al. (2012) Mean Proportion of 'Yes' Responses for each Group and for each Condition

<table>
<thead>
<tr>
<th>Age-Group</th>
<th>Proportion of 'yes' Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Each-Dis</td>
</tr>
<tr>
<td>4</td>
<td>96 (8)</td>
</tr>
<tr>
<td>5</td>
<td>100 (0)</td>
</tr>
<tr>
<td>6</td>
<td>98 (6)</td>
</tr>
<tr>
<td>7</td>
<td>100 (0)</td>
</tr>
<tr>
<td>8</td>
<td>100 (0)</td>
</tr>
<tr>
<td>9</td>
<td>100 (0)</td>
</tr>
<tr>
<td>10</td>
<td>100 (0)</td>
</tr>
<tr>
<td>11</td>
<td>100 (0)</td>
</tr>
<tr>
<td>12</td>
<td>98 (6)</td>
</tr>
<tr>
<td>13</td>
<td>99 (3)</td>
</tr>
<tr>
<td>Adults</td>
<td>96 (10)</td>
</tr>
</tbody>
</table>

For Condition The-Dis Pagliarini et al. (2012) found that younger children consistently accept this condition and that adults accept it around half of the times. Around the age of 10, children start rejecting this condition, however, even at the age of 13, they have not reached the adult interpretation. This is also the case for our results. We found that adults accept condition The-Dis around half of the times and that younger children still fully accept it. The only difference is that in our case children start rejecting this condition at a lower age, around 7 years old instead of the 10 years old that Pagliarini et al. (2012) found. So again, Dutch children seem to move toward an adult like interpretation earlier.

In the multi-level logistic regression model of Pagliarini et al. (2012), Age turned out to be a significant predictor, and so did Condition Each-Col. Furthermore two interactions were significant: Age with Condition Each-Col and Age with Condition The-Dis. Other conditions and their interactions with age were not significant. These results are also similar to our results, except for the significant effect of Age. In our results Age did not turn out to be a significant predictor (z=1.016, p>0.05), because of the minor differences between the age groups in Condition Each-Dis, which was the reference condition.

We were not only interested in the acceptance rates of the separate conditions, we also wanted to examine whether or not the acceptance of condition Each-Col played a role in the acceptance of Condition The-Dis. Do children who reject condition Each-Col, also
reject condition The-Dis, and vice-versa? We performed a correlation test and found a significant positive correlation between the two conditions ($\rho=0.3$, $p<0.001$). Pagliarini et al. (2012) also found a significant positive correlation between these conditions, using Spearman’s Rank Correlation ($\rho=0.5$, $p<0.001$) (Figure 7b).

The most important thing to notice is that there are no data points in the upper left corner of both graphs (See, Figure 7). This means that both experiments did not have any results that show children who reject Condition The-Dis, but accept condition Each-Col. Both of the experiments, ours and the one of Pagliarini et al. (2012) support our prediction that the rejection of distributive readings with non-quantificational noun phrases (Condition The-Dis) correlates with the rejection of the quantifier each in the collective context (Condition Each-Col). The rejection of the quantifier each predicts whether or not distributive readings are rejected with plural definites (non-quantificational noun phrases).

In summary, our results are overall similar to the results of Pagliarini et al. (2012). However, there are some minor differences. The biggest difference lies in the acceptance rate of condition Each-Col (the quantifier ‘each’ in the collective context). The results of Pagliarini et al. (2012) show that adults accept this condition around 9% of the times, whereas in our results this adult acceptance rate turned out to be higher, around 36%. Why is this the case? The two following sections discuss possible explanations.

3.3.2 Effect of the Verbs

The difference between the acceptance rates of condition Each-Col, might be due to the difference in used verbs. In the introduction we mentioned the difference between two types of distributivity: dependent and independent distributivity. In short, dependent distributivity involves different objects. So with the example sentence: The boys pushed a car, the boys pushed two different cars. This type is called dependent, because which
car is pushed depends on which boy we are talking about. In independent distributivity the object is the same: the boys pushed the same car, but one boy after the other. In our experiment we chose to use only dependent distributivity and this is also the case in the experiment of Pagliarini et al. (2012). However, in some cases in which we presented the collective context, the objects we used might be classified as independent distributivity, rather than just collectivity. Pagliarini et al. (2012) also mentioned this problem, and they marked the verbs ‘painting’ and ‘eating’ to belong to this category. They gave the following example: The boys are eating a pizza, with a picture with two boys eating one pizza. This picture is highlighting the independent distributive reading rather than the collective reading. The boys are not eating one pizza together, but they are eating the same pizza one after the other. This difference in context might affect the acceptance rate of condition Each-Col (the quantifier each/every in the collective context), because the quantifier each/every in combination with the independent distributive context is true, whereas the quantifier each/every in combination with the collective context is false. Pagliarini et al. (2012) were aware of this problem and they tested whether or not the verbs ‘eat’ and ‘paint’ showed different patterns than the other verbs. This was not the case and they concluded that the participants did not interpret Condition Each-Col as the dependent distributive context, but as the intended collective context.

In our experiment we wanted to avoid this problem as much as possible, so we decided to change some of the verbs that Pagliarini et al. (2012) used. ‘Eat’ and ‘paint’ were replaced by ‘push’ and ‘pull’. We believe that ‘repair’ falls in the same category as ‘eat’ and ‘paint’, so we replaced it with ‘wash’. We acknowledge that ‘wash’ might also be in the same category as ‘eat’ and ‘paint’, but ‘wash’ is easier to draw, making sure that it is clear that in the collective context the subjects are really washing the same object at the same time. We also noticed that ‘lift’ is too similar to ‘carry’ and too difficult to draw appropriately, we therefore decided to replace it with ‘hold’. For every verb we tried to create the pictures as natural as possible, with normal sized objects and real-life situations. However even with the replacement of some of the verbs, we still found a higher acceptance rate as expected (36%). Even higher than the results of Pagliarini et al. (2012) (around 9%).

To make sure that the results of condition Each-Col are not due to the verb problem mentioned above, we tested whether some of the verbs had significantly different acceptance rates compared to the others. Only the condition Each-Col is of interest in this case, so we excluded the other conditions from further analysis. We analyzed the difference between the verbs by using mixed effect linear models. The final model contained the response as the dependent variable and verb as a predictor. We also included two random effects for the intercept: AGE and PARTICIPANTS.
Table 5 reports the results of the mixed effect linear model. The model shows no significant difference between any of the verbs. Figure 8 shows a Q-Q plot showing the distribution of the verbs. The verbs ‘wash’ and ‘hold’ deviate the most, but looking at the results of table 5, these differences are not significant. All the verbs equally influenced the results. So we can conclude that the difference in our verbs had no significant effect on the acceptance rate of condition Each-Col. The verbs ‘wash’ and ‘build’ were not interpreted as independent distributive, instead of collective.

However, this still doesn’t explain why the acceptance rate of condition Each-Col is as high as 36%. Pagliarini et al. (2012) highlighted the problem, but they left the exploration to future research. The next section discusses another possible explanation for the high acceptance rate of the Condition Each-Col and the difference between the acceptance rates of the two experiments (9% vs. 36%).

Table 5: Fixed effects of the model examining the difference between the verbs

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Estimate</th>
<th>SE</th>
<th>z-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.6720</td>
<td>0.9636</td>
<td>7.962</td>
<td>1.7e-15</td>
</tr>
<tr>
<td>Carry</td>
<td>0.6084</td>
<td>0.5553</td>
<td>1.096</td>
<td>0.273</td>
</tr>
<tr>
<td>Push</td>
<td>-0.1405</td>
<td>0.5302</td>
<td>-0.265</td>
<td>0.791</td>
</tr>
<tr>
<td>Hold</td>
<td>0.6084</td>
<td>0.5554</td>
<td>1.096</td>
<td>0.273</td>
</tr>
<tr>
<td>Pull</td>
<td>0.2939</td>
<td>0.5430</td>
<td>0.541</td>
<td>0.588</td>
</tr>
<tr>
<td>Wash</td>
<td>-0.4098</td>
<td>0.5244</td>
<td>-0.781</td>
<td>0.435</td>
</tr>
</tbody>
</table>

Figure 8: Q-Q plot showing the distribution of the verbs
3.3.3 Iedere vs. Elke

Another difference with the experiment of Pagliarini et al. (2012) that we did not mention before is concerned with the quantifier ‘each’. In Dutch it is possible to translate ‘each’ with either *iedere* or with *elke*. We conducted our experiment using the quantifier *iedere*, assuming that there is no difference between the meaning of *iedere* and *elke*. However, after we conducted our experiment and the results of Condition Each-Col turned out to be different, we tried to look for an explanation. Tunstall (1998) discusses a possible difference between the English quantifiers *each* and *every*, which are equivalents of the Dutch quantifiers *elke* and *iedere*.

*Each* and *every* are both distributive universal quantifiers, all the other universal quantifiers are not (*most, some, all*). Tunstall (1998) states that *each* and *every* are interchangeable most of the times, but *each* is more strongly distributive than *every*. She claims that this property arises because *each* requires a completely distributive event structure, while *every* only requires a partially distributive event structure. Tunstall (1998) provides the following example sentences (10) and (11):

(10) Ricky weighed *each/every* apple from the basket.
(11) Jake photographed *each/every* student in the class.

Consider sentence (10) under the following situation: the basket contains 5 apples and Ricky weighed the first three apples by themselves, but the last two apples together. *Every* can describe this situation perfectly, but *each* cannot, because *each* requires a complete distributive situation/event, which entails that no two apples could have been weighed at the same subevent. The same goes for sentence (11), *each* can only be used, if no two students were photographed together and all the students were photographed separately. The most important point from Tunstall (1998)’s claims is the fact that *every* is partially distributive, objects can be affected individually, but also in subgroups. This in contrast to *each* which requires a fully distributive context. This particular difference between *each* and *every* can serve as an explanation for the relatively high acceptance rate of condition Each-Col in our experiment. In contrast to Pagliarini et al. (2012), we used the quantifier *iedere* instead of *elke*, suggesting partial distributivity rather than full distributivity, which could have been obtained by using *elke*. Looking back, condition Each-Col involved the quantifier *iedere* in the collective context. The expected answer in this condition is ‘no’, because not every subject is performing the action by itself, but they are performing it together. However, because we used *iedere*, it might be correct to answer ‘yes’. This characteristic of the quantifier *iedere* could have made participants wonder about the situation and eventually leading them to accept the condition. To further investigate this possible explanation, we conducted a follow-up experiment, replacing the quantifier *iedere* with the quantifier *elke*. The details of this experiment can be found in chapter 5.
Before looking at a possible difference between the quantifiers *iedere* and *elke* it’s important to look at the preferences of adults. Tunstall (1998) assumes that the quantifier *every* is partially distributive, which indicates that it can also be interpreted as collective. So, she claims that both interpretations are accessible, but are they equally accessible or do adults prefer one interpretation over the other?

The next chapter examines this preference of adults. What context (collective or distributive) do adults prefer in combination with the definite plural *de* 'the' and the quantifier *iedere* 'every'. Do they show a clear preference for the distributive interpretation in combination with the quantifier *iedere* 'every', as is the case for the quantifier 'each'? Or is their preference less clear, due to the partial distributive character of the quantifier *iedere* 'every'. The results of this experiment provide information about this assumption of Tunstall (1998). Is the interpretation of the quantifier *iedere* indeed influenced by its assumed partially distributive character?
Chapter 4

Experiment 2a - Adult Preferences

Tunstall (1998) claims that the quantifier 'every' is partially distributive, in the sense that it also allows the collective interpretation. Opposed to the quantifier 'each' which is fully distributive and only allows the distributive interpretation. The Dutch quantifiers *iedere* and *elke* are assumed to be translations of the English quantifiers 'each' and 'every'. This assumption leads to the following question: Do the claims of Tunstall (1998) also hold for the Dutch quantifiers *iedere* and *elke*. Is *iedere* indeed partially distributive rather than fully distributive? The answer to this question is relevant to our research, because the assumed partial distributive character of the Dutch quantifier *iedere* could explain its high acceptance rate in the collective context of experiment 1.

In this chapter we aim to answer this question by conducting a preference task with adults. Experiment 2a examines the interpretations of the quantifier *iedere* and the definite plural *de*. The quantifier *iedere* is of special interest, due to its assumed partially distributive character. Which interpretation is preferred in this particular case? We hypothesize that the assumed partially distributive character of the quantifier *iedere* should not lead to a clear preference for the distributive interpretation. The partially distributive character should evoke some confusion between the distributive and collective interpretation, resulting in a 50/50% preference for both the interpretations. The definite plural *de* is expected to be preferred in combination with the collective interpretation.

4.1 Method

4.1.1 Participants

Forty Dutch adults aged between 18 and 59 years old (mean age 26) participated in experiment 2a of study 1. All participants were recruited through a website and were mainly students of the faculty of mathematics and natural sciences. They performed
the experiment online, without the experimenter being present and they did not receive any compensation.

4.1.2 Materials

Experiment 2a involved a preference task in a 2x1 design. The 2x1 design consisted of the factors SENTENCE (de 'the' vs. iedere 'each/every') and PICTURE. The sentences used in experiment 2a were the same as the ones that were used in experiment 1. For a detailed description see section 3.1.2.2.

