Chapter 2 sets the stage for the rest of the thesis. It starts with a detailed discussion of the results obtained by studies dedicated to the interpretations of plural expressions by both children and adults. Additionally, several existing theoretical accounts of the different interpretations are discussed.
1 Children’s versus Adults’ Interpretations

The three examples from the introduction, with the definite plural the (1a), the distributive quantifier each (1b) and the universal quantifier all (1c), illustrate the differences in interpretation that different plural expressions can evoke.

(1) a. The children received a trophy at the ceremony.
    b. Each child received a trophy at the ceremony.
    c. All children received a trophy at the ceremony.

Dotlačil (2010), following the terminology of Beghelli and Stowell (1997), proposed three categories of plural expressions based on the acceptability of the distributive interpretation. He determined the acceptability of the distributive interpretation for these three categories on the basis of several experimental findings regarding the interpretations of different plural expressions (Brooks & Braine, 1996; Frazier et al., 1999; Gil, 1982; Kaup et al., 2002). The three categories can be placed on a scale of how acceptable the distributive interpretation is (Dotlačil, 2010):

Distributive Quantifiers > Counting Quantifiers > Group-Denoting DPs

- DPs with **distributive quantifiers** (*each* and *every*) are fully compatible with distributive interpretations. The distributive interpretation is even strongly preferred, with the collective interpretation being marginal.

- DPs with **counting quantifiers**, quantifiers that determine the cardinality of expressions and cardinality expressions build by modified numerals (such as *all, both* and *more/fewer than*), are compatible with both interpretations, but are slightly dispreferred with the distributive interpretation.

- **Group-denoting DPs**, such as definite plurals like ‘the girls’, bare numerals like ‘two girls’ and coordinations of proper names like ‘Emma and Sofia’, are compatible with both the collective and the distributive interpretation, similar to counting quantifiers. The distributive interpretation, however, is strongly dispreferred.

The results of the experiments discussed by Dotlačil (2010, pages 9-17), show that the distributive interpretation is degraded for many plural expressions, including universal quantifiers (*all*) (Brooks & Braine, 1996), indefinite numerals (Brooks &

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1 Please note that the term counting quantifier is also used in logic, but with a quite different definition.
Braine, 1996; Gil, 1982), pronouns (they and both) (Kaup et al., 2002) and coordinations of proper names (Frazier et al., 1999). These findings demonstrate that the distributive interpretation is acceptable to different degrees for different plural expressions. Dotlačil (2010), however, only discusses adult interpretations. This conclusion can thus only be made for adults, but what about children?

The next sections (1.1, 1.2 and 1.3) discuss experimental findings of children’s distributivity interpretations and how these interpretations differ from the adult interpretation. This is done for each of the three categories proposed by Dotlačil (2010). The distributive quantifiers that are predicted to be most acceptable with the distributive interpretation are discussed first. Subsequently, the counting quantifiers will be discussed. Counting quantifiers are placed at the center of Dotlačil’s distributivity acceptability scale and both the collective and the distributive interpretation are predicted to be equally acceptable with these quantifiers. The last category is formed by the group-denoting plurals, which are predicted to be least acceptable with the distributive interpretation.

### 1.1 Distributive Quantifiers

According to Dotlačil’s distributivity acceptability scale, distributive quantifiers such as each and every are predicted to be most acceptable with distributive interpretations. The literature shows that adults indeed have a strong preference for the distributive interpretation for such quantifiers and find a collective interpretation marginal (e.g., Brooks & Braine, 1996; Gil, 1982; Ioup, 1975; Pagliarini et al., 2012; Syrett & Musolino, 2013; Zimmermann, 2002). Several studies indicate that this is different for children. Young children do not show a strong distributive preference yet for distributive quantifiers and do not recognize the distributive character of each.

Brooks and Braine (1996) for example used a picture selection task with sentences like (2). They tested children from 4 to 9 years old, in addition to an adult control group.

(2) Each man is building a boat.

While adults selected the distributive interpretation in 99.2% of the cases, children of 4 and 5 years old selected the collective interpretation in 37.7% and 44.2% of the cases, respectively, only reaching the adult distributive preference around age 8.

