Acting Individually or Together?
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Chapter 9 starts with a short recap of the research questions. Subsequently, the research questions will be answered, with in addition a discussion of the theoretical implications and some directions for future research. Finally the work will be concluded by answering the main research question.
1 Introduction

This thesis investigated how Dutch-speaking children develop the adult interpretation pattern for definite plurals and distributive quantifiers. It is well-established in the semantic literature that sentences with plural expressions, like definite plurals and distributive quantifiers, can have different interpretations (e.g., Champollion, 2017; Landman, 1996, 2000; Lasersohn, 1995; Schwarzschild, 1996; Winter, 2002). How these interpretations arise and how children develop the adult interpretation pattern, however, remains unclear. The work in this thesis aimed to shed light on this issue, by specifically focusing on the degraded status of the distributive interpretation for definite plurals in Dutch.

To be able to answer the question of how children develop the adult interpretation pattern, the first step was to determine the interpretation pattern of Dutch adults (RQ 1). The second step was to determine the interpretation pattern of Dutch children, aiming to establish whether and how the interpretation patterns of the adults and children differed from each other (RQ 2). Given the observed differences in the interpretation patterns of adults and children, the thesis then focused on determining why these differences occur. This was investigated by considering several existing theoretical accounts: semantic accounts, a pragmatic account and a processing account. The pragmatic account attributes the adult interpretation pattern to a pragmatic process: a conversational implicature. The pragmatic account (Dotlačil, 2010) was contrasted with an alternative account that attributes children’s non-adult-like interpretations to processing limitations (Musolino, 2009). The work presented in this thesis investigated whether the Dutch interpretation patterns could be explained by one of these accounts (RQ 3). Additionally, the influence of cognitive factors was examined, since both the pragmatic account and the processing account predict a relationship with children’s working memory capacity (RQ 4). The last question addressed the interpretation patterns of distributive quantifiers in both Dutch and English. These quantifiers are assumed to be infelicitous in combination with the collective interpretation due to their distributive character. This assumption was investigated for the Dutch distributive quantifiers iedere and elke and their English equivalent each (RQ 5).

In the next section, I will return to the research questions posed in the introduction and summarized above. I will provide answers to each of these questions on the basis of the work presented in this thesis. Subsequently, I will discuss what the findings mean in terms of the existing theoretical accounts, and additionally I will provide some suggestions for future research. Finally, the work will be concluded by answering the main research question.
2 Putting the Pieces Together

In this section the research questions posed in the introduction will be answered on the basis of the findings presented in this thesis. Together the answers will provide more insight into the origin of the degraded status of the distributive interpretation and will help us answer the main research question of how children develop the adult interpretation pattern of definite plurals and distributive quantifiers. In answering the questions a comparison will be made with two studies that tested similar plural expressions and sentence types in different languages: a study in Italian by Pagliarini et al. (2012) and a study in Spanish by Padilla-Reyes (2018). These studies tested children from a wide age range to determine the acquisition of the distributive and collective interpretation of definite plurals and distributive quantifiers, similar to the work presented in this thesis. This makes a direct comparison possible and can reveal whether or not the acquisition of distributivity is a cross-linguistic phenomenon.

RQ 1 What is the adult pattern of interpretation of definite plurals and distributive quantifiers in Dutch?

In Chapters 3 and 4 the adult interpretation pattern was determined for the Dutch definite plural *de* ‘the’ and the Dutch distributive quantifiers *iedere* ‘each’ and *elke* ‘each’. The findings of the two studies presented in Chapters 3 and 4 were similar. First, they indicated that Dutch adults fully accepted sentences with the distributive quantifiers *iedere* and *elke* in distributive situations. The collective interpretation of these quantifiers, on the other hand, turned out to be less acceptable. Recall that distributive quantifiers are assumed to be almost incompatible with a collective interpretation due to their distributive character. This prediction was confirmed for the Spanish adults tested by Padilla-Reyes (2018) and the Italian adults tested by Pagliarini et al. (2012). Their adults showed very low acceptance rates for collective interpretations of sentences with a distributive quantifier (9% for Italian and 1% for Spanish). The results from our Dutch adults, however, show a different pattern, with higher acceptance rates of around 35%. This finding shows that Dutch distributive quantifiers are indeed less acceptable in collective contexts compared to distributive contexts, as predicted, but the combination does not seem to be as marginal as was previously assumed. In Chapter 7, we again tested the interpretation of the Dutch distributive quantifier *elke* by adults, but this time using a different method. In this chapter we argued that the high acceptance rates obtained in previous studies might be due to the characteristics of the previously used tasks. One of these tasks is a truth-value judgment task. A truth-value judgement task asks participants to judge whether or not a certain sentence-picture
combination is acceptable. Since sentences with distributive quantifiers are semantically compatible with the collective interpretation, this could lead to disproportionate acceptances of an actual dispreferred interpretation. To get around this issue, a different method was introduced in Chapter 7: a covered-box task. A covered-box task does not ask for participants’ acceptance of a certain sentence-picture combination, but rather determines their preference for a certain interpretation. Crucial in this paradigm is the fact that participants are explicitly asked to consider alternative interpretations, without actually being provided with these alternatives. The results of this study indeed showed a lower acceptance rate than the acceptance rates found in Chapters 3 and 4. The acceptance rate found in Chapter 7, however, was still quite high (19%), in light of the claim of the semantic literature that distributive quantifiers are almost incompatible with a collective interpretation. This issue is further examined in research question 5.