4.1.2.1 Picture

The pictures used in experiment 2a were the same as in experiment 1. The only difference is that two pictures (collective and distributive) were shown at the same time and that the participants were instructed to pick the one that matched the recorded target sentence. The participants had to show their preference, rather than accepting a picture with an associated sentence as was the case in experiment 1.

![Figure 9](image)

**Figure 9:** Example picture for experiment 2a: Participants were instructed to choose between picture 1 and 2.

Figure 9 shows an example, belonging to the sentences (12) and (13):

(12) **Iedere** hond trekt een slee.
    *Every* dog pull.3Psing.PRES a sledge.
    *Every* dog is pulling a sledge.

(13) **De** honden trekken een slee.
    *The* dog.PL pull.3PP1.PRES a sledge.
    *The* dogs are pulling a sledge.
4.1.2.2 Conditions

The conditions of experiment 2a are the same as in experiment 1, except for the adjustment of the pictures.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Sentence</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition 1:</td>
<td><em>Iedere</em> 'Every'</td>
<td>sentence (12)</td>
</tr>
<tr>
<td>Condition 2:</td>
<td><em>Plural definite De</em> 'The'</td>
<td>sentence (13)</td>
</tr>
</tbody>
</table>

4.1.3 Design and Procedure

Participants are presented 24 experimental items in total, 12 per condition. In each condition, the sentences are constructed using the same verbs as in experiment 1: *vasthouden, dragen, duwen, trekken, wassen and bouwen* (in English: 'hold', 'carry', 'push', 'pull', 'wash' and 'build'). The subjects and objects were also copied.

The experiment also includes 12 filler items, to mask the idea behind the experiment, because we are conducting this experiment with adults. The filler items are constructed using the same verbs as the controls of experiment 1: *staan op, zitten op and spelen met* (in English: 'sit on', 'stand on' and 'play with'). An example of a filler item is shown in Figure 10. The sentences belonging to this filler item were: *Alleen apen spelen met een ballon* 'Only monkeys are playing with a balloon' or *De apen spelen met een ballon* 'The monkeys are playing with a balloon'. Participants had to show their preference, choosing between pictures 1 and 2. Note that for the sentence with *alleen* 'only', both pictures can be right. We chose this sentence to create some confusion, which would distract the participants from the real goal of the experiment. We did not analyse the results of the filler items further, because they only served as distractors.

![Figure 10: Example Filler item for the verb 'play with'.](image-url)
The 12 filler items and the 24 experimental items result in a total of 36 items. Two different versions of the experiment were developed in which experimental and control items are presented in random order. We also varied the positions of the collective and distributive pictures in the experimental items. Participants were assigned randomly to one of the two versions and they all received different orders. The experiment started with one practice item to introduce the experiment. The pictures were displayed on a website, with buttons for choosing picture 1 or picture 2. The participants were presented with one picture at a time, while a recorded sentence was played. They were instructed to choose the picture that matched the sentence, by clicking on either picture 1 or picture 2.

4.2 Results

All 40 participants were able to complete the experiment. Figure 11 reports the mean proportion of 'distributive' and 'collective' answers for each condition. The descriptive statistics show a clear preference for the distributive interpretation with the quantifier 'iedere' every (99%) and a clear preference for the collective interpretation with the definite plural 'de' the (97%).

![Figure 11: Results Experiment 2a - Mean Proportion of Collective and Distributive Responses per Condition](image)

The results were analysed using mixed-effect linear models. The dependent variable was the interpretation (distributive or collective). The final model contained a predictor...
CONDITION, two random effects for the intercept: PARTICIPANTS and VERBS and one random effect for the slope of the VERBS: CONDITION. The final model showed a significant Intercept \( z=-10.27, \ p<0.001 \) and a significant predictor CONDITION IEDERE 'Each-Every' \( z=13.21, \ p<0.001 \).

4.3 Discussion

The purpose of this preference task was to examine which preference in context (distributive or collective) adults have for the quantifier iedere 'every' and the definite plural de 'the'. Due to the partial distributive character of the quantifier iedere, in contrast to the fully distributive character of the quantifier elke described in the previous chapter, it was necessary to examine whether adults have any doubt in preferring the distributive context for the quantifier iedere. Does the partial distributive character of the quantifier influence their preference and are there adults who prefer the collective context in combination with the quantifier iedere?

We hypothesized that the assumed partially distributive character of the quantifier iedere should result in confusion about the appropriate interpretation, leading to a 50/50% preference for both the collective and distributive interpretation. However, the results show a clear preference for the distributive context in combination with the partial distributive quantifier iedere. 99.1% of all interpretations with the quantifier iedere were distributive, which means that only one participant chose the collective interpretation for one experimental item with the quantifier iedere. So, we can conclude that there is a clear preference for the distributive context with the quantifier iedere and a clear preference for the collective context with the definite plural de. The quantifier iedere did not cause any confusion or doubt about the possible interpretations. All participants preferred the distributive interpretation over the collective interpretation. Therefore, the results do not provide an explanation for the high acceptance rate of the quantifier iedere in the collective context in experiment 1 and they do not provide any support to the claims of Tunstall (1998).

However, we can’t rule out a possible difference between the quantifiers iedere and elke by only doing a preference task. The next chapter involves a follow-up experiment, containing the truth-value judgment task of experiment 1, replacing the quantifier iedere with the quantifier elke. This experiment can provide us evidence for the explanation that the difference in the distributive character of the two quantifiers indeed caused the high acceptance rate of the quantifier iedere in the collective context.
Chapter 5

Experiment 2b - Each vs. Every

Experiment 2b examines the adult interpretations of the quantifier *elke* and the definite plural *de*, by using a Truth-value Judgment Task (TVJT). This experiment is conducted to examine the difference between the interpretations of the quantifiers *iedere* and *elke*, by comparing the results to the results of experiment 1. It’s expected that the condition with the quantifier *elke* in the collective context will have a lower acceptance rate in comparison with the condition with the quantifier *iedere* in the collective context from experiment 1. This due to the fact that the quantifier *elke* is expected to have a fully distributive character, as opposed to the quantifier *iedere*, which can also be used in partial distributive situations (Tunstall, 1998).

5.1 Method

5.1.1 Participants

Twenty-four Dutch adults aged between 18 and 51 years old (mean age 26) participated in experiment 2b of study 1. All participants were recruited through a website and performed the experiment online, without the experimenter being present. They did not receive any compensation.

5.1.2 Materials

For experiment 2b a Truth-value Judgment Task (TVJT) in a 2x2 design was used. The 2x2 design consisted of the factors PICTURE (*collective* vs. *distributive*) and SENTENCE (*de* 'the' vs. *elke* 'each'). The pictures used in experiment 2b were the same as the ones that were used in experiment 1.

5.1.2.1 Sentence

To give a more detailed overview of our materials, we will provide a different example as provided in chapter 2 ‘Experiment 1’.
Experiment 2b contains two types of sentences: one with the quantifier *elke* ‘each’ (Sentence 14) and one with the plural definite *de* ‘the’ (Sentence 15). The sentences are all of the form Subject-Verb-Indefinite Object and were kept the same as the sentences of experiment 1, except for the adjustment of *iedere*.

### 5.1.2.2 Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Sentence</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elke ’Each’</td>
<td>Distributive picture.</td>
</tr>
<tr>
<td>2</td>
<td>Elke ’Each’</td>
<td>Collective picture.</td>
</tr>
<tr>
<td>3</td>
<td>Plural definite De ’The’</td>
<td>Distributive picture.</td>
</tr>
<tr>
<td>4</td>
<td>Plural definite De ’The’</td>
<td>Collective picture.</td>
</tr>
</tbody>
</table>

The conditions of experiment 2b are the same as in experiment 1, except for the adjustment of *iedere*. For a detailed description go back to section 3.1.2.3. Figure 12 provides the pictures belonging to sentences (14) and (15).

The four possible conditions in summary:

Figure 12: A. Distributive Interpretation  B. Collective Interpretation
5.1.3 Design and Procedure

The design and procedure of experiment 2b are the same as in experiment 1. For a detailed description go back to section 3.1.3.

5.2 Results

All 24 participants were able to complete the experiment. Participants answered incorrectly to control items 0.5% of the times (only one person answered incorrectly to one control item). Figure 13 reports the mean proportion of 'yes' answers for each condition. The descriptive statistics show a full acceptance for conditions Elke-Dis and De-Col. Condition De-Dis gets accepted around half of the times. Condition Elke-Col is accepted the least, with an acceptance rate of 36.8%.

The results were analysed using mixed-effect linear models. The dependent variable was the response (0 for a 'no' answer rejecting an item, 1 for a 'yes' answer accepting an item). The predictor was CONDITION. Two random effects for the intercept were included: PARTICIPANTS and VERBS. We also included one random effect for the slope of the VERBS: CONDITION.

The resulting model (Table 6) shows a significant INTERCEPT (z=2.9, p<0.001) and two significant predictors: CONDITION ELKE-COL (z=-3.2, p<0.001) and CONDITION DE-DIS (z=-2.81, p<0.001). CONDITION DE-COL turned out to be not significant.
Table 6: Fixed effects of the maximally best fitting logistic mixed-effects model

Formula

\[
\text{Response} \sim \text{Condition} + (1 + \text{Condition} | \text{Verbs}) + (1 | \text{Participants})
\]

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Estimate</th>
<th>SE</th>
<th>z-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept **</td>
<td>7.055</td>
<td>2.407</td>
<td>2.931</td>
<td>0.00338</td>
</tr>
<tr>
<td>Elke - Col  **</td>
<td>-7.747</td>
<td>2.396</td>
<td>-3.233</td>
<td>0.00123</td>
</tr>
<tr>
<td>De - Dis **</td>
<td>-6.921</td>
<td>2.449</td>
<td>-2.826</td>
<td>0.00471</td>
</tr>
<tr>
<td>De - Col</td>
<td>-2.589</td>
<td>2.399</td>
<td>-1.079</td>
<td>0.28061</td>
</tr>
</tbody>
</table>

The results show that Conditions Elke-Col and De-Dis are rejected more than the other two conditions, which are accepted almost all the time. We also performed a pairwise comparison using the same mixed effect linear model to examine the difference between the conditions in more detail. Table 7 reports the results.

Table 7: Results of Pairwise Comparison Experiment 2a

<table>
<thead>
<tr>
<th>Cond.</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>z-Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 1 **</td>
<td>-7.7466</td>
<td>2.3961</td>
<td>-3.233</td>
<td>0.00523</td>
</tr>
<tr>
<td>3 - 1 *</td>
<td>-6.9211</td>
<td>2.4489</td>
<td>-2.826</td>
<td>0.01859</td>
</tr>
<tr>
<td>4 - 1</td>
<td>-2.5889</td>
<td>2.3995</td>
<td>-1.079</td>
<td>0.66450</td>
</tr>
<tr>
<td>3 - 2</td>
<td>0.8255</td>
<td>0.3494</td>
<td>2.363</td>
<td>0.06745</td>
</tr>
<tr>
<td>4 - 2 ***</td>
<td>5.1577</td>
<td>0.6412</td>
<td>8.044</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>4 - 3 ***</td>
<td>4.3322</td>
<td>0.6800</td>
<td>6.371</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

All combinations turn out to be significantly different, except for the combinations 4 - 1 and 3 - 2. Conditions De-Col and Elke-Dis are both almost fully accepted and therefore not significantly different. Condition Elke-Col is rejected more often than Condition De-Dis, but it turned out to be no significant difference.

5.3 Discussion

The purpose of this experiment was to examine the possible difference between the quantifiers elke and iedere ('each' and 'every' in English), because a difference between these two quantifiers could explain the difference between the acceptance rates of condition Each-Col (the quantifier iedere in the collective context) from experiment 1 and the experiment of Pagliarini et al. (2012).

Figure 14 and 15 show the descriptive statistics for the adults of experiment 1 and experiment 2b. It immediately becomes clear that the results are virtually identical, except for some minor differences. There is no significant difference between any of the conditions.
We included the factor EXPERIMENT to the mixed effect linear model of experiment 1 (including the results of the participants from the experiment with the quantifier elke) and it did not turn out to be a significant predictor (z=0.754, p=0.451). Neither did the interactions with the different conditions.

Especially the conditions Elke-Col and Iedere-Col were of interest, because the Iedere-Col condition showed the biggest difference between experiment 1 and the experiment of Pagliarini et al. (2012). However, the acceptance rate of the Elke-Col condition turned out to be 36.8%, in comparison with the 36.3% of the Iedere-Col condition. This means that the replacement of the quantifier iedere with the quantifier elke did not change the results. The difference between these quantifiers therefore doesn’t serve as evidence for the difference in acceptance rates between experiment 1 and the experiment of Pagliarini et al. (2012). However, why didn’t we find any differences in results when changing the quantifier? What about the claims of Tunstall (1998) about partial distributivity?