Similarly, Syrett and Musolino (2013) found, using a picture verification task, that 4 and 5-year-old children accepted sentences like (3) in collective contexts in 86.7% of the cases. Contrary to children, adults only accepted these situations in 31.9% of the cases.
(3) Two boys each pushed a car.

The results of Brooks and Braine (1996) and Syrett and Musolino (2013), discussed above, indicate that children can interpret each both collectively and distributively and not purely distributively, as adults do. This finding is in line with the results from Roeper et al. (2011), testing 5- to 9-year-old children. Although they tested exhaustivity\(^2\) rather than collectivity, their results also seem to point to an incomplete lexical understanding of the quantifier each. They found that children, unlike adults, preferred exhaustivity over distributivity as a defining feature for each and every. They conclude that distributivity is not yet acquired as a lexical property. Exhaustivity answers became less frequent among the older children, indicating that children’s sensitivity to distributivity increases with age.

Novogrodsky et al. (2013) also found non-adult-like interpretations of each. Using a contrastive narrative task, they found that children, unlike adults, only had a tendency towards distributive interpretations for each (only 43% of children’s responses were distributive). Contrary to children, adults did not give collective responses to questions containing the distributive quantifier each.

The previous studies all indicate that English-speaking children seem to be unaware of the lexical semantics of each. Contrary to adults, they also accept each in collective situations. But what about other languages? Do we see similar patterns for other languages as well? The studies of Rouweler and Hollebrandse (2015) testing Dutch elke ‘each’, Pagliarini et al. (2012) testing Italian ciascuno ‘each’ and Padilla-Reyes (2018) testing Spanish cada ‘each’, show similar results and indicate that children’s incomplete lexical understanding of distributive quantifiers seems to be a cross-linguistic phenomenon. The lexical understanding of the distributive character of these quantifiers seems to develop gradually (Brooks & Braine, 1996; Padilla-Reyes, 2018; Pagliarini et al., 2012; Roeper et al., 2011).

\(^{2}\) The distributive interpretation requires a one-to-one pairing between individuals and objects, whereas an exhaustive interpretation requires that all present entities are included in the action. Roeper et al. (2011) use an example with flowers distributed over vases in combination with sentences such as each/every flower is in a vase. In this example, a distributive interpretation requires that all flowers are divided over the vases with exactly one flower in each vase (multiple flowers in one vase would be a collective interpretation). For the distributive interpretation it does not matter that there are empty vases, as long as the flowers are one-to-one paired with the vases. For the exhaustive interpretation, on the other hand, it is necessary that all vases have one or more flowers in them, independent of the distribution of flowers.
1.2 Counting Quantifiers

Besides testing sentences with the distributive quantifier *each* (2), Brooks and Braine (1996) also tested sentences with the counting quantifier *all* (4).

(4) All the men are building a boat.

Counting quantifiers such as *all, both* and *more than*, are placed at the center of the distributivity acceptability scale, with collective and distributive interpretations both being possible and the distributive interpretation being slightly dispreferred.

This is consistent with the findings of Brooks and Braine (1996) for English-speaking adults. The adults selected the collective interpretation of *all* in 83.3% of the cases, which means that they only selected a distributive interpretation in 16.7% of the cases. The children, on the other hand, interpreted the quantifier *all* differently. The 4-year-old children showed a similar pattern for the quantifier *all* as they did for the quantifier *each*, sometimes preferring the distributive picture and sometimes the collective picture. The 4-year-old children preferred the collective picture in 54.4% of the cases and the distributive picture the rest of the times. The children approached the adult preference rate at age 9, showing a preference for the collective picture in 72.2% of the cases. These results suggest that children gradually develop the adult preference for the quantifier *all*, similar to what was found for the quantifier *each*. Note, however, that the adult preference for the quantifier *each* is a distributive preference. This in contrast with the adult preference for the quantifier *all*, which is a collective preference.

Rouweler and Hollebrandse's (2015) results for Dutch are also in line with Dotlačil's (2010) scale. They used both a truth-value judgment task and a preference task. The adults accepted the collective interpretation of Dutch *alle* ‘all’ in 90% of the cases and the distributive interpretation in 95% of the cases, indicating that both interpretations are possible. The results of the preference task reveal that the adults chose a distributive picture for sentences with *all* in 60% of the cases. This indicates a slight preference for the distributive interpretation, contrary to the English adults tested by Brooks and Braine (1996), who showed a collective preference. The results of the Dutch children (5- to 6 years old) are quite similar to the results of the Dutch adults and show acceptances of the collective interpretation in 80% of the cases and acceptances of the distributive interpretation in 90% of the cases. The preference task, however, shows a different pattern. The children preferred the distributive interpretation in 84% of the cases, a stronger preference than the adults.