Second, the studies presented in Chapters 3 and 4 showed that, as predicted, the Dutch definite plural de ‘the’ is fully acceptable in collective situations for adults. The distributive interpretation, however, showed a different pattern. Recall that according to Dotlačil’s distributivity acceptability scale, the distributive interpretation is predicted to be degraded for group-denoting plurals such as definite plurals. This prediction is confirmed by our findings, since the distributive interpretation of the Dutch definite plural de ‘the’ was only accepted in 52% of cases in Chapter 3 and 25% of cases in Chapter 4. These results pattern with the results of the Italian adults (50%) and the Spanish adults (6%). Furthermore, the findings obtained in Chapters 3 and 4 were confirmed in Chapter 7. The covered-box task in Chapter 7 also revealed a dispreference for the distributive interpretation of the Dutch definite plural de ‘the’ for adults (38% in Experiment 1 and 47% in Experiment 2).1

In summary, we can conclude that Dutch adults indeed prefer the distributive interpretation for the distributive quantifiers iedere ‘each’ and elke ‘each’, consistent with the semantic literature. The collective interpretation, however, turned out to be moderately acceptable rather than completely incompatible, as was assumed. In line with Dotlačil’s distributivity acceptability scale, the distributive interpretation was indeed degraded for the Dutch definite plural de ‘the’. The adults fully accepted the collective interpretation for definite plurals, but found the distributive interpretation marginal.

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1 Please note that the variation in acceptance rates of definite plurals in distributive contexts in the mentioned studies is not unexpected and can be explained by the fact that implicature rates seem to vary, mostly ranging from 30% to 70% (van Tiel et al., 2016).
RQ 2 How do Dutch children interpret definite plurals and distributive quantifiers?

The studies presented in Chapters 3 and 4 were not only dedicated to determining the adult interpretation pattern, but also investigated how Dutch children interpret definite plurals and distributive quantifiers. Both studies aimed to determine the developmental path by establishing the interpretations of children from four to eleven years old.

The results of the children obtained in these studies turned out to be similar, as was the case for the adults. The Dutch children, like the Dutch adults, fully accepted the distributive interpretation of the distributive quantifiers *iedere* and *elke* from the early age of 4 years old. They, however, also fully accepted the collective interpretation, unlike adults. The Dutch children thus seem to be insensitive to the distributive character of *iedere* and *elke* until around age 8, since until then, they largely accept both the collective and the distributive interpretation. Comparing these results of the Dutch children to the earlier results of the Italian and Spanish children, the Italian and the Spanish children seem to be a bit later in their development of the understanding of the distributive character of distributive quantifiers. The Spanish study (Padilla-Reyes, 2018) tested children until age 10 and they did not reach the adult interpretation of distributive quantifiers. The Italian children were adult-like around age 11. This difference between the Dutch children, on the one hand, and the Spanish and Italian children, on the other hand, might be caused by the fact that the Dutch distributive quantifiers seem to be more acceptable in collective contexts than the distributive quantifiers in Spanish and Italian. What all studies have in common is the fact that the development of the distributive character of *each* seems to be a gradual development. Children start by accepting both interpretations and step by step move towards limiting their interpretations of distributive quantifiers to distributive interpretations. The age at which the adult interpretation is reached seems to differ between languages. This might be related to a difference in the acceptability of distributive quantifiers in collective contexts between languages.