5.3.1 Each/Every vs. Elke/Iedere

Tunstall (1998) made her claims about the English quantifiers each and every. The Dutch equivalents of these quantifiers are elke and iedere, but are they actually equivalents? Let’s have a look at the differences between the English quantifiers each and every and check whether these differences also apply to the Dutch quantifiers elke and iedere.

As previously mentioned, Tunstall (1998) proposes a semantic distinction between each and every. Each only allows fully distributive events, whereas every also allows partial distributive events. Is this also the case for elke and iedere? We previously mentioned the example sentence of Tunstall (1998) (16). In the context that Ricky weighed the first three apples by itself and the last two apples together.
(16) Ricky weighed each / every apple from the basket.
(17) Rik woog elke / iedere appel uit de mand.

The quantifier each can only be used if the apples are all weighed individually, and not together. For every this is different, because every can also be used in the case that multiple apples were weighed at the same time. This explains the partial distributive character of the quantifier every. In addition to the semantic distinction mentioned by Tunstall (1998), Roeper et al. (2011) also mention several other distinctions:

1. Every is generic: 'Does every cow have one tail (every cow in the world).
   Each is specific: 'Does each cow have one tail (presupposes a defined set).

2. Each only allows a partitive:
   a. Each of the boys.
   b. Every of the boys.

3. Each can float, but every cannot:
   a. Each boy has a bike. The boys each have a bike.
   b. Every boy has a bike. The boys every have a bike.

In contrast to each and every, there is not much known about the difference between elke and iedere in Dutch. However it is possible to compare them with the distinctions posed by Roeper et al. (2011) and Tunstall (1998), because there are some differences. The first thing to mention is that the semantic distinction posed by Tunstall (1998) is less strong in Dutch as it is in English. The difference in distributive events is less noticeable. Vendler (1967) states that the difference between each and every can be explained as follows: "every stresses completeness, or exhaustiveness, each on the other hand directs one’s attention to the individuals as they appear". Dik (1974) states that a difference of this kind in English has not yet been established in Dutch, and if it is present, it is less prominent as it is in English.

The second difference lies in the fact that in Dutch both iedere and elke can float, as can be seen in sentences (18) and (19).

(18) Elke jongen heeft een fiets. De jongens hebben elk een fiets.
(19) Iedere jongen heeft een fiets. De jongens hebben ieder een fiets.

There is another difference between the English each and every and the Dutch iedere and elke. When elke and iedere are placed before a noun, they have to be inflected according to the gender of the noun, which is not the case in English.

In Dutch there are two determiners de and het. Every noun belongs either to the determiner de or to the determiner het. When the noun belongs to the determiner de both
*iede* and *elk* have to be inflected with an -e, so they become *iedere* and *elke*. When the noun belongs to the determiner *het*, we say *iede* and *elk*.

This distinction is also present in our experiment, because we used different subjects: *jongens, meisjes, apen en honden*. The noun *meisje* is a *het*-noun, which means that *iede* and *elk* don’t have to be inflected with an -e. This is not the case for the other subjects we used.

Besides from these differences, there is another distinction between *iedere* and *elke* which is not present in English. In Dutch there is a tendency to use *iedere* for persons and to use *elke* for things. Dik (1974) illustrates that the affinity of *iedere* with human complement is demonstrated by the fact that the quantifier *iedere* originates from *een ieder*, which is a more archaic variant of *iedereen* ‘everyone’. This origine is illustrated by an example shown in sentence (20).

(20 a.) Iedereen die deelneemt moet een lezing houden.
(20 b.) Een ieder die deelneemt moet een lezing houden.
(20 c.) Ieder die deelneemt moet een lezing houden.

*Everyone who participates must hold a lecture.*

(20 c) is only possible when humans are involved. This property of the quantifier *iede* is not applicable to the quantifier *elke*, because ’een elk’ and ’elkeen’ are ungrammatical.

The previously mentioned differences all show that *each* and *every* and *iedere* and *elke* might differ more from each other than initial impressions suggest. The distinction between *iedere* and *elke* might be less noticeable, as it is between *each* and *every*. This assumption could explain our results, where we found no significant difference between *iedere* and *elke*.

Another finding that partially supports our results comes from Roeper et al. (2011). They predicted that children show incomplete lexical learning, to the extent that are not able to distinguish between *each* and *every* and that those two quantifiers would have the same semantic properties for them. They indeed found that children -although unlike adults- did not distinguish between *each* and *every*. So in English children learn to distinguish between *each* and *every* when they have a full lexical understanding. However in our experiment the adults did not show any difference between the quantifiers *iedere* and *elke*, so this might indicate that there are less lexical differences between *iedere* and *elke* as there are in English. Further research is necessary to examine this hypothesis.
Chapter 6

Conclusion Study 1

In study 1 we tested the hypothesis that the acquisition of *iedere* 'each/every' should correlate with the rejection of the definite plural *de* 'the' in the distributive context, due to conversational implicature: a definite plural noun phrase, such as *the boys* will not be interpreted distributively, because if the speaker had meant the distributive interpretation, he or she would have used the unambiguous quantifier *each*.

This leads to the prediction that participants who understand that *iedere* in the collective context is marginal, will also understand that *de* in the distributive context is less appropriate than in the collective context. To make an even more stronger claim we also predicted that this correlation will hold at the level of the individual child. In other words the level of the acquisition of *each* predicts whether children will reject the distributive reading of the definite plural *de* or not.

The results show that children indeed learn to reject the collective reading of *each* before they learn to reject the distributive reading of the plural definite *the*. We also found a significant positive correlation between the conditions 'Each-Collective' and 'The-Distributive'. As expected, individual children who acquired the meaning of each, also rejected the plural definite *the* in the distributive context. Therefore, the results support our hypothesis.

However, we also found some unexpected results: the acceptance rates of the conditions 'Each-Collective' and 'The-Distributive' both turned out to be higher as expected for the adult group, with rates of 36% and 52%. An analysis of the verbs in experiment 1, showed that these high percentages were not due to a difference between the verbs. All verbs had equal influence on the results.

In experiments 2a and b, we tried to look for another explanation. We hypothesized that the quantifier *iedere* might have a partial distributive character rather than a fully distributive character. However, the results of experiment 2a show us that adults do
prefer the distributive interpretation for the quantifier *iedere* and the collective interpretation for the definite plural *de*. They did not show any signs of confusion in choosing the distributive interpretation for the quantifier *iedere*.

The results of experiment 2a did not satisfy us, so therefore we conducted experiment 2b, to check for a possible difference between the quantifiers *iedere* and *elke*, examining the partial distributive character of the quantifier *iedere*. This proposed partial distributive character could explain the high acceptance rate of 36% in the ‘Each-Collective’ condition. However, the results of this experiment turned out to be virtually identical to the results of experiment 1. We did not find a significant difference between the quantifiers *iedere* and *elke*. We therefore have to conclude that the quantifier *iedere* is less distributive than expected. The same goes for the definite plural *de*, we expected this to be fully collective, but it turned out to be weakly distributive. Further research is necessary to examine these particular conditions.

The next chapter continues with Study 2. In Study 2 we aim to find a relationship between distributivity and the adjective of comparison *andere* ‘different’.

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The complete materials of study 1 can be found in Appendix A.
Chapter 7

Study 2

The relationship between distributivity and the AOC ‘Different’

7.1 The sentence-internal reading of ‘different’

Besides markers as ‘each’ and ‘every’ there are other ways to enforce the distributive interpretation. The literature often connects distributivity with adjectives of comparison, used to compare different elements in language. It’s assumed to be the basis of the sentence-internal reading of such adjectives. Study 2 aims to find the assumed relationship between the adjective of comparison ‘different’ and the phenomenon of distributivity. Is understanding the sentence-internal reading of the adjective of comparison ‘different’ related to an understanding of distributivity? This is examined by using a TVJT involving the definite plural ‘the’ and the quantifier ‘each/every’.

Before we go into the details of this experiment, we first provide an introduction to the connection between the adjectives of comparison and distributivity.

In most languages it’s possible to compare two elements and express a difference or similarity between them. Words such as ‘same’ and ‘different’ involve such an implicit comparison, hence they are called adjectives of comparison (AOCs). AOCs are mostly used in sentences like ‘this is the same book as I read yesterday’, in which a comparison is made between ‘this book’ and the book I read yesterday. The presence of the word ‘as’ immediately suggests a comparison between two or more comparative elements. However, in some cases the comparison is not that obvious, lacking markers such as ‘than’ and ‘as’. Take for example (21) below:

(21) a. Frank read ‘Harry Potter and the Chamber of Secrets’.
    b. Mark read the same / a different book.

In (21) the covert comparison is made between something in the current sentence (a certain book in this case) and something that is understood by the listener as already
defined in the earlier discourse (in this case 'Harry Potter and the Chamber of Secrets'). This interpretation is called a sentence-external reading, because the comparison is made between an element in the current sentence, and a sentence-external element mentioned in the previous discourse functioning like an antecedent. The sentence-external reading is not the only possible reading, AOCs can also compare sentence internally. In the sentence-internal reading the antecedent is provided by subject argument of the same clause, without referring to a previously mentioned element in the discourse.

(22) a. Two students read the same / a different book.  
   b. The students read the same / a different book.  
   c. All the students read the same / a different book.

Sentence (22) shows examples of sentence-internal readings, in which the comparison is made between referents introduced in the same clause. Each of the examples in (22) contains a plural NP subject. This is necessary and explains why the sentence-internal reading is not possible in example (21). Note that if we change example (21b) by making the singular subject a plural subject via coordination, as in (21b’), the sentence internal reading becomes possible:

(21b’) Mark and Frank read the same / a different book.

Example (21b’) clearly shows that a sentence-internal reading is made possible by the presence of a plural NP. Such an NP will be referred to as a licensing NP, the NP that is licensed is called a dependent NP.

### 7.2 ‘Different’ and Distributivity

Carlson (1987) claims that it is not simply the property of morphological or syntactic plurality that is crucial for the sentence-internal reading, as there are phrases that are grammatically singular that license the AOCs 'same’ and ‘different’, as shown in sentence (23).

(23) Each student read the same / a different book.

Carlson (1987) proposes that some further property is responsible, most accurately described as the semantic notion of distributivity. He supports his claims with the evidence that NPs capable of a distributive reading also have a collective reading associated with it. Carlson (1987) claims the distributive interpretation to be the basis of the sentence-internal reading of the AOCs ‘same’ and ‘different’. He proposes this for the fact that the distributive/collective ambiguity disappears in the presence of the AOC 'different' in the sentence-internal reading.

Sentence (24) clearly shows that the presence of the AOC 'different' results in only a distributive reading:
Sentence (24) in the sentence-internal reading does not provide a collective interpretation in which the boys are acting together. There must be at least two boys and two cars for the sentence to be true. In summary, Carlson (1987) claims that the AOCs 'same' and 'different' are licensed by the presence of a distributively-interpreted NP within the same scope domain as the dependent NP. It’s well known that not all plural NPs are able to license sentence-internal readings of AOCs and it is also has been found that many NP’s can only license some AOC’s. Brasoveanu (2011) provides a summary of the previous literature concerning sentence-internal ‘different’ and its possible licensors.

For the purpose of our research we will focus on the licensors ‘the’ and ‘each’, the distributivity markers that are examined in study 1.

(24) The boys are pushing different cars.

<table>
<thead>
<tr>
<th>(25) Each ( u_0 ) boy recited a ( u_1 ) different ( u_1 ) poem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(26) a. ( \emptyset ) ⇒ ( \text{Each}^u_0 \text{boy} ) ( \text{dist}_{u_0} ) (recited a ( u_1 ) different ( u_1 ) poem)</td>
</tr>
<tr>
<td>b. { i. ( u_0 ) ( u_1 ) ( \text{boy}_1 \text{poem}_1 ) ( \text{boy}_2 \text{poem}_2 ) &amp; ( \text{poem}_1 \neq \text{poem}_2 )</td>
</tr>
<tr>
<td>c. ( \text{sum all updates} ) ⇒ ( u_0 ) ( u_1 ) ( \text{boy}_1 \text{poem}_1 ) ( \text{boy}_2 \text{poem}_2 ) ( \text{boy}_3 \text{poem}_3 )</td>
</tr>
</tbody>
</table>

There is a long tradition of connecting the sentence-internal reading of AOC’s with distributivity. Subsequent discussions in the literature all accept the assumption of Carlson (1987) and it forms the basis of all the analyses of the AOC ‘different’ (e.g. Moltmann, 1992; Beck, 2000; Barker, 2007). To make the connection even more clear, we will now provide an analysis of the AOC ‘different’ in a dynamic semantics system proposed by Brasoveanu (2011). Sentences (25) and (26) show this system.

Sentences (26a - c) show a sequence of updates caused by Sentence (25). The update caused by each boy stores all the boys in a variable, \( u_0 \) (shown in the one-column table
in sentence (26a). The distributive operator dist distributes over all the boys in three steps: (i) pick two distinct boys, (ii) check that each of the two boys recited a poem and (iii) check that the two poems are different. This procedure is shown in sentence (5bi-v) and repeated for any pair of boys in the set \( u_0 \), necessary to verify sentence (25). This example serves to clarify the connection by showing that the dist operator distributes over pairs of individuals in order to license sentence-internal 'different'. In other words, the phenomenon of distributivity is necessary to interpret the sentence-internal reading of the AOC 'different'.