Overall, the results are in line with Dotlačil's (2010) prediction that both a collective and a distributive interpretation are possible for sentences with the quantifier *all*.
The prediction that the distributive interpretation is slightly dispreferred for such sentences, however, is not confirmed for Dutch. The Dutch results indicated that both the adults and the children showed a (slight) preference for the distributive interpretation. The English adults, unlike the Dutch adults, did show a collective preference, but the English children, on the other hand, did not show a clear preference and selected the distributive and collective interpretation to a similar degree.

1.3 Group-denoting Plurals

Group-denoting plurals, such as plural definites (*the girls*), numerals (*three girls*) and coordinations of proper names (*Emma and Sofia*), are placed at the end of Dotlačil’s (2010) scale, meaning that they are predicted to be the least acceptable with distributive readings. Semantically these plurals are compatible with both the collective and the distributive interpretation, as was the case for the counting quantifiers. However, several studies have indicated that adults show a preference towards a collective interpretation, even more so than for the counting quantifiers (Brooks & Braine, 1996; Frazier et al., 1999; Padilla-Reyes, 2018; Pagliarini et al., 2012; Syrett & Musolino, 2013). In the next paragraphs of this section the interpretations of the children and how they differ from the adult interpretation pattern will be discussed.

Brooks and Braine (1996) tested sentences with the numeral *three* such as in (5), using a preference task, and found that adults selected collective pictures in 97.5% of the cases. This shows a clear collective preference.

(5) Three men are building a boat.

The children, however, showed a different response pattern and selected the collective picture in only 62.2% of the cases at the age of 4. The collective preference gradually increased with increasing age, reaching an adult like preference (95.6%) at around age 9.

These results are similar to the results found by Syrett and Musolino (2013), who also performed a preference task with similar sentence types containing the numeral *two*. Their results show that adults selected the collective picture in 88.9% of the cases. This again indicates a clear preference for the collective reading. 4- to 5-year-old children, on the other hand, selected the collective picture in only 31.5% of the cases, showing a preference for the distributive picture (68.5%).

Similar patterns are observed for the definite plural *the* in both Spanish (*los*: Padilla-Reyes, 2018) and Italian (*i*: Pagliarini et al., 2012). Using a truth-value judgment task with stop-motion videos, Padilla-Reyes (2018) showed that adults accepted distributive readings of the definite plural *los ‘the’* in only 6% of the cases.
The collective reading, on the other hand, was accepted in 99% of the cases. This was different for children. The 5-year-old children showed an acceptance rate of 96% for the distributive reading and 100% for the collective reading. These results show that Spanish children start with a full acceptance of both readings. This gradually changes, with an acceptance rate of around 20% for the distributive reading and a full acceptance for the collective reading at age 10.

Pagliarini et al. (2012) found similar results for Italian. They used a truth-value judgment task with static pictures and found that adults fully accepted the collective reading of the definite plural *i* ‘the’. The distributive reading, on the other hand, was only accepted in 50% of the cases. The Italian children, similar to the Spanish children, started with a full acceptance of both readings at age 4. This response pattern again gradually changed towards the adult interpretation. However, even at age 13 the Italian children did not show similar acceptance rates as the adults, with a 72% acceptance rate of the distributive reading (versus a 50% acceptance rate for adults). Both the Spanish and the Italian results showed that the distributive reading of the definite plural *the* is degraded for adults, but not for children. Children fully accept both readings.

Although the Spanish and Italian results seem to be similar, it has to be noted that the adult acceptance rate for the distributive reading of the Spanish *los* was lower than the adult acceptance rate for the distributive reading of the Italian *i* (6% versus 50%). This might have to do with a difference in method. Padilla-Reyes (2018) used stop-motion videos in his truth-value judgment task. In the videos, he tried to include as much pragmatic context as possible in order to make the videos and target sentences felicitous and unmarked. Additionally, they also included actions in the scenarios to meet the Condition of Plausible Dissent (Crain & McKee, 1985) and the Question-Answer Requirement (Roberts, 2012). They give the following example to illustrate how the aforementioned requirements were met.