The Dutch children also showed a full acceptance of the collective interpretation of definite plurals, similar to the Dutch adults. They already show this full acceptance at the age of 4. The distributive interpretation of definite plurals, on the other hand, turned out to be degraded for Dutch adults, but not for Dutch children. Similar to the interpretation of distributive quantifiers, Dutch children start with accepting both the collective and the distributive interpretation for the definite plural *de 'the'.* Our findings indicated that even the oldest children of around twelve years old did not yet reach the adult interpretation. They still accepted the distributive interpretation of definite plurals to a large degree. A similar observation has been made for the Spanish and the Italian children. Both the Spanish study and the Italian study
indicated that the oldest children (10 years old for the Spanish study, and thirteen years old for the Italian study) had not reached the adult interpretation yet. The development of the adult collective preference again seems to be gradual, similar to the development of the distributive character of distributive quantifiers. The adult interpretation of the definite plurals, however, is reached at a later age than the adult interpretation of distributive quantifiers.

To conclude, Dutch children, like Italian and Spanish children, seem to be insensitive to the different plural expressions at an early age. They gradually develop the adult interpretation, which is reached around age 8 for distributive quantifiers. The adult interpretation of definite plurals, on the other hand, is acquired much later. We showed that Dutch twelve year old children did not show an acceptance rate similar to adults yet.

RQ 3 What existing account in language acquisition research can explain children’s non-adult-like interpretations and the transition from the child to the adult interpretation?

Now that both the adult and child interpretation patterns have been determined, it is time to discuss which account is able to explain our two main findings:

(i) The degraded status of the distributive interpretation of the Dutch definite plural *de ‘the’* for adults, and

(ii) Dutch children’s gradual development of the adult interpretation pattern, starting from an acceptance of both the collective and distributive interpretation.

The pragmatic account was primarily investigated in Chapters 3 and 7, but also contrasted with the alternative processing account in Chapter 4.

Recall that the pragmatic account attributes the degraded status of the distributive interpretation of definite plurals to a pragmatic process, namely a conversational implicature. This entails that adults dislike a distributive interpretation of definite plurals, because there is a more specific way to convey the distributive interpretation, using a distributive quantifier. Adults infer that a collective interpretation is probably intended when a speaker does not use a distributive quantifier, hence their dispreference for the distributive interpretation for definite plurals. The pragmatic account crucially assumes that children have to learn the distributive character of distributive quantifiers before they can calculate the proposed implicature. The results of the studies presented in Chapters 3 and 7 indeed confirmed this assumption. Children only start to reject the distributive interpretation of the definite plural *de ‘the’*, once they show a full understanding of the distributive character of *iedere ‘each’* and *elke ‘each’* by rejecting them in
collective contexts. This finding serves as evidence for the pragmatic account and is in line with the results of Pagliarini et al. (2012) on Italian. The Italian children, similar to the Dutch children, only showed the adult interpretation pattern for definite plurals once they showed a full understanding of the distributive quantifier *ciascuno* 'each'.

Furthermore, in Chapter 7 we showed that our adult (and some child) participants considered alternative options, a crucial element in implicature calculation. The two experiments presented in this chapter showed that the participants preferred self-generated alternative interpretations over interpretations provided by the task. The truth-value judgment task used in Chapter 3 could not determine this, since this task only asks for acceptance or rejection of a sentence-picture combination. It cannot reveal whether or not participants reject a certain combination because they prefer an alternative interpretation. The results of the study in Chapter 7, obtained via a more sensitive method, thus serve as extra evidence for the pragmatic account and confirm the findings of Chapter 3.

One issue concerning the acquisition path of the proposed implicature, however, needs to be addressed. Crucially, the pragmatic account assumes that children first need to understand the distributive character of *iedere* and *elke*, before they can use their absence to calculate the implicature. We determined that Dutch children show a full understanding of *iedere* and *elke* around age 8, but that they do not yet show the adult interpretation for definite plurals at age 12. So how could this age gap be explained? One possibility is that children first need to gain experience with the implicature. After children have acquired the lexical semantics of the distributive quantifier, they may still need experience with calculating the implicature for plural definites to be able to reliably use the meaning of the quantifier as an alternative in their interpretation of plural definites. The pragmatic account merely predicts that the lexical semantics of the quantifier is a prerequisite for implicature calculation. This is also consistent with the well-known ‘some-all’ implicature in which children also show an age gap between the understanding of the literal meaning of *some* and *all* (around age 4) and the complete ability to calculate the implicature (around age 7) (e.g., Foppolo et al., 2012; Noveck, 2001; Pouscoulous et al., 2007). Furthermore, previous findings indicate that different implicatures are acquired at different ages. Noveck (2001) for example examined the ‘might-must’ implicature in which the modal *might* implies that the stronger *must* does not hold. He found that 7-year-olds were the youngest to demonstrate modal competence overall, but that 7- and 9-year-olds still interpreted the infelicitous *might* logically significantly more often than adults did.
This shows that 9-year-old children did not fully master the ‘might-must’ implicature yet, contrary to the ‘some-all’ implicature. Additionally, Cremers et al. (2018) demonstrated that a different kind of implicature, namely temporal inferences, are acquired before scalar implicatures such as the ‘some-all’ and ‘might-must’ implicature. Temporal inferences arise in sentences involving past tense verbs, such as ‘the children were playing outside’, which tend to give rise to the inference that the corresponding present tense version ‘the children are playing outside’ does not hold. 4- to 6-year-old children were shown to be more adult-like with respect to temporal inferences than scalar implicatures. The finding that different types of implicatures are acquired at different ages shows that different factors, besides the lexical semantics of the words involved, contribute to the ease in which children learn to generate an implicature, such as for example frequency of the words involved and experience with the implicature.