### 7.3 Assumed Parallelism

This explanation is supported by a found parallelism between the ‘strength’ of distributivity markers and the gradience of acceptability of sentence-internal 'different' licensors. Dotlacil (2010) observed that the distributive interpretation of sentences like 'pushing a car' depends on the type of subject. The accessibility of the distributive interpretation is shown in (27), where > means that the NPs on the left are more likely to strengthen the distributive interpretation than the NPs on the right.

\[
(27) \text{Distributive interpretation: } \text{EACH} > \text{ALL} > \text{THE}
\]

Regarding the strength of the licensors, there is not much known about whether or not plural NPs can be described as either licensing or not-licensing the sentence-internal reading of an AOC. Brasoveanu and Dotlacić (2012) state that licensing is more fine-grained, and plural NPs can be licensors for the sentence-internal reading in varying degrees. To examine this gradience, they conducted an experiment to examine which NPs license which AOCs in English and to what extent. They used questionnaires to test people’s intuitions about sentence-internal readings of three AOCs, same, different and similar, with four licensors, NPs headed by each, all, none and the (\( 3 \times 4 = 12 \) conditions in total). Participants were asked to judge each item with respect to truth: whether the item was true or not given the accompanying scenario, and acceptibility: how acceptable is the item (licensor) on a 5-point scale. For the purpose of our study, we are only going to discuss the results of the AOC 'different'. The gradience of acceptability associated with sentence-internal readings of 'different' is listed in example (28):

\[
(28) \text{Different: } \text{EACH} > \text{ALL} > \{\text{THE, NONE}\}
\]

It immediately becomes clear that the gradience in strength of the distributivity markers (27) is the same as the gradience of acceptability of the sentence-internal 'different' licensors (28). This parallelism provides support for the assumption that sentence-internal reading of 'different' requires distributivity to be licensed.
7.4 Conclusion

The parallelism found in the study of Brasoveanu and Dotlačil (2012) greatly supports the idea of a relationship between distributivity and in special the AOC ‘different’. In Study 1 we examined the interpretations of the distributivity markers de ‘the’ and iedere ‘each’. It’s interesting to examine whether the sentence-internal reading of ‘different’ is related to our findings of Study 1. Does the sentence-internal reading of the AOC ‘different’ indeed require distributivity? We are going to examine this relationship by doing two experiments. Experiment 1a, described in the next chapter, will examine the readings of the AOC ‘different’ in combination with the licensors de ‘the’ and iedere ‘each’. Following the parallelism, we hypothesize that the strong marker of distributivity ‘each’ will lead to the internal reading. The weak marker ‘the’ on the other hand is expected to lead to the external reading. We are not only interested in the assumed relationship, but we also want to know how this assumed relationship develops in children. Is the development of distributivity related to the preference for a certain reading of ‘different’? We hypothesize that the preference for the distributive interpretation in children will lead to an overall preference for the internal reading of ‘different’. The preference for the collective interpretation in adults is expected to lead to the external reading in combination with the definite plural ‘the’. To examine this relationship further we will also perform a correlation test between the results of Study 1 and Study 2. To check if the external reading of ‘different’ in combination with the definite plural ‘the’ is related to a rejection of the distributive reading in combination with ‘the’.

The second experiment 1b is conducted to check adults preferences for either the internal or the external reading of ‘different’ in combination with the quantifier iedere ‘each’ and the definite plural de ‘the’. This is interesting, because it is necessary to check if adults indeed show the clear the preferences, following from the parallelism. Those preferences can’t be found using a TVJT as in experiment 1a.

The results do not show a clear relationship between the AOC ‘different’ and distributivity. Due to the complex character of experiment 1a, we are not able to draw clear conclusions. However, we do believe that distributivity is related to the sentence-internal reading of ‘different’. The results of Study 1 can be connected to the results of Study 2 and will be further discussed in chapter 11.
Chapter 8

Experiment 1a - TVJT examining the AOC ‘different’

Previous research has claimed that there is a parallelism between the AOC ‘different’ and distributivity. Not much research has been dedicated to this assumed relationship and its development in children. This lead to experiment 1a, in which we are going to examine the assumed relationship between distributivity and the AOC ‘different’. As in Study 1 we will conduct the experiments of Study 2 in Dutch, examining the Dutch AOC andere. This will be done by using a TVJT with two factors PICTURE and SENTENCE. The pictures are either non-parallel or parallel and the sentences either start with the definite plural ‘the’ de or the quantifier ‘each/every’ iedere as licensors (note that these licensors were also used in the experiments of Study 1 as distributivity markers). The details of the TVJT will be discussed in the method section of this chapter.

The research question whether or not the sentence-internal reading of ‘different’ is dependent on distributivity will be examined by means of two subquestions:

1. Does the parallelism between the distributivity markers and sentence-internal ‘different’ licensors exist? Is there a difference in acceptability of the sentence-internal reading between the distributive quantifier ‘each’ and the weakly distributive definite plural ‘the’?

2. Is a preference for the distributive interpretation related to a preference for the sentence-internal reading of ‘different’?

The assumed parallelism between the distributivity markers and the sentence-internal ‘different’ licensors plus the results of Study 1 lead to the following hypothesis:

The results of Study 1 showed that the definite plural ‘the’ de indeed is a weak marker for distributivity, we therefore hypothesize that it will also be a weak licensor for sentence-internal ‘different’. The results of Study 1 showed that ‘each/every’ iedere is a strong
marker for distributivity, leading to the prediction that it also will be a strong licensor for sentence-internal ‘different’.

In the background section of Study 1, we discussed several findings regarding distributivity research, concerning both adults and children. From this short review it became clear that adults prefer the collective interpretation in combination with plural arguments (such as the definite plural ‘the’) whereas children prefer the distributive interpretation. The addition of the quantifier ‘each’ serves as a strong marker for distributivity for adults. Children on the other hand don’t have this intuition, they are not aware of the lexical semantics of ‘each’.

The background section of Study 2 discussed the assumption that the distributive interpretation is necessary to interpret the sentence-internal reading of the AOC ‘different’. The external reading on the other hand does not require distributivity. We predict that children will be drawn to the sentence-internal reading of ‘different’, for both the quantifier ‘each’ and the definite plural ‘the’, due to their preference for the distributive interpretation in combination with plural arguments. Adults on the other hand are expected to get the sentence-external reading of ‘different’ in combination with the definite plural ‘the’, because of their preference for the collective interpretation. Sentences with the quantifier ‘each’ will force the distributive interpretation for adults, resulting in the sentence-internal reading of ‘different’.

To answer the main research question whether or not the sentence-internal reading of *andere* ‘different’ requires distributivity, we will also perform a correlation test between Study 1 and Study 2 (Study 2 is conducted with the same children as Study 1). In Study 1 we examined the acquisition of distributivity and we now want to know whether or not this acquisition plays a role in the interpretation of sentence-internal ‘different’. We predict that children who acquired adult-like distributivity/collectivity intuitions in Study 1 (rejecting the distributive interpretation in combination with the definite plural *de* ‘the’, will also reject the definite plural *de* in the context of the internal reading. Interpreting *de* ‘the’ as a weak licensor for the sentence-internal reading of ‘different’.

The following table summarizes our predictions:

<table>
<thead>
<tr>
<th>Adults and Children rejecting The-Dis from Study 1</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>Reading</td>
</tr>
<tr>
<td>The</td>
<td>Collective -</td>
</tr>
<tr>
<td>Each</td>
<td>Distributive -</td>
</tr>
</tbody>
</table>
8.1 Method

8.1.1 Participants

86 Dutch children aged between 6 and 9 years old and 52 Dutch adults participated in experiment 1a of study 2. The participants were divided into 5 different age-groups. The main features of these groups are summarized in Table 9. All children were recruited from the same primary school in Groningen and also participated in experiment 1 of study 1 (Chapter 3). We chose to leave out the 5 year old children in study 2, because they turned out to be too young to remain focused. The adults were recruited through a website and did not participate in study 1.

The children were tested individually by the experimenter, in a quiet classroom at their school. The adults performed the experiment online, without the experimenter being present. They did not receive any compensation.

<table>
<thead>
<tr>
<th>Age-Group</th>
<th>Number of Participants</th>
<th>Group Mean Age (with SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>6*</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>7*</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>8*</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>9*</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Adults</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>76</td>
</tr>
</tbody>
</table>

* Same Participants as in Experiment 1

8.1.2 Materials

For experiment 1a a Truth-value Judgment Task (TVJT) in a 2x2 design was used. The 2x2 design consisted of the factors PICTURE (non-parallel vs. parallel) and SENTENCE (de ‘the’ vs. iedere ‘each/every’).

8.1.2.1 Picture

Figure 16a shows the non-parallel picture and figure 16b shows the parallel picture. The names of the pictures represent the way the pictures are drawn. In the non-parallel picture the two subjects (in this case girls and boys) perform the action differently.
Figure 16: Two Picture Types
The girls push the same car one after the other and the boys push three different cars at the same time. In the parallel picture both the girls and the boys push the same car one after another. However the two cars are different. Hence the names of the pictures. The pictures have to be 'read' like little comics. Stressed by the numbers from 1 till 4 in the corners of each subpicture, highlighting the order of the events.

The two types of pictures are chosen in the context of an internal reading and external reading. Take the sentence "The boys are pushing a different car" as an example. For the non-parallel picture this sentence is only true in the sentence-internal reading (only looking at the boys). For the parallel picture it’s only true in the sentence-external reading (comparing the boys to the girls).

8.1.2.2 Context

Each experimental item consists of a picture and a target sentence. However each picture is also accompanied by a short context story explaining the events in the comic style picture. The following stories show the context belonging to the pictures of 16a and b, the actual Dutch text is shown after an English translation:

**NON-PARALLEL:**
There are three cars, a green one, a blue one and a red one. The girls are pushing the green car one after another. The first boy is also pushing the green car. The second boy is pushing the blue car and the last boy is pushing the red car.

*Er zijn drie auto’s, een groene, een blauwe en een rode. De meisjes duwen om de beurt de groene auto. De eerste jongen duwt ook de groene auto. De tweede jongen duwt de blauwe auto en de laatste jongen duwt de rode auto.*

**PARALLEL:**
There are two cars, a green one and a blue one. The girls are pushing the green car, one after another. The boys are pushing the blue car, one after another.

*Er zijn twee auto’s, een groene en een blauwe. De meisjes duwen om de beurt de groene auto. De jongens duwen om de beurt de blauwe auto.*
8.1.2.3 Sentence

The target sentence was asked after the context story was played. Each target sentence consists of a short context sentence and a question, containing either the quantifier *iedere* or the definite plural *de* with the adjective of comparison 'different' *andere*. Sentence (29) shows the target sentences belonging to the pictures 16a and b, again first an English translation before the actual Dutch target sentences.

(29)

The girls were pushing the same green car.

(1) Is it true that the boys pushed a different car?

(2) Is it true that each boy pushed a different car?

De meisjes duwden dezelfde groene auto.

(1) Klopt het dat *de jongens* een *andere* auto duwden?

(2) Klopt het dat *iedere jongen* een *andere* auto duwde?

The numbers (1) and (2) show the different types of sentences that were asked. The underlined word indicates the adjective of comparison.

8.1.2.4 Conditions

The 2x2 design of experiment 1a results in four conditions. In each conditions participants are asked to answer a target question, with 'yes' or 'no', in the context of a short story accompanied by a picture.

The four possible conditions:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Sentence</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition 1:</td>
<td>Plural definite <em>De 'The'</em></td>
<td>Non-Parallel picture.</td>
</tr>
<tr>
<td>Condition 2:</td>
<td><em>Iedere 'Each/Every'</em></td>
<td>Non-Parallel picture.</td>
</tr>
<tr>
<td>Condition 3:</td>
<td>Plural definite <em>De 'The'</em></td>
<td>Parallel picture.</td>
</tr>
<tr>
<td>Condition 4:</td>
<td><em>Iedere 'Each/Every'</em></td>
<td>Parallel picture.</td>
</tr>
</tbody>
</table>

In conditions 1 and 2 participants have to verify either the definite plural *de* 'the' or the quantifier *iedere* 'each' in the context of the non-parallel picture (16a). A 'yes' answer to these conditions is interpreted as a sentence-internal reading of the adjective of comparison 'different' *andere*. A 'no' answer is interpreted as a sentence-external reading, because in the case of a 'no' answer the boys are compared with the girls (an external element).
For conditions 3 and 4 the definite plural *de* or the quantifier *iedere* have to be verified in the context of the parallel picture (16b). A 'yes' answer to these conditions is interpreted as a sentence-external reading of the adjective of comparison 'different', because of a comparison with the girls. A 'no' answer is interpreted as a sentence-internal reading, because the boys are only compared to each other.