In one video (with a distributive context), participants see a toy barn with three toy rocks and three toy characters in front of it and hear the following sentence:

“The minions are working on the farm and they have to move a rock.”

They are then asked the following question, by attempting to directly establish the question under discussion:

“There is more than one (rock) and they look pretty light. How will they do it?”

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3 The collective context was conveyed by a scene in which three toy characters are pushing one big rock (instead of three small rocks as in the distributive context).
Then, following the Condition of Plausible Dissent of Crain & McKee (1985), the minions appear to confer as to how to accomplish the pushing of these three rocks, to make it clear that they think that there are multiple logical possibilities. The three minions then each proceed to push a rock, one minion per rock and then the sentence is uttered:

“I know how they did it: the/each minion(s) pushed a rock.”

When the clip finished, the participants were asked to either affirm or deny whether what they had heard was a correct representation of what they had seen.

This procedure is much more detailed than the truth-value judgment task used by Pagliarini et al. (2012), who used static pictures without a context story, with only a target sentence. The fact that Padilla-Reyes (2018) included as much pragmatic context as possible, by for example providing information like “there are more than one (rock) and they look pretty light”, explains the much lower acceptance rate of the definite plural los ‘the’ in a distributive context for adults (6%) compared to the acceptance rate of the definite plural i ‘the’ for adults in Italian (50%). Explicitly stating that there are three rocks and that they are light emphasizes the distributive interpretation for adults more than a static picture does. For the Spanish adults, it thus became evident what the most appropriate interpretation was due to the presented context.

The studies presented in this section show that, contrary to adults, children seem to be insensitive to the different properties of different plural expressions as reflected by Dotlačil’s (2010) distributivity acceptability scale. Children fully accept both the distributive and the collective interpretation, regardless of the type of plurality. Even the distributive quantifiers, that are fully distributive for adults, are ambiguous for children until age 9. This raises the question of how the different interpretation preferences are acquired. How do children develop the adult interpretation preferences? As mentioned in the introduction, the focus of this thesis will be on the group-denoting plurals, in particular sentences with definite plurals. There is a great body of work dedicated to the different types of plural expressions and their interpretations, however, the least seems to be known about the interpretations of definite plurals. The studies by Pagliarini et al. (2012) and Padilla-Reyes (2018) are the only ones that tested the proposed degraded status of the distributive interpretation in combination with definite plurals. They indeed confirmed this degraded status, but where does the collective preference for such plurals find its origin? In the following section, several theoretical accounts will be discussed.
2 Theoretical Accounts of Distributivity

This section is devoted to the discussion of several theoretical accounts that try to explain the origin of the different interpretations of plural expressions and how preferences for a certain interpretation arise. The first section is dedicated to two prominent semantic accounts. Additionally, some empirical evidence for these accounts will be discussed. Subsequently, the focus will be on the processing account (Musolino, 2009) that aims to explain the acquisition of distributivity, focusing merely on children’s non-adult-like distributivity interpretations and connecting those interpretations to a well-known phenomenon in quantifier acquisition: spreading errors. Lastly, the pragmatic account (Dotlačil, 2010) will be discussed. This account attributes the degraded status of the distributive interpretation to a pragmatic implicature.

2.1 Semantic Accounts

The current section discusses two prominent semantic accounts. These two accounts come with different assumptions regarding the difference between the collective and the distributive interpretation of plural expressions. A prominent question is whether this difference in interpretations should be regarded as a case of ambiguity or underspecification. Do the different interpretations of plural expressions result from a difference in semantics, a true ambiguity? Or do these plural expressions actually have one underspecified reading and are the different interpretations a result from pragmatic factors such as implicated meaning and contextual information?