It also has been suggested that children’s abilities to generate implicatures are related to their Theory of Mind (ToM) abilities, in other words their abilities to reason about other people’s mental states, such as beliefs, desires, knowledge and intentions. Recently, Foppolo et al. (2020) found that children’s performance on the scalar ‘some-all’ implicature positively correlated with their ToM scores. This thesis, however, did not examine the role of Theory of Mind in the generation of the proposed collectivity implicature, because children have been found to develop first-order ToM around age 4 and second-order ToM around age 6 or 7 (e.g., Perner & Wimmer, 1985; Sullivan et al., 1994), whereas the collectivity implicature is not even fully mastered around age 12. It is therefore not very insightful to examine a relationship between children’s performance on the collectivity implicature and their ToM abilities.

The results discussed so far are in line with the predictions made by the pragmatic account. More evidence in favor of this account is provided by Chapter 4. The study in Chapter 4 took a different approach than the studies presented in Chapters 3 and 7. Whereas Chapters 3 and 7 primarily focused on the pragmatic account, Chapter 4 contrasted the pragmatic account with the processing account (Musolino, 2009). The aim of this study was to find out if the alternative processing account could explain children’s non-adult-like distributivity interpretations. Recall that the processing account attributes both children’s spreading errors and their non-adult-like distributivity interpretations to the same processing limitations. This prediction is based on an existing account (Geurts, 2003) that relates spreading errors to the incorrect interpretation of quantifiers caused by children’s processing limitations.

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2 Note, however, that Noveck (2001) also found that 8- and 10-year-old children and even adults to some degree treated French certains ‘some’ as compatible with French tous ‘all’. This contrasts with other studies arguing that children master the ‘some-all’ implicature around 7 years old (e.g., Foppolo et al., 2012; Pouscoulous et al., 2007).
Under this account children are predicted to process strong quantifiers as weak quantifiers, for the simple reason that weak quantifiers are easier to process. If children’s spreading errors and distributivity interpretations are indeed related and caused by their processing limitations, it is expected that they would occur at approximately the same age and disappear at the same age as well. In Chapter 4, we tested both spreading errors and distributivity interpretations in the same children to find out whether the acquisition paths of the two phenomena correspond. We did not find such a correspondence. Spreading errors disappeared around age 9, whereas the children only started showing the adult interpretation of definite plurals around age 12 and even at that age children had not fully acquired the adult interpretation. We thus found an age gap of more than two years between the development of the adult distributivity interpretations and the disappearance of spreading errors. Given these results, a common origin of distributivity interpretations and spreading errors seems to be highly unlikely. The results presented in Chapter 4 therefore do not support the alternative processing account.

So far, we can conclude that the pragmatic account is able to explain children’s non-adult-like distributivity interpretations. The results presented are in line with the assumption that children’s development of the adult interpretation strongly depends on their understanding of the distributive character of distributive quantifiers. Moreover, we did not find any evidence in support of the alternative processing account. However, explaining the child interpretation pattern is not enough. To give a complete explanation, the account should also be able to explain the origin of the adult interpretation. Contrary to the alternative processing account, the pragmatic account is able to do this by predicting that the adult interpretation of definite plurals results from the calculation of an implicature. Further evidence for this prediction will be discussed in the answer to the next research question.

RQ 4 How are cognitive factors, such as working memory, involved in the interpretation of definite plurals?