We will refer to the different conditions in the following way: 'the-non-par', 'each-non-par', 'the-par' and 'each-par’. Table 10 summarizes the readings that result from 'yes' or 'no' answers per condition.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>'Yes' Answer</th>
<th>'No' Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The - Non-Par</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Each - Non-Par</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>The - Par</td>
<td>External</td>
<td>Internal</td>
</tr>
<tr>
<td>Each - Par</td>
<td>External</td>
<td>Internal</td>
</tr>
</tbody>
</table>

Because it’s hard to fully grasp the materials and the hypotheses, we will now provide a short reminder to the predictions and hypothesis, by looking at the expected answers per condition. Table 11 shows the expected answers per condition, for the adults. This table serves as a reminder to the parallelism between distributivity markers and *different* licensors and also to the results of Study 1. The parallelism leads to the prediction of an assumed relationship between distributivity and the adjective of comparison *different*.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Preference</th>
<th>Hypothesis</th>
<th>Reading</th>
<th>Expected Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The - Non-Par</td>
<td>Collective</td>
<td>Weak Licensor</td>
<td>-&gt;External</td>
<td>No</td>
</tr>
<tr>
<td>Each - Non-Par</td>
<td>Distributive</td>
<td>Strong Licensor</td>
<td>-&gt;Internal</td>
<td>Yes</td>
</tr>
<tr>
<td>The - Par</td>
<td>Collective</td>
<td>Weak Licensor</td>
<td>-&gt;External</td>
<td>Yes</td>
</tr>
<tr>
<td>Each - Par</td>
<td>Distributive</td>
<td>Strong Licensor</td>
<td>-&gt;Internal</td>
<td>No</td>
</tr>
</tbody>
</table>

'The' is a weak marker for distributivity (adults prefer the collective interpretation), so following the parallelism it is expected to be a weak licensor for the sentence-internal reading of *different*, leading to the sentence-external interpretation. 'Each’ is a strong marker for distributivity (the distributivity marker ‘each’ leads to an adult preference
for the distributive interpretation), so a strong licensor for the sentence-internal reading of *different*. This prediction leads to the expected answers shown in table 10. 'The' is a weak licensor, so therefore it’s predicted to enforce the sentence-external interpretation. In the non-parallel picture this will lead to a 'No' answer, because the boys are compared to the girls. In the parallel picture this will lead to a 'Yes' answer, again due to a comparison with the girls.

'Each' is a strong licensor, so therefore it’s predicted to enforce the sentence-internal interpretation. In the non-parallel picture this will lead to a 'Yes' answer, because the boys are only internally compared to each other. In the parallel picture this will lead to a 'No' answer, again caused by the internal comparison of the boys.

The predictions for children are a bit different, due to their distributive preference. Table 12 shows the expected answers per condition for the children.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Preference</th>
<th>Reading</th>
<th>Expected Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The - Non-Par</td>
<td>Distributive</td>
<td>-&gt;Internal</td>
<td>Yes</td>
</tr>
<tr>
<td>Each - Non-Par</td>
<td>Distributive</td>
<td>-&gt;Internal</td>
<td>Yes</td>
</tr>
<tr>
<td>The - Par</td>
<td>Distributive</td>
<td>-&gt;Internal</td>
<td>No</td>
</tr>
<tr>
<td>Each - Par</td>
<td>Distributive</td>
<td>-&gt;Internal</td>
<td>No</td>
</tr>
</tbody>
</table>

Due to the distributive preference of the children, we expect them to only get the internal reading. The internal reading in both pictures will lead to the expected answers shown in table 12. For the non-parallel picture (16a) in combination with the definite plural 'the' and the quantifier 'each', children are expected to say 'yes', because they only look internally to the boys. In contrast to adults, children prefer the distributive interpretation in combination with 'the' and not the collective one. Because of this distributive preference, the parallelism between the distributivity strength and sentence-internal 'different' licensors dissapears. Children are not able to reason that the definite plural 'the' is a weak marker for distributivity and thus a weak licensor for sentence-internal 'different'. They don’t see a difference between the definite plural 'the' and the quantifier 'each'. For the parallel picture (16b) in combination with the definite plural 'the' and the quantifier 'each', this will both result in a 'no' answer, because the boys are only internally compared to each other. So to conclude, the distributive preference of the children will result in an internal-reading of 'different' in all conditions.
8.1.3 Design and Procedure

Participants were presented 20 experimental items in total, 5 sentence-picture pairs for each condition. The following 5 verbs were used: *vasthouden, dragen, duwen, trekken* and *wassen* (in English: 'hold', 'carry', 'push', 'pull', and 'wash'). These verbs are the same as in Study 1, except for the verb *bouwen* 'build'. We decided to leave this verb out, because it was too difficult to create clear comics in the context of 'building' things. The subjects of the items are again girls, boys, monkeys and dogs and the objects were varied across all items.

The experiment also included 12 control items, of whom 6 were false and 6 were true. The controls were constructed using the same four subjects as for the items but with three different verbs: *eten, rijden op and bouwen* (in English: 'eat', 'ride on' and 'build'). The controls also contained the adjective of comparison 'different' *andere*. Sentence 26 provides an example of the control items for the subject 'dog':

(30)

(a) Is it true that the dog is eating a different lollypop than the monkey?
(b) Is it true that the dog is building a different tower than the monkey?
(c) A dog and a monkey are walking outside. They are going to the playground. When they arrive they can choose between the slide and riding on a scooter. Together they decide to ride on a scooter. Is it true that the dog is riding a different scooter than the monkey?

Boys and girls were always compared to each other and so were the monkeys and the dogs. Figure 17 shows the pictures belonging to sentence 30. For each subject, one of the controls was created like a story rather than just one picture, to check if the participants really understood the comic style of the experimental items (Figure 17c and Sentence 30c).

The 32 items were distributed across four different lists and randomized per participant. The experiment started with one practice item, to introduce the stories and comic style pictures. The pictures were displayed on a laptop screen.
The participants were presented with one comic style picture at a time, while the recorded story and target sentence was played. They were instructed to answer the target sentence, by saying ‘yes’ or ‘no’.

Figure 17: Pictures belonging to sentence 30
8.2 Results

Table 13: Results of Experiment 1a

<table>
<thead>
<tr>
<th>Age-Group</th>
<th>Proportion of ‘true’ answers (with SD)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The-Non-Par</td>
<td>Each-Non-Par</td>
</tr>
<tr>
<td>6</td>
<td>81.0 (39.4)</td>
<td>82.0 (38.6)</td>
</tr>
<tr>
<td>7</td>
<td>85.2 (35.6)</td>
<td>87.8 (32.8)</td>
</tr>
<tr>
<td>8</td>
<td>73.0 (44.6)</td>
<td>80.0 (40.2)</td>
</tr>
<tr>
<td>9</td>
<td>63.0 (48.5)</td>
<td>77.0 (42.3)</td>
</tr>
<tr>
<td>Adults</td>
<td>59.6 (49.2)</td>
<td>71.5 (45.2)</td>
</tr>
</tbody>
</table>

All 138 participants were able to complete the experiment. Participants answered incorrectly to control items 2.0% of the time. Table 13. and Figure 18. report the mean proportion of ‘yes’ answers for each group and for each condition. Figure 18a shows the results for the conditions The-Non-Par and Each-Non-Par, Figure 18b shows the results for the conditions The-Par and Each-Par. The last columns of each condition show our prediction.

Looking at the descriptive statistics of Figure 18a, it can be seen that adults accept Condition The-Non-Par in about 60% of the cases. Children start with accepting this condition in about 82% of the cases, gradually moving to the adult interpretation which they reach at the age of 9. The same goes for the Condition Each-Non-Par, which is accepted by adults in about 71% of the cases. Children start around 83% gradually moving to the adult interpretation. Looking at our predictions, it becomes clear that for these two conditions the results do not completely follow our hypothesis. For the Condition The-Non-Par we expected the adults to answer ‘no’, because of the weak sentence-internal different licensor de ‘the’ and their collective preference. However even adults accept this conditions with about 60%. This percentage could be explained by the fact that the adults showed an acceptance rate of about 50% for the The-Dis condition in Study 1 (shown in the prediction column). They turned out to have a smaller preference for the collective interpretation than we thought and is assumed in the literature (Pagliarini et al., 2012; Brooks and Braine, 1996; Frazier et al., 1999). This finding of Study 1 might explain the acceptance rate of 60% in the The-Non-Par condition, because we expected that the collective preference of the adults would lead to the external reading. For the Condition Each-Non-Par we expected the participants to answer ‘yes’, because of the strong sentence-internal licensor iedere ‘each’. The results show an acceptance rate of 71%, which is lower than expected.
Figure 18: Proportion of 'yes' Responses per Age Group for (A) the Conditions The - Non-Par and Each - Non-Par. (B) the Conditions The - Par and Each - Par. The last column of each Condition shows the prediction.
In case of the children, we expected them to accept both conditions, due to their distributive preference. Looking at the descriptive statistics, the results of the children also turned out to be lower than expected, accepting both condition The-Non-Par and condition Each-Non-Par around 80%. This could be explained by the fact that there might be children who already show the adult intuition for condition The-Non-Par.

The results of the conditions The-Par and Each-Par follow our predictions for the adults, but not for the children. We expected the adults to accept the condition The-Par and to reject the condition Each-Par. Looking at the descriptive statistics, the adults indeed accepted condition The-Par with 90% and overall rejected condition Each-Par (although the acceptance rate of 22% is higher than expected). Children, like adults start with accepting condition The-Par in 90% of the cases, however at the age of 7 the acceptance rate drops to 81%. After the age of 7 the acceptance rate gradually moves to the adult interpretation again. This does not follow our predictions, because we expected children to reject this condition, because of their distributive preference. Young children however accept this condition with 90%. For condition Each-Par Children start at an acceptance rate of 64%, but at the age of 8 the acceptance rate drops to the adult interpretation. This again does not follow our predictions; we expected young children to reject this condition and to be drawn to the sentence-internal reading, but they accepted the condition in 64% of the cases. Looking at the prediction columns, we can clearly see that the results of the adults tend to follow our hypothesis. However, the condition Each-Par turned out to be a higher as expected.

To summarize, the descriptive statistics show us that the conditions The-Non-Par and Each-Non-Par do not completely follow our hypothesis. We expected young children to accept both conditions, due to their distributive preference, but their results turned out to be a bit lower as expected. We expected the adults to reject condition The-Non-Par, thus rejecting the sentence-internal reading but we found an acceptance rate of 60%. The acceptance rate of the condition Each-Non-Par also turned out to be lower than expected.

The results of conditions The-Par and Each-Par on the other hand, follow our hypothesis more. Only the children showed unexpected results. Young children were expected to reject both conditions, due to an sentence-internal preference, however they turned out to accept both conditions suggesting a sentence-external interpretation.

The results were analyzed using mixed-effect linear models. The dependent variable was the response (0 for a ‘no’ answer rejecting an item, 1 for a ‘yes’ answer accepting an item). The predictors were: CONDITION, AGE, the interaction of those two and GENDER. We also included two random effects for the intercept: PARTICIPANTS and VERBS, and one random effect for the slope of the VERBS: CONDITION.
In the resulting model (Table 14), CONDITIONS The-Par and Each-Par turned out to be significant predictors ($z=2.3$, $p<0.01$) and ($z=-12.0$, $p<0.001$). Their interactions with AGE were also significant ($z=4.8$, $p<0.001$) and ($z=2.9$, $p<0.001$). Furthermore, the predictors AGE and GENDER also turned out to be significant ($z=-4.8$, $p<0.001$) and ($z=-3.1$, $p<0.001$).

These results show us that Condition The - Par is accepted more than the other conditions. Condition Each - Par on the other hand is rejected more. Further more, the significant interaction of those two conditions with the predictor AGE, shows us that with higher age, the previous mentioned results become even more significant. The factor GENDER also turned out to be a significant predictor. A more detailed analysis using a different linear model shows us that this significance lies in the fact that males accept condition Each-Par more than females do ($z=3.6$, $p<0.001$).

Coming back to our main research question examining whether or not there is a relationship between distributivity and the adjective of comparison ‘different’, we also performed a correlation test between study 1 and study 2. We were interested in the role that distributivity plays in the interpretation of the adjective of comparison ‘different’. Therefore, we examined the correlation between each child’s acceptance of the Condition The-Dis from study 1 (showing if they acquired distributivity) and their acceptance of the Condition The-Non-Par (showing their interpretation of sentence-internal ‘different’) of study 2. We defined ‘acceptance’ as the number of items that a child accepted in a
condition. We expect that children who rejected Condition The-Dis from study 1, will also reject Condition The-Non-Par from study 2. Showing the parallelism between weak the distributivity marker *de 'The'* and the weak licensor for sentence internal 'different’ *de 'The’*.

![Figure 19: Correlation between the acceptance rates of Condition The-Non-Par and The-Dis: The triangles represent the individual children](image)

The correlation between these two conditions was measured using Spearman’s rank correlation. Figure 19 reports the results, by showing how many times each child accepted Condition The-Dis (x-axis) and Condition The-Non-Par (y-axis). We did not find a correlation between the two conditions ($\rho=0.1$, $p<0.29$). As a reminder, we expected children who rejected condition The-Dis (in Study 1, Experiment 1), to also reject Condition The-Non-Par. This would have meant many datapoints in the lower left corner. However, this corner is almost empty. Figure 19 shows us that most of the children accepted both conditions. These results do not follow our hypothesis. The correlation test between study 1 and study 2 did not provide any evidence supporting an assumed relationship between distributivity and the adjective of comparison 'different’.