One semantic account that assumes that the difference between the interpretations of plural expressions is a case of ambiguity, argues that collectivity is a property of a predicate, while distributivity is an operation that can be applied to the predicate. This is commonly referred to as the D-operator and was first introduced by Link (1991), but also discussed by, among others, Roberts (1987) and Landman (2000). The D-operator is often referred to as the silent counterpart of adverbial each, since they behave similarly (Champollion, 2016). We will refer to this account as the semantic ambiguity account. According to the semantic ambiguity account, the collective interpretation is understood as the default reading. It is assumed that plurals are individuals, that can have other individuals as their parts (Landman, 2000; Link, 1998). The D-operator can shift a (by default collective) verb phrase to a distributive interpretation. The verb phrase then holds for a plural entity x, from which each of its singular individuals satisfies the conditions predicated by the verb phrase. This results in two different interpretations. The representation in (6) illustrates how the semantic ambiguity account differentiates between the interpretations of the examples mentioned in the introduction.
The collective interpretation is represented by (6a) and the distributive interpretation is represented by (6b).

(6) The/All/Each child/children received a trophy at the ceremony.

a. \[[\text{receive a trophy}] = \{ x | \text{there is a trophy that x receives} \}\]

b. \[D[\text{receive a trophy}] = \{ x | \text{for all singular individuals y in x, there is a trophy that y receives} \}\]

It is important to note that under the semantic ambiguity account, the distributive and the collective interpretation differ in their representational complexity due to the operation that is required to achieve the distributive interpretation. The distributive interpretation contains a D-operator. The collective interpretation, on the other hand, does not contain this operator, which makes the collective interpretation less complex. This difference in complexity has implications for the acquisition of the distributive interpretation. These will be discussed later.

One problem with the semantic ambiguity account, however, lies in the fact that it treats the differentiation between the collective and the distributive interpretation as dichotomous. This means that it can only explain these two interpretations. The collective interpretation is the default and no extra operation is necessary, because following the view that pluralities are single entities that can have singular individuals as parts, verb phrases are by default interpreted as collective (one entity that performs an action). A distributive operator is necessary to break apart this entity, and let each of the singular individuals of the entity satisfy the verb phrase. Please recall that although in this thesis the focus lies on the distributive and the collective interpretation, there are also cumulative interpretations, which can be seen as intermediate interpretations, partially collective and partially distributive.

Recall example (1) from the introduction, which is repeated as example (7) below:

(7) The children received a trophy at the ceremony.

The cumulative interpretation can be clarified by considering the following situation: imagine a situation in which eleven children participated in the team that won a school tournament. The school, however, miscalculated and only bought ten trophies. So as a result, two children have to share a trophy. Example (7) can also describe this situation, in addition to a collective and a distributive interpretation. The semantic ambiguity account, however, cannot explain this intermediate interpretation, due to its dichotomous character. This account fails to make enough distinctions to be able to account for cumulative interpretations. So the question remains: how can we account for this interpretation?
In addition to the ambiguity approach, there is also the view that the difference between the interpretations of plural expressions is a case of underspecification rather than ambiguity. We will refer to this view as the semantic underspecification account. The semantic underspecification account, contrary to the semantic ambiguity account, is able to deal with these (intermediate) cumulative interpretations. This account is set-based and takes plurals to denote sets (Schwarzschild, 1996; Winter, 2002). Under this assumption plurals are a single entity, a set, that can also have several elements as its members. Schwarzschild (1996), following Higginbotham (1980) and Gillon (1987), proposes an underspecification approach to account for the different interpretations, including intermediate cumulative interpretations. The plurals are underspecified with respect to the different interpretations. The distinction between the different interpretations can be made via partitioning within the plural entity. This partitioning results from the application of a cover. A cover is an operator that creates subsets of a main set. See (8) for a definition, following Schwarzschild (1996), Gillon (1987) and Higginbotham (1980):

\[(8) \quad [\text{NP}_{\text{plural}} \text{VP}] \text{ is true iff there is a partition } C \text{ of the plurality } P \text{ denoted by NP such that } \text{VP is true for every element in } C.\]

A partition is a kind of cover, where:

- C is a cover of P if and only if:
  1. C is a set of subsets of P
  2. Every member of P belongs to some set in C
  3. There is no empty set in C

So the different interpretations, either distributive, collective or (intermediate) cumulative are reached by the application of different covers. A distributive interpretation requires a cover that results in a total partition that goes to the level of the individual. This means that the main set is divided in several subsets so that each individual member of the plural entity has its own set and the sets do not overlap. The predicate then applies to all these different sets, with as a result the distributive interpretation. The collective interpretation, on the other hand, results from a cover with one partition, thus, a set with one set member (the group of individuals). The predicate then only applies to this single set member and thus results in a collective interpretation. The cumulative interpretations result from covers that require an intermediate partition: subsets that contain multiple individuals, but also sets that only contain a single individual.