The pragmatic account predicts that the degraded status of the adult distributive interpretation for definite plurals results from a pragmatic implicature. In answering the previous question (RQ 3), it was established that the child interpretation pattern was in line with the predictions of the pragmatic account. However, to be able to give a complete explanation, it is necessary to show whether the adult interpretation is derived by an implicature. This was done by examining the relationship with cognitive factors, specifically working memory.
Part of the implicature processing literature has concluded that implicatures are not default inferences. Their calculation takes time, because it occurs after the calculation of the literal (semantic) interpretation (e.g., Bott and Noveck, 2004; Huang and Snedeker, 2009; Bott et al. 2012) and requires memory resources since both alternatives have to be kept active in memory (e.g., De Neys and Schaeken, 2007; Dieussaert et al., 2011; Marty and Chemla, 2013; Marty et al., 2013). This view predicts a relationship between the development of the adult interpretation pattern and children’s developing working memory capacity. Evidence in favor of this prediction is provided by the studies presented in Chapters 4 and 5.

As mentioned before, Chapter 4 tested children’s distributivity interpretations and spreading errors. However, this was not the only aim of the study, as it also involved a word span task to assess children’s working memory capacity. The obtained working memory scores were used to investigate the assumed relationship with the adult interpretation pattern. The results from Chapter 4 indicated that higher working memory scores were significantly related to children’s adult-like responses. In other words, children with a higher working memory capacity showed significantly more adult-like rejections of the distributive interpretation for sentences with the definite plural *de* ‘the’. No such correlation was present with children’s spreading errors. Children’s spreading errors turned out to be unrelated to their working memory capacity.

The study presented in Chapter 5 examined the same prediction, but from a different perspective. Chapter 4 focused on children by testing the relationship between children’s developing working memory capacity and the adult interpretation pattern. Chapter 5, on the other hand, focused on adults and tested whether limiting their working memory capacity would result in more child-like distributivity interpretations. This is exactly what was found in Chapter 5. Adults performing a dual-task experiment, that limited their working memory capacity, showed significantly more child-like acceptances of the distributive interpretation for sentences with the definite plural *de* ‘the’.

The results obtained in Chapters 4 and 5 are in line with the prediction that the degraded status of the distributive interpretation for definite plurals results from a pragmatic implicature: i) children gave more adult-like responses with increasing working memory capacity and ii) adults gave more child-like responses with a limited working memory capacity. This indicates that cognitive factors are indeed involved in the interpretation of definite plurals, serving as evidence for the

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3 Please note that there is an ongoing debate about the way to analyze implicatures. Some argue that implicatures are default inferences (e.g., Levinson, 2000), while others claim that they are cognitively costly and not automatic (e.g., Bott & Noveck, 2004). A more detailed discussion is provided in the Introduction section of Chapter 5.
pragmatic account, under the assumption that implicature calculation requires working memory resources.

Recall that the alternative processing account also predicts a relationship with cognitive factors. As explained before, this account is an extension of a resource-based account of spreading that attributes children's spreading errors to their processing limitations (Geurts, 2003). This account assumes that children misinterpret complex strong quantifiers as simpler, weak quantifiers and that this results in spreading errors. The processing account extends this theory, by arguing that it can also explain children's non-adult-like distributivity interpretations.

The extension of this resource-based account of spreading entails that the following assumptions must hold:

i) The development of the adult distributivity interpretation pattern is related to cognitive factors, such as working memory, and

ii) Children's spreading errors depend on cognitive factors, such as working memory, and will disappear with increasing working memory capacity.

The first assumption seems to hold: Chapters 4 and 5 showed that children's distributivity interpretations were related to their working memory capacity. The results of the studies presented in Chapters 4 and 6, however, suggest that the second assumption does not hold. First of all, we did not find a relationship between children's spreading errors and their working memory capacity in Chapter 4. Second, the results of Chapter 6 showed that adults did not show spreading errors when their working memory was limited. If it is indeed the case that spreading errors are caused by processing limitations, which is a prediction of the processing account, it is expected that adults show spreading errors if their working memory capacity is limited. This, however, is not what we found. These findings, therefore, serve as evidence for the pragmatic account and contradict the alternative processing account. Cognitive factors were indeed found to be involved in both children's and adults' distributivity interpretations. Spreading errors, on the other hand, turned out to be unrelated to cognitive resources, serving as evidence against the processing account.
RQ 5  What are the differences in the interpretation pattern of distributive quantifiers between Dutch and English?

The collectivity implicature, proposed by the pragmatic account, crucially relies on the distributive force of distributive quantifiers such as Dutch *iedere* and *elke* and English *each* and *every*. Distributive quantifiers are assumed to be almost incompatible with the collective interpretation, due to their lexical semantics. This assumption forms the basis of the implicature and entails that adults should dislike and reject collective interpretations of these quantifiers. However, in Chapter 3 we found an unexpectedly high acceptance rate for the distributive quantifier *iedere* in collective contexts. Dutch adults accepted these situations in 36% of cases, which is unexpected if distributive quantifiers are indeed semantically distributive.