### 8.3 Discussion

The TVJT we used for this experiment consisted of two factors: SENTENCE and PICTURE. The sentence was either *de or iedere* and the picture was either parallel or non-parallel. Looking back at the results, the conditions The-Non-Par and Each-Non-Par did not completely follow our hypothesis, but the conditions The-Par and Each-Par
followed our hypothesis more in case of the adults. So in other words the results for the
non-parallel picture did not turn out to be as expected, but the results for the parallel
picture did follow our predictions more.
In both pictures the subjects of the sentence have to be compared to an external ele-
ment. A possible explanation for the fact that results of the parallel picture did follow
our hypothesis more, is that it might be the case that the parallel picture was easier to
understand and more clear.
In the parallel picture (Figure 16b) there is a clear separation between the boys and
the girls. The girls are pushing one car and the boys are pushing one car. The four
subpictures are very similar and the order of the events is really clear. It might also be
the case that this picture made the comparison between the boys and girls very salient,
due to the parallel character of the picture. This in contrary to the non-parallel picture
(Figure 16a), in which the comic consists of more difficult subpictures. The separation
between the girls and boys is less present and the events are harder to understand. It
might be the case that the participants just ignored or did not see that the first boy
was pushing the same car as the girls. The target sentence was stated at the end of the
story, so the participants are basing their answer on the last picture. This last picture
does indeed show that the three boys are pushing different cars. In order to reject this
picture participants have to recognize that the last boy is pushing the same car as the
girls did before him.
Another point that supports this idea is the length of the stories. Looking back at the
example stories in section 7.1.2.2, it becomes clear that the story for the non-parallel
picture is longer than the story for the parallel picture. It might be the case that the
children lost their attention and just did not pay attention to the one boy that is pushing
the same car as the girls. They are basing their answer to the last thing they heard.
However, we do have to take into account that not only the children showed unexpected
results. The adults also accepted condition The-Non-Par with a rate of almost 60%.
Because we believe adults were able to focus during an experiment of 15 minutes, so the
explanation for these unexpected results is not that simple. Even the adults don’t seem
to get or care about the difference between internal and external ‘different’.
What might be interesting is to look at another correlation test between study 1 and
study 2. In the previous section we tested whether or not there was a correlation be-
tween the conditions The-Dis and The-Non-Par. The results did not show a significant
correlation. If it really is the case that the non-parallel picture was too hard to un-
derstand and that this fact influenced our results, it might be interesting to look for a
correlation between study 1 and the parallel picture of study 2. To be precise, between
the condition Each-Col of study 1 and the condition Each-Par of study 2. In the con-
dition Each-Par participants did ignore the sentence external element, because of the
strong internal licensor *iedere*. To look for a parallelism between this strong licensor and the strong marker for distributivity we have to do a correlation test with the condition Each-Col. It’s expected that children who reject the Each-Col condition of study 1, will also reject the Each-Par condition of study 2.

We measured the correlation between the proportion of items accepted in the Condition Each-Col and the proportion of items accepted in the condition Each-Par, using a Spearman’s rank correlation test. Figure 20 shows the results.

The correlation test revealed that there is no significant correlation between the conditions Each-Col and Each-Par ($\rho=0.25$, $p<0.05$). This can also be seen in Figure 20 in which the datapoints are spread across the graph. The results do show that the data approaches significance, with a small p-value of 0.05. However, this test again did not provide any evidence supporting the idea of a relationship between distributivity and the adjective of comparison ‘different’. The results do suggest that there might be a relationship, with a p-value approaching significance, so further research into this assumed relationship is still valuable.

To check whether the unexpected results were indeed due to a poor understanding of the internal picture we decided to do another experiment, using a preference task to check if the adults are able to understand the difference between sentence-internal and sentence-external ‘different’ enforced by the licensors *de* and *iedere*.
Chapter 9

Experiment 1b - Adult Preferences

The unexpected results of Experiment 1a indicated that the materials, in special the parallel picture, were not clear and influenced our results. Experiment 1b is conducted to check adult preferences for a certain reading of ‘different’ and to examine whether or not these preferences are the same as they are proposed in the parallelism found in the study of Brasoveanu and Dotlačil (2012). Experiment 1b examines this by looking at the interpretations of the licensors de and iedere, by using a preference task. This experiment is conducted to check whether or not adults are able to distinguish between the external and internal interpretation, by examining their preference for an internal or external interpretation, with the licensors de and iedere. Based on the parallelism between distributivity markers and ‘different’ licensors, we hypothesize that the weak licensor de will lead to the external interpretation and the strong licensor iedere to the internal interpretation.

9.1 Method

9.1.1 Participants

36 Dutch adults aged between 19 and 52 years old (mean age 30) participated in experiment 1b. All participants were recruited through a website. They performed the experiment online, without the experimenter being present and they did not receive any compensation.

9.1.2 Materials

Experiment 1b involved a preference task in a 2x1 design. The 2x1 design consisted of the factors SENTENCE (de ’the’ vs. iedere ’each/every’) and PICTURE.
9.1.2.1 Picture

The pictures used in this preference task are based on the comic style picture of experiment 1a of study 2. The four subpictures are combined into one picture, resulting in one picture for the internal interpretation and one picture for the external interpretation. These two pictures were shown at the same time and the participants were instructed to pick the one that matched the recorded target sentence. The participants had to show their preference, rather than accepting the comic style picture as in experiment 1a.

Figure 21: Example picture for experiment 1b: Participants were instructed to choose between picture 1 and 2.

Figure 21 shows an example, picture 1 represents the external interpretation and picture 2 represents the internal interpretation. When comparing this Figure to Figure 16, it becomes clear that the 4 subpictures are merged into one picture, for both the internal and external interpretation.

9.1.2.2 Sentence

This experiment contains the same target sentence as experiment 1a of study 2. However in this experiment we left out the context story and just provided the target sentence, with the context sentence. These two pictures need no story to explain the events, because they show clear actions in just one picture.

(31) The girls are pushing the same green car. The boys are pushing a different car.

De meisjes duwen dezelfde groene auto. De jongens duwen een andere auto.
The girls are pushing the same green car. **Each/Every** boy is pushing a different car. De meisjes duwen dezelfde groene auto. **Iedere** jongen duwt een andere auto.

We also decided to leave out the phrase *Klopt het dat?* 'Is it true that', because this is not necessary in the context of a preference task.

### 9.1.2.3 Conditions

The conditions of experiment 1b are the same as in experiment 1a, except for the adjustment of the pictures.

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Condition 1: Plural definite <em>De 'The'</em> sentence (31)</th>
<th>Condition 2: <em>Iedere</em> 'Each/Every' sentence (32)</th>
</tr>
</thead>
</table>

As a reminder to our hypothesis, we expect participants to prefer the external picture (picture 1 in Figure 21) for the definite plural 'The' and the internal picture (picture 2 in Figure 21) for the quantifier 'Each/Every'. This hypothesis is again based on the parallelism between the distributivity markers and 'different' licensors. The weak sentence-internal 'different' licensor 'The' will lead to the external interpretation. The strong sentence-internal 'different' licensor 'Each/Every' will lead to the internal interpretation.

### 9.1.3 Design and Procedure

Participants are presented 20 experimental items in total, 10 per condition. In each condition, the sentences are constructed using the same verbs as in experiment 1a: *vasthouden, dragen, duwen, trekken and wassen* (in English: 'hold', 'carry', 'push', 'pull' and 'wash'. The subjects and objects were also copied.

![Figure 22: Example Filler item for the verb 'eat'](image)

The experiment also includes 12 filler items, to mask the idea behind the experiment, for the reason that we are conducting this experiment with adults. The filler items are
constructed using the same verbs as the controls of experiment 1a: *eten, rijden op and bouwen* (in English: 'eat', 'ride on' and 'build'). An example of a filler item is shown in Figure 22. The sentences belonging to this filler item are shown in sentence (33).

(33)

(a) The girls are eating a slice of pizza. The boys are also eating a slice of pizza.
   
   *De meisjes eten een stuk pizza. De jongens eten ook een stuk pizza.*

(b) Each/Every girl is eating a slice of pizza. Each/Every boy is also eating a slice of pizza.
   
   *Ieder meisje eet een stuk pizza. Iedere jongen eet ook een stuk pizza.*

Note that for the sentence with *de* 'the', both pictures can be right. This sentence is chosen to create confusion about the experiment, distracting the participants from the real goal of the experiment. The results of the filler items are not analyzed.

The 12 filler items and the 20 experimental items result in a total of 32 items. Two different versions of the experiment were created, in which the experimental and filler items were presented in random order. The positions of the internal and external pictures were also varied across all items.

Participants were assigned randomly to one of the two versions and they all received different orders. The experiment started with one practice item to introduce the experiment and explaining the preference task. The pictures were displayed on a website, with buttons for choosing picture 1 or picture 2. The items were presented one at a time, while the recorded sentence was played. Participants were instructed to choose the picture that matched the sentence, by clicking on the corresponding button.

### 9.2 Results

All 36 participants were able to complete the experiment. Figure 23 reports the mean proportion of 'internal' and 'external' responses for the two conditions. The descriptive statistics show a clear preference for the internal interpretation with the quantifier *iedere* 'each/every' (89%) and a clear preference for the collective interpretation with the definite plural *de* 'the' (94%).

The results were analysed using mixed-effect linear models. The dependent variable was the interpretation (internal or external). The final model contained a predictor CONDITION, two random effects for the intercept: PARTICIPANTS and VERBS and one random effect for the slope of the VERBS: CONDITION. The final model showed a significant Intercept ($z=7.29, p<0.001$) and a significant predictor CONDITION IEDERE 'EACH-EVERY' ($z=-9.98, p<0.001$).
Chapter 9. Experiment 1b

9.3 Discussion

This preference task aimed to examine whether or not adults are able to distinguish the 'internal' and 'external' interpretation, due to the unexpected results of experiment 1a, the results of the parallel picture did follow our hypothesis, but the results of the non-parallel picture were unexpected. We have a possible explanation: maybe the non-parallel picture was too difficult and unclear to process, even for adults. This preference task served to examine whether or not adults are able to understand the non-parallel picture and prefer it combination with the quantifier *iedere*, as expected.

The results indeed show a clear preference for the internal interpretation in combination with the quantifier *iedere* 'each/every’. 89.2% of all interpretations with the quantifier *iedere* were internal. The results also show a clear preference for the external interpretation in combination with the definite plural *de* 'the’. 94.2% of all interpretations with the definite plural *de* were external. So we can conclude that adults are definitely able to distinguish between the internal and external interpretation. They even showed a clear preference for the internal interpretation, which was expected and was not showed in experiment 1a. Therefore we are able to conclude that the design of our experiment 1a did not influence the results. The unexpected results of the internal picture were not due to a lack of understanding of the internal picture, because this preference task shows us that adults can interpret the quantifier *iedere* internally.
The preference task of this experiment only focused on the adults. However, it might also be interesting to look at the preferences of the children. We therefore conducted a small preference task with the children of experiment 1a. Due to the size of the project and the extensive testing of the children, we were only able to test the children with two experimental items. One with the quantifier *iedere* and one with the definite plural *de*.

It has to be mentioned that this small experiment only serves as a direction for further research, we are not able to draw any statistical conclusions, due to the small amount of data. Figure 24 and 25 show the pictures for the two items.

![Preference Task item for the children with the verb 'wash'](image1)

**Figure 24:** Preference Task item for the children with the verb 'wash'

![Preference Task item for the children with the verb 'pull'](image2)

**Figure 25:** Preference Task item for the children with the verb 'pull'

We chose to use the verbs *wassen* 'wash' and *trekken* 'pull', because these verbs are easy to draw and result in clear pictures. The subjects of these items are also new and not used in previous experiments, namely clowns and elephants. The children were instructed to pick the picture that matched the sentence. The corresponding sentences are shown in sentence (34) and (35).

(34) The clowns are washing the same red circus tent. **The** elephants are washing a different circus tent.
De clowns wassen dezelfde rode circustent. De olifanten wassen een andere circustent.

(35) The elephants are pulling the same blue caravan. Each/Every clown is pulling a different caravan.

De olifanten trekken dezelfde blauwe caravan. Iedere clown trekt een andere caravan.

**Figure 26:** Proportion of Internal and External Responses per Condition for the 6 and 7 year olds.

**Figure 27:** Proportion of Internal and External Responses per Condition for the 8 and 9 year olds.
So every child received two items, one with the quantifier *iedere* and one with the definite plural *de*. We tested the 86 children of experiment 1a, which results in 172 datapoints, 86 per condition divided over the different age groups (see Table 8 for the features of those groups). The results are reported in Figure 26 and 27.