These different covers thus create different subsets within a main entity. Schwarzschild (1996) refers to this operation as the Part-operator. He argues that which cover is applied depends on context. In different contexts, different covers
might be salient, that is, a given plurality may have parts that are relevant in one context but not in another. If a sentence contains a distributive quantifier such as *each*, the cover that needs to be applied is specified due to the lexical semantics of *each*, whereas in case of a counting quantifier or a group-denoting plural, the cover is unspecified and needs to be determined via pragmatics.

Under the semantic underspecification account there is no difference in complexity between the three interpretations. A cover needs to be applied to achieve either reading. This is in contrast with the semantic ambiguity account, where the distributive reading requires an extra operation and the collective interpretation is the default.

### 2.1.1 Empirical Evidence for the Ambiguity Approach

In an eye-tracking study, Frazier et al. (1999) empirically determined whether the collective/distributive distinction is a matter of ambiguity or underspecification. Their results seem to favor the ambiguity view. Frazier et al. (1999) tested sentences such as (9), containing a coordination of proper names,⁴ with either the distributive quantifier *each* or the collective adverb *together*. *Each* disambiguates the sentence to a distributive interpretation and *together* disambiguates the sentence to a collective interpretation. The sentences differed in this disambiguation. Sentences (9a) and (9b) have late disambiguation, whereas sentences (9c) and (9d) have early disambiguation.

(9)  

|   |  
|---|---|---|---|
| a. Lynne and Patrick saved $1000 **each** to pay for their honeymoon. | b. Lynne and Patrick saved $1000 **together** to pay for their honeymoon. |
| c. Lynne and Patrick **each** saved $1000 to pay for their honeymoon. | d. Lynne and Patrick **together** saved $1000 to pay for their honeymoon. |

Frazier et al. (1999) tested participants’ reading difficulties of these sentences, by examining participants’ eye-movements in a reading task. When the disambiguation occurred early in the sentence there was no difference in reading speed between sentences with *each* and sentences with *together*. However, for the sentences with late disambiguation, Frazier et al. (1999) found a difference in reading speed between sentences with *each* and sentences with *together*. For sentences with *each* there was a significant slowdown, located at the region following the disambiguation. Frazier et al. (1999) attribute this difference to a mismatch between participants’ initial preferred interpretation and the interpretation forced by *each*. *Each* is a distributive quantifier that forces the distributive interpretation.

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⁴ Recall that coordinations of proper names fall into the category of group-denoting plurals (Beghelli & Stowell, 1997). Dotlačil (2010) argues that for these plurals the distributive interpretation is strongly dispreferred.
This suggests that participants initially interpreted the sentence collectively up to the point of disambiguation. At that point, the mismatch between the forced distributive interpretation and the initial (preferred) collective interpretation most likely caused the slowdown. Under the assumption that readers resolve ambiguity early on, whereas they leave underspecification unresolved as long as possible, Frazier et al. (1999) conclude that the slowdown must result from ambiguity rather than underspecification.

Although the results of Frazier et al. (1999) seem to support the semantic ambiguity account, it remains unclear how the collective preference arises. How can the semantic ambiguity account explain this preference? Frazier et al. (1999) give two suggestions: (i) collective readings may be preferred for semantic reasons. While distributive readings introduce several separate events, collective readings introduce only one event. The preference for fewer events can drive the collective preference. Alternatively, (ii) the distributive interpretation may be more complex due to the presence of the D-operator. The semantic ambiguity account argues that the collective reading is the default, whereas the distributive reading needs an additional operation. This operation might be effortful, resulting in processing difficulties.