This unexpected finding was hypothesized to be caused by a semantic distinction between distributive quantifiers. Similar to English *each* and *every*, Dutch also has two different distributive quantifiers, *iedere* and *elke*. Tunstall (1998) argued that a semantic distinction can be made between English *each* and *every*. English *every*, contrary to *each*, is argued to be partially distributive, also allowing a collective interpretation. In Chapter 3 we examined whether this proposed distinction could also be found between Dutch *iedere* and *elke* and that the fact that we tested *iedere* could explain the unexpectedly high acceptance rates of the collective interpretation. However, we found no such distinction. Both *iedere* and *elke* showed similar (high) acceptance rates of the collective interpretation. This is also confirmed by the results presented in Chapter 4 testing *elke*. Following these results, it was concluded that both Dutch *iedere* and Dutch *elke* seem to be similar to English *every*, in the sense that they also allow the collective interpretation.

The issue was further investigated in Chapter 8. The study in Chapter 8 hypothesized that collective situations can be interpreted as distributive depending on several factors. Chapter 8 tested the influence of verb type. The results indicated that seemingly collective situations were interpreted as distributive to a large degree when the verb denoted an independent action (such as *brush* and *wash*) instead of a dependent action (such as *hold* and *carry*). This was not only the case for Dutch *elke*, but also for English *each*. The fact that English *each* turned out to be acceptable in collective situations is highly unexpected, since distributivity is assumed to be a lexical property. Tunstall (1998) argued that English *each*, unlike *every*, has an additional requirement, besides the distributivity requirement. This requirement is referred to as the differentiation condition and it entails that all the subevents of a distributive event must be differentiated from the other subevents in some way. This additional requirement explains the stronger distributive character of English *each* compared to English *every*.
The results of Chapter 8 suggest that this differentiation condition can be met in several ways. Consider for example the sentence ‘each girl is brushing a goat’. The subevents in this sentence can be differentiated in different ways other than by just distributing over objects (different goats in this case). Differentiation can also be reached by for example distributing over:

- **Time**: the same goat brushed by different girls at different times.
- **Place**: the same goat brushed at different places by different girls or even different places on the goat itself, with, for example, one girl brushing the head of the goat and another girl brushing the tail of the goat.
- **Actions**: the different brushing actions performed by different girls, regardless of time, place or object.

Note that in experimental designs collective situations are usually depicted as several actors performing an action on a single object. This situation is predicted to violate the differentiation condition, since the actors are performing an action on the same object. The results of Chapter 8, however, indicate that the experimental participants found a way to meet the differentiation condition by distributing over the independent actions denoted by independent verbs such as *brush* and *wash*, rather than over the object. Dependent verbs such as *hold* and *carry*, on the other hand, did not evoke this distribution over actions.

All in all, Chapter 8 shows that the interpretation of distributive quantifiers in Dutch and English is not as clear-cut as was previously assumed. The fact that seemingly collective situations can be interpreted as distributive depending on several factors has important methodological implications. It shows that care has to be taken when constructing experimental materials that should probe collective and distributive situations. This finding also offers an explanation for the unexpectedly high acceptance rates of distributive quantifiers in collective contexts found in previous work: it is quite plausible that they are not caused by a difference in the distributive character of distributive quantifiers, but rather due to the different ways in which the differentiation condition can be met. This conclusion is further supported by the fact that similar results were found for Dutch *elke* as well as English *each*. However, future research is necessary to find out what other factors can influence the interpretations of distributive quantifiers.
3 Theoretical Implications

The different interpretations of plural expressions are by some argued to be caused by the semantics of these expressions, whereas others claim that the interpretations are of a pragmatic nature. The findings in this thesis do not point to one of these views in particular but rather point at an interplay between semantics and pragmatics. How the interpretations of group-denoting plurals such as definite plurals can be explained by both semantic and pragmatic processes was investigated by focusing on an existing theoretical account that we dubbed the pragmatic account. This pragmatic account (Dotlačil, 2010) predicts that the degraded status of the distributive interpretation for definite plurals results from a pragmatic implicature. This implicature is based on the lexical semantics of the distributive quantifier *each*. These distributive quantifiers mark the distributive interpretation. Unmarked definite plurals, on the other hand, are less informative and can convey both interpretations. Although they can convey both interpretations, the collective interpretation is preferred due to the calculation of the implicature. This entails that the (distributive) interpretation of the marked form is excluded for the reason that the marked form was not used.