Looking at the descriptive results of Figure 26 and 27 it becomes clear that the adult interpretation is almost reached at 9 years old. Children do prefer the external interpretation in combination with the definite plural *de*, but the interpretation for the quantifier *iedere* is still a bit unclear. The proportion of the internal interpretation is bigger with a percentage of 65.5%, but this is still much lower than the 89.2% of the adults (Figure 23). What we also see is that children already prefer the external interpretation in combination with the definite plural *de* at an age of 7 years old, 84.6% opposed to the 15.4% of the internal interpretation. This indicates that children learn to understand the external interpretation before they understand the internal interpretation. Which becomes also clear from the results of experiment 1a, in which the external picture followed our hypothesis. However, it must be mentioned that these results are only descriptive and come from a small amount of data. To examine whether our indications really hold, a full preference task must be conducted.
Chapter 10

Conclusion Study 2

In study 2 we examined the assumed relationship between the phenomenon of distributivity and the adjective of comparison *andere* ’different’. We hypothesized that the found parallelism between the distributivity markers and the sentence-internal ’different’ licensors indicated a relationship between the two phenomena. To interpret the adjective of comparison ‘different’ one must acquire distributivity, in other words the understanding of the adjective of comparison ‘different’ is dependent on the acquisition of distributivity.

We predicted that the strong marker for distributivity *iedere* and therefore strong licensor for sentence-internal ‘different’ would lead to the internal interpretation. The weak marker for distributivity *de* on the other hand would lead to the external interpretation, because it’s assumed to be a weak licensor for sentence-internal ‘different’. We also predicted that a preference for the distributive interpretation should results in a preference for the sentence-internal reading of ’different’.

The results of the TVJT turned out to partially follow our hypothesis. Adults accepted the non-parallel picture with both licensors, but we expected it to be only accepted with the quantifier *iedere*. The high acceptance rate of the condition The-Non-Par however, might be explained by the high acceptance rate of the condition The-Dis from Study 1. Study 1 clearly showed that adults had a smaller collective preference than we initially thought and is assumed in the literature. We predicted that the adult preference for the collective interpretation (with the definite plural ‘the’) should lead to an external reading. The adults however showed an acceptance rate of about 60% for the internal reading. Children, like adults accepted both conditions, indicating a preference for the internal reading as expected. The acceptance rates however, turned out to be lower as expected.

The parallel picture on the other hand did follow our hypothesis in case of the adults. Adults accepted the parallel picture in combination with the definite plural *de*, but rejected it with the quantifier *iedere* suggesting a preference for an external reading. Children on the other hand, accepted both the definite plural ‘the’ and the quantifier
'each', suggesting an external reading for both conditions. This does not follow our predictions, because we expected the children to have a preference for the internal reading, due to their preference for the distributive interpretation.

To answer the question whether or not the understanding of the sentence-internal reading of 'different' requires distributivity, we also performed a correlation test between Study 1 and 2. We predicted that children who rejected the plural definite 'the' in the distributive context (thus showing the adult intuition), would also reject the plural definite 'the' in combination with the sentence-internal reading of 'different', suggesting a preference for the external reading. The results of this correlation test unfortunately did not provide any evidence supporting this hypothesis. We did not find a significant correlation between the two studies.

The unexpected results of the parallel picture made us think about the design of our experiment, because even the adults did not show expected results for this picture. Maybe the picture was not clear enough? We therefore conducted a preference task with adults to examine whether or not they are able to distinguish between the internal and external interpretation. The results were very clear and followed our hypothesis completely. The adults preferred the internal interpretation in combination with the quantifier *iedere* and the external interpretation in combination with the definite plural *de*. So, we can conclude that the unexpected results of experiment 1a were not due to our materials, especially concerning the parallel picture.

Our results did not provide clear evidence to the idea of a relationship between the acquisition of distributivity and interpretation preferences for the adjective of comparison 'different', but our results did show that the interpretation of the adjective of comparison 'different' is influenced by a preference for either the distributive or collective reading. We therefore believe that future research is necessary to examine this relationship further.
Chapter 11

General Discussion

This thesis aimed to examine the acquisition and development of distributivity and to connect it to the sentence-internal reading of the adjective of comparison ‘different’. Distributivity is evoked in sentences with plural arguments, such as definite plurals, definite numerals and universal quantifiers. It’s commonly assumed that these plural arguments can give rise to both the distributive and the collective interpretation. However, the literature showed that adults often find the distributive interpretation in combination with plural arguments marginal. In the background section of study 1, we listed several studies concerning this marginal status of the distributive interpretation. This short literature review showed little agreement on the acceptability of the distributive interpretation. Many authors state that the distributive interpretation is indeed possible with any plural argument, but on the other hand many others claim that the distributive interpretation is marginal and even unacceptable. Following the thesis of Dotlacil (2010), we discussed three experiments that showed that the collective interpretation is preferred over the distributive one in case of plural arguments like numerals, plural definites and coordinations of proper names. It has also been shown that this collective preference is not present in case of quantifiers like ‘each’ and ‘every’. Those quantifiers serve as strong distributive markers for adults, leading to a distributive preference. This contradictory line of research and a lack of explanations lead to Study 1 of this thesis examining the acquisition of distributivity. Distributivity is often connected to the sentence-internal reading of the adjective of comparison ‘different’. It’s assumed that distributivity is required to interpret the sentence-internal reading of ‘different’. Not much research has been dedicated to this assumed relationship and its development in children. This lead to Study 2, in which we examined the assumed relationship between distributivity and the AOC ‘different’.
11.1 Summary of the two Studies

Experiment 1 of Study 1 aimed to answer the question: Why is the distributive interpretation of definite plural noun phrases degraded and how do children develop these adult-like intuitions? We examined this by looking at the interpretations of the Dutch quantifier *iedere* 'each' and the Dutch definite plural *de* 'the'. Our experiment is based on the experiment of Pagliarini et al. (2012), who tested the interpretations of the Italian quantifier *ciascun* and the Italian plural definite *i/le*. We investigated the same hypothesis, which is based on Dotlacil (2010) ideas about conversational implicature. This hypothesis offers an explanation for the degraded status of the distributive interpretation resulting in the adult preference for the collective interpretation. In summary, it assumes that adults are able to reason about an alternative and more informative option, using the quantifier 'each'. The literature shows that the quantifier 'each' is a strong marker for distributivity and leads to an adult distributive preference. Conversational implicature involves the reasoning about alternative options and choosing the most informative one. It's based on the principle that a speaker always wants to inform his listeners in the most informative way. Using this knowledge, adults are able to exclude the distributive interpretation in combination with definite plural noun phrases, because if someone means the distributive interpretation he or she would have used the quantifier 'each'. The literature shows that children are unaware of the lexical semantics of 'each' (Syrett and Musolino, 2013; Brooks and Braine, 1996; Brooks and Sekerina, 2006, among others), which entails that 'each' is not a marker for distributivity to them. They are therefore not able to use the principles of conversational implicature, because to them sentences with the definite plural 'the' are just as informative as sentences with the quantifier 'each'.

We therefore predicted that children first have to understand 'each' as a marker for distributivity, before they can infer the marginal status of the distributive interpretation in combination with definite plural noun phrases. Our results were very similar to the results of Pagliarini et al. (2012). We both found a significant correlation between the rejection of the quantifier 'each' in the collective context and the rejection of the plural definite 'the' in the distributive context. This indicates that children’s acceptance of the collective reading of 'each' is a significant predictor of children’s acceptance of the plural definite in the distributive context.

However, distributivity is not only enforced by markers such as 'each' and 'every', this can also be achieved by using adjectives of comparison, used to compare two elements in language. The second study of this thesis involved the investigation of the adjective of comparison 'different' and its assumed relationship with distributivity. Adjectives of comparison are often connected to distributivity. Carlson (1987) was the first one to
connect the sentence-internal reading of the AOC 'different' to distributivity and claimed it to be necessary to interpret the sentence-internal reading of 'different'. Subsequent studies all accept this assumption and build upon it. Not much empirical research has been dedicated to this assumption, but it finds support in a found parallelism between the strength of distributivity markers and the licensors for sentence-internal 'different'. Brasoveanu and Dotlačil (2012) found in an experiment concerning the acceptibility of 'different' licensors, that the licensor 'each' is preferred as a licensor for sentence-internal 'different', favored over the NP 'all' and the definite plural 'the'. This is also the case for the preference of the distributive interpretation, following the literature shown in the background section of this thesis. 'Each' is assumed to be a strong marker for distributivity, whereas 'The' is assumed to be weakly distributive. In study 2 we connected the distributive interpretation to the adjective of comparison 'different', to examine the assumed relationship. To be more precise, we examined the parallelism between the distributivity markers and the 'different' licensors, proposed by Brasoveanu and Dotlačil (2012). Is there a difference in acceptibility of the sentence-internal reading between the distributive quantifier 'each' and the weakly distributive definite plural 'the'? We hypothesized that a preference for the distributive interpretation would lead to a preference for the sentence-internal reading of 'different'. We performed a correlation test between Study 1 and Study 2 to examine the relationship between the acquisition of distributivity and the sentence-internal reading of 'different'. Unfortunately we did not find a significant correlation.

11.2 Connection between the results

11.2.0.1 The collective interpretation of the definite plural 'the'

An important and unexpected result of Study 1 is the adult acceptance rate of the definite plural 'the' in the distributive context. Following the literature, the distributive interpretation of plural arguments (such as, definite plurals, numerals and coordinations of proper names) is found to be marginal and sometimes even unacceptable (Schwarzschild, 1993; Scha, 1984; Williams, 1991; Moltmann, 1992). However, both our results and the results of Pagliarini et al. (2012) show an acceptance rate of about 50%, which is quite high when we expect the distributive interpretation to be unacceptable. The results show us that adults find the distributive interpretation of the plural definite 'the' acceptable half of the times. This in comparison with the acceptance rate of the definite plural 'the' in the collective context, which is accepted in 100% of the cases. This indicates that adults indeed prefer the collective interpretation of plural definates, but they still accept the distributive interpretation in 50% of the cases. This acceptance rate is too high to claim that the distributive interpretation of definite plurals is unavailable. So
based on our results and the results of Pagliarini et al. (2012), we have to conclude that adults are less collective than expected.

11.2.0.2 'The' as a weak licensor for sentence-internal 'different'

The literature shows that 'the' is a weak marker for distributivity, preferring the collective interpretation. Following the parallelism, proposed by Brasoveanu and Dotlačil (2012), this would mean that it also is a weak licensor for sentence-internal different, preferring the external reading. But is this actually the case? Our results of the non-parallel picture showed that for adults the definite plural 'the' in the internal reading is accepted in about 60% of the cases. This in comparison with the quantifier 'each', which is accepted in the internal reading in about 70% of the cases. These results differ less than the found difference in the study of Brasoveanu and Dotlačil (2012), where they found that the quantifier 'each' is significantly preferred over the definite plural 'the' as a licensor for sentence internal 'different'. In our experiment the licensors 'each' and 'the' turned out to be quite similar, concerning their acceptance of the sentence-internal reading. This can be explained by making a connection to the results of Study 1. One of the unexpected results we found in Study 1, concerned the acceptance of the distributive interpretation in combination with the definite plural 'the'. This turned out to be less strong as proposed in the literature. We found that adults are less collective as they are assumed to be. We also found that the Dutch quantifier *iedere* isn’t such a strong distributive marker as is proposed in the literature. It makes sense to connect these results to the similarity between the sentence-internal 'different' licensors 'each' and 'the' found in study 2, because the results seem to be related.

Our results of study 2 show that the strength difference between the licensors 'each' and 'the' did not turn out to be significant, this in contrary to the results of Brasoveanu and Dotlačil (2012). Our results of study 1 show that adults are less collective as assumed in the literature. The smaller preference for the collective interpretation of the adults in study 1, lead to a bigger preference for the internal interpretation in Study 2, even with the assumed weak licensor 'the'. So our results do support a relationship between distributivity and the sentence-internal reading of 'different', but the findings concerning distributivity of Study 1 are different than assumed in the literature, which led to a smaller difference between the sentence-internal 'different' licensors in Study 2.

11.2.0.3 The collective interpretation of the quantifier 'each'

Another unexpected finding in Study 1 is the adult acceptance rate of the quantifier 'each' in the collective context. We found that adults accepted the quantifier 'each' in the collective context in 36% of the cases. This is much higher than expected, because the experiments of for example Brooks and Braine (1996); Gil (1982); Zimmermann
(2002) all showed that the addition of the quantifier ‘each’ lead to a strong distributive preference for adults. The results of Pagliarini et al. (2012), which was methodologically parallel to ours, also showed a much lower acceptance rate of 9%. Our TVJT however, showed that adults are able to interpret ‘each’ collectively, which is assumed to be very marginal. Our follow-up Experiment 2a involving a preference task with adults, showed that adults indeed strongly prefer the distributive interpretation in combination with the quantifier ‘each’. But this still does not explain why they accept the collective interpretation of the quantifier ‘each’ in our TVJT. Recall that we came up with a possible explanation concerning a difference between the quantifiers ‘each’ and ‘every’, in Dutch ‘elke’ and ‘iedere’. The quantifiers ‘each’ and ‘every’ are often assumed to be interchangeable, but others claim that there might be a difference concerning distributivity. Following Tunstall (1998), we examined in Experiment 2b of Study 1 whether or not the difference between ‘each’ and ‘every’ influenced our results.