Frazier et al. (1999), however, acknowledge that the latter conclusion does not match the acquisition data. As mentioned in the previous section, children seem to be insensitive to the different plural expressions and their interpretations. The collective and the distributive interpretation are equally acceptable to them. This finding does not match the hypothesis of the semantic ambiguity account that the collective interpretation is the default because the distributive interpretation is more complex. This hypothesis would entail that children should start with a collective interpretation, as it is the default, and have to develop the more complex distributive interpretation. However, the opposite seems to be the case, as young children fully accept both interpretations of group-denoting plurals (such as definite plurals and coordinations of proper names), whereas adults find the distributive interpretations of these plurals marginal and prefer the collective interpretation. Thus, it seems to be the case that children have to learn the degraded status of the distributive interpretation rather than learn how to access it. Frazier et al. (1999) even state that young children seem to start with a preference for the distributive interpretation. By referring to the work of Donaldson and McGarrigle (1973) and Philip and Takahashi (1991), they suggest that this might be the result of nonlinguistic reasons involving a conceptual preference for one-to-one pairing.

Although Frazier et al.’s (1999) results suggest that the difference between the collective and the distributive interpretation is a matter of ambiguity, the semantic underspecification account seems to be more appropriate from an acquisition point of view. Under the semantic underspecification account all interpretations are of
similar representational complexity, as the different interpretations result from the application of different covers. The covers are either lexically specified or need to be determined via pragmatics. The development of the different interpretations therefore goes hand in hand with children’s development of pragmatic reasoning and the development of the lexical semantics that are necessary for the specified covers, such as the development of the lexical semantics of the distributive quantifier each. The semantic underspecification account therefore has two advantages over the semantic ambiguity account: (i) it can explain (intermediate) cumulative interpretations and (ii) it can explain the acquisition path of the distributive interpretation.

2.2 The Processing Account

The previous section discussed two accounts that attribute the different interpretations of plural expressions to semantics, by assuming that the difference between the collective and the distributive interpretation is either a matter of ambiguity or underspecification. The current section discusses an account that focusses on processing rather than semantics. The processing account introduced by Musolino (2009) attributes children’s non-adult-like distributivity interpretations to their processing limitations, such as an underdeveloped working memory capacity. As discussed earlier, children, unlike adults, seem to be insensitive to the different types of pluralities and their compatibility with a distributive interpretation. For children, both interpretations (distributivity and collectivity) are equally possible regardless of the type of plural expression. From around age 8 they start to understand the distributive character of distributive quantifiers such as each and every (Brooks & Braine, 1996; Padilla-Reyes, 2018; Pagliarini et al., 2012) and around age 12 they start to show a collective preference for group-denoting plurals (such as the definite plural the and numerals) (Padilla-Reyes, 2018; Pagliarini et al., 2012).

To explain children’s interpretation patterns, Musolino (2009) connects their non-adult-like distributivity interpretations to another well-known phenomenon in child language and especially quantifier acquisition: spreading errors (also often referred to as overexhaustive pairing errors). Spreading errors refer to children’s difficulties in interpreting universal quantifiers, such as all and each. Quantifiers describe the relation between two sets (Barwise & Cooper, 1981): the restrictor set, denoted by the subject, and the scopal set, denoted by the predicate. Distinguishing the two sets involved and determining the relation between these sets seems to be difficult for children. Children up to the age of 10 incorrectly reject a sentence such as (10) in a situation where all the girls are lifting a trophy and in addition one trophy is on the floor without a girl lifting it.

(10) Each girl is lifting a trophy.
Universal quantifiers denote a subset relation between the restrictor set and the scopal set: the set of girls and the set of trophy lifters in (10), respectively. The set of girls must be a subset of the set of trophy lifters for sentence (10) to be true. A member of the set of girls that is not a member of the set of trophy lifters is evidence against sentence (10) and makes it an incorrect description of the situation. The extra trophy, on the other hand, is irrelevant for the truth value of the sentence and can be ignored, which is evident for adults. Children until age 10, however, do not apprehend this and base their rejection of (10) on the extra trophy that is not lifted by a girl. They prefer a complete symmetry between girls and trophy lifters and do not understand that members of the scopal set (trophy lifters) can be ignored.

The finding that children seem to prefer symmetrical situations already hints to a possible relation with children's non-adult-like distributivity interpretations, since a similar pattern can be observed there. For adults a distributive interpretation is often marginal, but for children the distributive interpretation is perfectly fine and sometimes even preferred (Brooks & Braine, 1996; Syrett & Musolino, 2013). This finding is consistent with children's preference for symmetrical situations, since distributivity interpretations are symmetrical, with each subject referent acting on his or her own object referent, and collective interpretations are not, with a group of subject referents acting on one object referent together.