The implicature is thus based on the semantics of plural expressions. Distributive quantifiers are semantically distributive. Definite plurals, on the other hand, are unmarked for distributivity. As discussed in Chapter 2, some semantic theories assume that these unmarked plural expressions, such as definite plurals, are ambiguous between the collective and the distributive interpretation, whereas others assume that they are underspecified with respect to the different interpretations. The work in this thesis sheds some light on this ongoing debate, as our findings seem to support the assumption that the different interpretations are a case of underspecification rather than ambiguity. The ambiguity account claims that plural expressions are by default collective and that the distributive interpretation results from the application of a distributivity operation. This assumption entails that the distributive interpretation is more complex than the collective interpretation. This, however, does not match the findings presented in this thesis. The experimental studies presented in this thesis and the previous literature indicate that children can access both the collective and the distributive interpretation from a very early age, which is unlikely if the distributive interpretation is more complex. If an extra operation is indeed necessary to arrive at the distributive interpretation, it would be expected that children start with the collective interpretation and have to develop the distributive interpretation. The results from this thesis, however, are not in line with this prediction. Both the results of the children and of the adults indicate that the collective interpretation is far from the default. Moreover, we also found that cognitive processes such as working memory are involved.
The underspecification assumption, on the other hand, seems to be a better match. The semantic underspecification account, discussed in Chapter 2, makes no assumptions about complexity and argues that all the interpretations are the result of the same operation: the application of a cover. The different interpretations result from the applications of different covers and which cover is applied depends on pragmatic factors. A cover can be completely specified or left unspecified. If a sentence contains the distributive quantifier *each* the cover is specified and requires a full partition. In case of definite plurals, on the other hand, the cover is unspecified and in this case context and pragmatic reasoning are predicted to determine the cover. The semantic underspecification account, however, does not further discuss how these pragmatic factors determine which cover is applied and how certain preferences for a particular interpretation arise. Furthermore, the account also cannot fully explain the interpretations of children. It could be the case that children’s abilities to select the appropriate covers depends on their development of pragmatic reasoning, but this is not a clear prediction. What kind of pragmatic reasoning is necessary for these covers and how do children learn what cover needs to be selected? These questions remain unanswered.

The pragmatic account, on the other hand, has a clear prediction of how pragmatic reasoning is involved and is in line with the underspecification assumption of pluralities. This account, however, does not assume that the underspecification is resolved due to the use of covers, but argues that the different interpretation preferences are a result of a pragmatic process: an implicature. An implicature is a pragmatic process that goes well with the underspecification approach, since Gricean reasoning is commonly used to strengthen underspecified meanings. The pragmatic account can both explain the adult collective preference for definite plurals, as well as the child interpretation pattern starting from an acceptance of both the collective and the distributive interpretation. Recall that the child data cannot be explained by the semantic ambiguity account, because this ambiguity approach assumes that the collective preference is the default, while the distributive interpretation is more complex as it results from an operation. The pragmatic account, however, attributes children’s non-adult-like interpretations of definite plurals to their inability to calculate the implicature. Their ability to calculate the implicature develops over time primarily depending on the development of the lexical semantics of the words involved, but also under the influence of different factors such as the development of cognitive factors and the exposure to the implicature. The pragmatic account is therefore able to provide a complete picture of the development of distributivity.

The pragmatic account, however, does not completely rule out the ambiguity assumption, as Gricean reasoning has also been connected to the interpretations of ambiguous expressions. Gricean reasoning is hardly ever argued to play a role in
semantic disambiguation, but it is not entirely unheard of. Geurts (2010, page 24) for example points out in his book about quantity implicatures that the first passage in Grice’s work hinting at the Cooperative Principle (1957) concerns the resolution of ambiguities. More research is therefore necessary to find out whether the collective/distributive distinction truly is a matter of underspecification or that it could also be a matter of ambiguity.

The work in this thesis also gave rise to some new research questions and in the next section I will provide some directions for future research.

4 Future Directions

The work presented in this thesis demonstrates that the interpretations of distributive quantifiers seem to differ between and even within languages. The Dutch distributive quantifiers iedere and elke turned out to be more acceptable in collective contexts than distributive quantifiers from languages such as English (each), Italian (ciascuno) and Spanish (cada). Additionally, we found that Dutch children reached the adult interpretation of distributive quantifiers earlier than the English, Italian and Spanish children. It is not yet clear (i) why distributive quantifiers are interpreted differently between languages and (ii) how these differences affect the acquisition paths of the different distributive quantifiers. Furthermore, the results of Chapter 5 indicated that the interpretation of each in collective situations required memory resources. This finding suggests that the distributive character of distributive quantifiers is more than just semantics. These unexpected findings show the necessity of doing cross-linguistic research on distributivity to reveal the complete picture of distributive quantifiers.