In our TVJT we used the quantifier ‘iedere’ ‘every’, and Tunstall (1998) assumes that ‘every’ is partially distributive, in the sense that it also allows the collective interpretation. This assumption could explain why the adults accepted the collective interpretation in combination with the quantifier ‘iedere’. We conducted a follow-up TVJT only replacing the quantifier ‘each’ with the quantifier ‘every’ elke in Dutch. We found no significant difference, the adults still accepted the collective condition in 36% of the cases. A possible explanation might be that in Dutch the distinction between the quantifiers ‘iedere’ and ‘elke’ is not as big as it is in English, following Dik (1974). If this is the case, and the results are indeed not influenced by a difference between ‘iedere’ and ‘elke’, we have no explanation for the fact that adults accepted the collective interpretation. In a preference task they show a very strong preference for the distributive interpretation (99%), but in a TVJT they accept the collective interpretation in a considerable number of cases.

There is not much known about the assumed difference between ‘each’ and ‘every’. We found no difference between the Dutch quantifiers ‘iedere’ and ‘elke’, indicating that they might differ from the English quantifiers ‘each’ and ‘every’. So it is interesting to look at this difference, do English adults accept ‘Every’ in the collective context and does this differ from their acceptance of the quantifier ‘each’? Maybe elke and iedere are weaker markers for distributivity in Dutch than the quantifiers each and every in English?

11.2.0.4 The results of the children

We hypothesized that the children would have a preference for the sentence-internal reading of ‘different’ in Study 2. This hypothesis was based on childrens preference for the distributive interpretation, found in the literature (Brooks and Braine, 1996; Syrett and Musolino, 2013) consisted with our results of Study 1, in which the children preferred the distributive interpretation for both the quantifier ‘iedere’ ‘each’ and the definite plural...
de 'the'. However, the results of the parallel picture indicated an unexpected external reading. Why did the children interpret this picture externally, for both the quantifier 'each' and the definite plural 'the'? This can possibly be explained by the difference between the pictures. The situation in the non-parallel picture is not as clear as in the parallel picture, due to the non-parallel character. The boys are performing the action differently than the girls. In the parallel picture, the boys and girls perform the action similarly (one after the other). It might be the case that the parallel picture stressed the external reading more than the non-parallel picture. The parallelism in the external picture made a comparison between the girls and the boys very salient, resulting in a very strong indication to the external reading. This explanation provides evidence for the fact that the results of the children might be influenced by the pictures. Especially when considering that the children showed an expected preference for the internal reading in combination with the non-parallel picture.

11.2.1 What to do next?

We conducted Experiment 1b in Study 2 to check if the non-parallel picture was too hard to understand (even for adults) and might have influenced the interpretations of the adults. We examined this as a possible explanation for the unexpected results concerning the definite plural 'the' in combination with the non-parallel picture, indicating an internal reading where an external reading was expected. The results of experiment 1b ruled out that the pictures were too difficult for the adults, because they showed clear expected preferences. However, the unexpected results of Study 2, concerning the children, clearly showed that the non-parallel picture was not the only problem. The observed difference between the pictures in combination with the context stories indicates that the experiment of Study 2 was too complex. There are too much uncertainties to draw strong conclusions. We therefore suggest that the next thing to do is to conduct an experiment concerning the quantifier 'each' and the definite plural 'the' again in combination with the AOC 'different', but in a much more simple format. We suggest to perform a TVJT containing the pictures and the sentences of the preference task of experiment 1b (Study 2). The four pictures of the TVJT are combined in just one simple picture, in combination with one sentence without a long context story. In this way, the participants won’t be influenced by distractions in the pictures accompanied by a long context stories, before the actual target sentence.

11.2.1.1 Act-out Task

The most commonly used tasks in distributivity research are truth-value-judgment tasks and picture preference tasks. However, these tasks also have their drawbacks. A preference task for example cannot tell us whether participants are able to access both
interpretations. And a TVJT can only tell us what they accept, not what they prefer. An even more serious problem is that TVJT’s and preference tasks might be biasing the participants to only a subset of interpretations. In a preference task, participants are able to choose between two provided interpretations. Provided is the critical point in this sentence. Participants don’t have to come up with the interpretations themselves, they either have to indicate whether they accept it or they have to choose which interpretation they prefer.

We propose that it is more interesting to examine what kind of interpretations the participants come up with themselves. This could be realized by performing an act-out task, in which the participants have to show their own interpretation of a provided ambiguous sentence. A major drawback of an act-out task, contrary to a preference or TVJT, is the difficulty to realize it. For an act out task, multiple objects and subjects are necessary and they also have to be suitable to perform actions, such as ’pushing’ and ’holding’ etc. This is not the only thing to consider, it’s also important to look at the number of subjects and objects that are provided to the participants. Consider the following situation: when a child hears the sentence ’The boys are pushing a car’ and it has to create that situation using for example ’play mobile toys’. The question is, how many boys and cars do you provide? When the child gets for example three boys and three cars, it might be forced to the distributive interpretation, influencing their own interpretation. A possible solution to these drawbacks, is developing an act-out task using a tablet game, in which the participants can pick as many subjects and objects as they want, by dragging and dropping them. In this way you don’t give them a fixed number of items to choose from. To avoid this influence even more, it’s also possible to let them pick from a range of subject and objects, so not only providing them boys and cars, but also girls, sandcastles and other subjects and objects. This task can be used to examine the adult interpretations that turned out to be unexpected in our results. Are adults indeed less collective than we think and do they interpret ’each’ and ’every’ differently?

Although a TVJT task might not be the best method as explained in the paragraph above, the clear results of the preference task in Experiment 2b do make us believe that this is the right way to continue the research concerning the relationship between distributivity and the AOC ’different’. After conducting this proposed TVJT, we should change our methods and start thinking about doing act-out tasks rather than TVJT’s and preference tasks, to examine the true interpretations without influencing the subjects.
11.3 Conclusion

From our results it becomes clear that distributivity does relate to the interpretation of the AOC 'different', but do to the complex structure of our experiment, we are not able to draw clear conclusions. While we hope that our recent investigations have shed new light on some aspects of distributivity and its acquisition, we have also recognized a number of new challenges because of some of our unexpected results. Distributivity and distributivity marking seems to be extremely complex, and much more work is needed before we can claim to truly understand this fundamental concept.
Appendix A

Study 1

Girls

De meisjes houden een vlag vast.
The girls are holding a flag.
Ieder/Elk meisje houdt een vlag vast.
Every/Each girl is holding a flag.

De meisjes dragen een koffer.
The girls are carrying a suitcase.
Ieder/Elk meisje draagt een koffer.
Every/Each girl is carrying a suitcase.

De meisjes duwen een kinderwagen.
The girls are pushing a stroller.
Ieder/Elk meisje duwt een kinderwagen.
Every/Each girl is pushing a stroller.

De meisjes trekken een trein.
The girls are pulling a train.
Ieder/Elk meisje trekt een trein.
Every/Each girl is pulling at train.

De meisjes bouwen een zandkasteel.
The girls are building a sandcastle.
Ieder/Elk meisje bouwt een zandkasteel.
Every/Each girl is building a sandcastle.

De meisjes wassen een hond.
The girls are washing a dog.
Ieder/Elk meisje wast een hond.
Every/Each girl is washing a dog.
Boys

De jongens houden een pakje vast.
The boys are holding a present.
Iedere/Elke jongen houdt een pakje vast.
Every/Each boy is holding a present.

De jongens dragen een ladder.
The boys are carrying a ladder.
Iedere/Elke jongen draagt een ladder.
Every/Each boy is carrying a ladder.

De jongens duwen een auto
The boys are pushing a car.
Iedere/Elke jongen duwt een auto.
Every/Each boy is pushing a car.

De jongens trekken een aanhangwagen.
The boys are pulling a trailer
Iedere/Elke jongen trekt een aanhangwagen.
Every/Each boy is pulling a trailer.

De jongens bouwen een sneeuwpop.
The boys are building a snowman.
Iedere/Elke jongen bouwt een sneeuwpop.
Every/Each boy is building a snowman.

De jongens wassen een boot.
The boys are washing a boat.
Iedere/Elke jongen wast een boot.
Every/Each boy is washing a boat.
Monkeys

De apen houden een tak vast.
The monkeys are holding a branche.
Iedere/Elke aap houdt een tak vast.
Every/Each monkey is holding a branche.

De apen dragen een autoband.
The monkeys are carrying a tire.
Iedere/Elke aap draagt een autoband.
Every/Each monkey is carrying a tire.

De apen duwen een kruiwagen.
The monkeys are pushing a wheelbarrow.
Iedere/Elke aap duwt een kruiwagen.
Every/Each monkey is pushing a wheelbarrow.

De apen trekken een speelgoedaauto.
The monkeys are pulling a toy car.
Iedere/Elke aap trekt een speelgoedaauto.
Every/Each monkey is pulling a toy car.

De apen bouwen een hut.
The monkeys are building a cabin.
Iedere/Elke aap bouwt een hut.
Every/Each monkey is building a cabin.

De apen wassen een raam.
The monkeys are washing a window.
Iedere/Elke aap wast een raam.
Every/Each monkey is washing a window.
Dogs

De honden houden een bot vast.
The dogs are holding a bone.
Iedere/Elke hond houdt een bot vast.
Every/Each dog is holding a bone.

De honden dragen een boomstam.
The dogs are carrying a tree trunk.
Iedere/Elke hond draagt een boomstam.
Every/Each dog is carrying a tree trunk.

De honden duwen een winkelwagen.
The dogs are pushing a shopping cart
Iedere/Elke hond duwt een winkelwagen.
Every/Each dog is pushing a shopping cart.

De honden trekken een slee.
The dogs are pulling a sledge.
Iedere/Elke hond trekt een slee.
Every/Each dog is pulling a sledge.

De honden bouwen een blokkentoren.
The dogs are building a tower.
Iedere/Elke hond bouwt een blokkentoren.
Every/Each dog is building a tower.

De honden wassen een busje.
The dogs are washing a van.
Iedere/Elke hond wast een busje.
Every/Each dog is washing a van.
Controls

Het meisje staat op de tafel.
The girl is standing on the table.
De jongen staat op het dak.
The boy is standing on the roof.

De aap staat op de rots.
The monkey is standing on the rock.
De hond staat op het gras.
The dog is standing on the grass.

Het meisje zit op de stoel.
The girl is sitting on the chair.
De jongen zit op het paard.
The boy is sitting on the horse.

De aap zit op de fiets.
The monkey is sitting on the bike.
De hond zit op de bank.
The dog is sitting on the couch.

Het meisje speelt met blokken.
The girl is playing with blocks.
De jongen speelt met een kat.
The boy is playing with a cat.

De aap speelt met een computer.
The monkey is playing on a computer.
De hond speelt met de bal.
The dog is playing with the ball.
Appendix A. Study 1

Fillers Preference Task

Alleen meisjes spelen met een pop.
*Only girls are playing with a doll.*
De meisjes spelen met een pop.
*The girls are playing with a doll.*

Alleen meisjes staan op tafel.
*Only girls are standing on a table.*
De meisjes staan op tafel.
*The girls are standing on a table.*

Alleen meisjes zitten op een stoel.
*Only girls are sitting on a chair.*
De meisjes zitten op een stoel.
*The girls sitting on a chair.*

Alleen jongens spelen met een kat.
*Only boys are playing with a cat.*
De jongens spelen met een kat.
*The boys are playing with a cat.*

Alleen jongens staan op het dak.
*Only boys are standing on the roof.*
De jongens staan op het dak.
*The boys are standing on the roof.*

Alleen jongens zitten op een paard.
*Only boys are sitting on a horse.*
De jongens zitten op een paard.
*The boys are sitting on a horse.*
Alleen apen spelen met een ballon.
*Only monkeys are playing with a balloon.*
De apen spelen met een ballon.
*The monkeys are playing with a balloon.*

Alleen apen staan op de rots.
*Only monkeys are standing on a rock.*
De apen staan op de rots.
*The monkeys are standing on a rock.*

Alleen apen zitten op een fiets.
*Only monkeys are sitting on a bike.*
De apen zitten op een fiets.
*The monkeys are sitting on a bike.*

Alleen honden spelen met een bal.
*Only dogs are playing with a ball.*
De honden spelen met een bal.
*The dogs are playing with a ball.*

Alleen honden staan op het gras.
*Only dogs are standing on the grass.*
De honden staan op het gras.
*The dogs are standing on the grass.*

Alleen honden zitten op de bank.
*Only dogs are sitting in the couch.*
De honden zitten op de bank.
*The dogs are sitting in the couch.*
Appendix B

Study 2

The items of study 2 are not provided due to space limitations. All the items were based on the items of study 1, using the same subjects and objects in the same combinations. However the pictures were changed into comic style pictures in which the object was passed around the subjects.

The items of experiment 1a and b of study 2 are quite similar. We just combined the comic style pictures (consisting of 4 subpictures) into one picture. The items of the preference task contained the (merged) internal and external picture from which the participants had to choose.

If you are interested in the complete materials of study 2, please contact the experimenter.
Bibliography


Zimmermann, M. (2002). Boys buying two sausages each: On the syntax and semantics of distance-distributivity. LOT.