A second possible direction for future research involves the relation between situations and interpretations. The results of Chapter 8 demonstrated that the distributivity requirement of distributive quantifiers can be met in different ways, for example by distributing over times, places and events. Pictures intended to convey a collective situation were interpreted distributively by participants. This unexpected finding raises the question of what factors influence the way participants interpret a visual scene and which verification strategies are used by the participants to arrive at their interpretations. Furthermore, it is important to find out whether these different interpretation patterns are a matter of individual differences between participants or that they reveal more general differences caused by for example the experimental design. Looking into this further is crucial as the interpretational possibilities allowed by the visual scene influence the participants’ interpretations of distributive quantifiers in relation to the visual scene.
The work presented in this thesis focused on the collective and the distributive interpretation of definite plurals and distributive quantifiers. Definite plurals and distributive quantifiers, however, can also give rise to cumulative interpretations. Musolino (2009) and Drozd et al. (2017) examined the interpretations of English distributive quantifiers by also looking at cumulative interpretations and showed that children are more permissive in accepting cumulative interpretations with distributive quantifiers than adults. Their results seem to suggest that adults dislike cumulative interpretations of distributive quantifiers. This might be caused by fact that distributive quantifiers have a distributivity requirement. Tunstall (1998), however, claimed that there is a difference between the English distributive quantifiers *each* and *every*. She argues that English *each* is different from English *every* in the sense that both *each* and *every* have a distributivity requirement, but that *each* but not *every* has an extra differentiation requirement. English *every* does not require differentiation and is argued to be only partially distributive, also allowing collective interpretations, contrary to *each*. Cumulative interpretations are well-suited to examine this prediction and may be able to shed light on the difference between distributive quantifiers within languages. This could be achieved by not only examining English *each* and *every*, but also Dutch *iedere* and *elke*. Examining cumulative interpretations of these quantifiers could show us whether there are cross-linguistic similarities or that the different distributive quantifiers might have a language specific interpretation. Continuing the work of Musolino (2009) and Drozd et al. (2017) would therefore provide a more complete picture of the distributivity requirement of distributive quantifiers, and on which factors it depends.

This thesis focused on the acquisition of quantificational distributivity, as expressed by distributive quantifiers. We found that Dutch children until age 8 are insensitive to the distributive character of distributive quantifiers. In addition to quantificational distributivity, little is known about the acquisition of lexical distributivity: the distributive interpretation of predicates such as *smile*, *eat* or *drink*. In the latter case the distributive meaning is included in the semantics of the predicate, and no distributive marker is necessary to express the distributive interpretation. Adults simply know that *eating* and *drinking* are distributive properties, but how do children interpret these predicates? Do they start with both interpretations being possible, similar to what we have found for quantificational distributivity, or do they immediately recognize the distributive character of these predicates?
5 Conclusions

The use of plural expressions can evoke different interpretations. Pluralities can be interpreted in various ways: are the individuals performing an action themselves or are several individuals performing an action together as a group? This phenomenon is referred to as the phenomenon of distributivity. For listeners it is important to find out which interpretation is intended by the speaker. However, it is not clear how listeners arrive at a certain interpretation and how children develop the adult interpretation pattern.

This thesis investigated the acquisition of the phenomenon of distributivity, by answering the question of how children develop the adult interpretation pattern of definite plurals and distributive quantifiers. Definite plurals are semantically ambiguous, or underspecified, with respect to the collective and the distributive interpretation. Despite this ambiguity or underspecification, adults show a preference for the collective interpretation. How this preference arises is far from clear-cut. The current thesis determined the interpretation patterns of Dutch children and adults via several experimental studies. These studies did not only investigate the interpretations of different plural expressions, but also examined the possible involvement of cognitive resources.

Together the presented studies show that the adult interpretation pattern can be explained by a pragmatic implicature and the child interpretation pattern results from children’s inability to calculate this implicature. Young children need to learn the lexical semantics of distributive quantifiers before they can use the implicature to arrive at the adult interpretation of definite plurals. Additionally, the studies presented in this thesis provided evidence for the involvement of cognitive resources. Implicature calculation may be dependent on working memory capacity. The findings of this thesis also shed light on the origin of the different interpretations, as the results obtained in this thesis support the assumption that the difference between the collective and the distributive interpretation is a case of underspecification rather than ambiguity.

In sum, the results provide a fuller picture of the division of labor between semantics and pragmatics in the interpretation of sentences with plural expressions. The thesis not only yields new insights in how semantics contributes to the interpretation of plural expressions, but also provides evidence in favor of the involvement of pragmatics in the adult interpretation of plural expressions.