Similar to distributivity interpretations, spreading errors have been extensively studied experimentally (e.g., Crain et al., 1996; Drozd, 2001; Philip, 1995; Roeper et al., 2004), and there are a number of competing theoretical accounts of children's spreading errors. Some accounts argue that children's spreading errors are caused by a lack of linguistic knowledge, whereas other accounts claim that the origin of spreading errors can be found in pragmatics. A third explanation is resource-based and attributes children's spreading errors to their processing limitations. A detailed overview, in which the three theoretical accounts are discussed in detail, can be found in Chapter 6. For the remainder of this section, however, the focus will be on the resource-based accounts of spreading, in particular the weak-strong account by Geurts (2003). Musolino (2009) argues that the weak-strong account by Geurts (2003), might also explain children's non-adult-like distributivity interpretations. A short explanation of Geurts' (2003) account will be provided below. A more detailed explanation can be found in Chapters 4 and 6.

The weak-strong account by Geurts (2003) attributes children's spreading errors to their preference for a simpler semantic structure when a complex structure is required. Geurts (2003) argues that children treat strong quantifiers like each and all as if they were weak. As mentioned before, quantifiers generally denote relations between sets. However, not all quantifiers require a relational interpretation. Weak quantifiers, like some, do not require a relational interpretation and are compatible
with a less complex semantic structure. To determine the truth-value of a sentence with a weak quantifier, like (11), one needs to only look at the intersection set.

(11) Some girls are lifting a trophy.

This sentence can be verified by simply checking that the set of girls that lift a trophy contains at least one member. A strong quantifier like each, on the other hand, as in (10), does require a relational interpretation and depends on two sets (both the restrictor set and the scopal set need to be checked to determine the truth-value of (10)). Strong quantifiers, therefore, have a more complex semantic structure and are asymmetrical, which entails that the two sets cannot be interchanged. Interchanging the sets results in different meanings: each girl is lifting a trophy is different from each trophy lifter is a girl. Correctly identifying the restrictor set is therefore necessary to be able to correctly interpret a strong quantifier.

Weak quantifiers, on the other hand, are symmetrical and interchanging the sets results in a similar meaning: some girls are lifting a trophy has the same truth conditions as some trophy lifters are girls. Geurts (2003) argues that children initially treat strong quantifiers as if they are weak, due to processing limitations, since weak quantifiers with a less complex semantic structure are easier to process than strong quantifiers. Crucially, the weak-strong account attributes children's spreading errors to processing limitations rather than a lack of knowledge. Geurts (2003) claims that children do understand that strong quantifiers need a more complex structure. However, due to their processing limitations the structure remains unspecified. Specifically, the restrictor set remains underdetermined. Children realize that the restrictor set cannot remain underspecified and pragmatics comes into play to solve the underspecification. Children will identify the restrictor set via pragmatics, meaning that they will determine the set by choosing the most salient discourse unit, rather than using the available semantic and/or syntactic information. If the children interpret a given set of girls as the most salient discourse entity they will show adult-like responses, but if they find a given set of trophies most salient, spreading errors will occur. If the set of trophies becomes the restrictor, the children will interpret (10) as if it were: each trophy is lifted by a girl, leading to an incorrect rejection of the sentence: a spreading error.

Musolino extended Geurts' (2003) account to also explain children's non-adult-like responses found in his experiment testing numerically quantified expressions in collective, distributive and cumulative situations. He used a truth-value judgement task with English adults and children between the ages of four and six to study sentences with numerically quantified subjects with the quantifier each (12) as the object.

(12) Three boys are holding each balloon.
His results showed that adults only accepted a distributive interpretation of (12) (depicted via a picture where three boys are each holding two balloons) in 31% of the cases. Contrary to adults, children accepted distributive interpretations in 91% of the cases. The adults fully accepted collective interpretations of (12), where three boys are holding two balloons together. The children showed an acceptance rate of 80% for these collective interpretations. These results follow the previously discussed findings that for adults the distributive interpretation is degraded for sentences with group-denoting plurals such as in (12). Children again gave answers suggesting that they are insensitive to the interpretation differences and accepted the distributive as well as the collective interpretation to a high degree (91% and 80%). A more detailed discussion of Musolino’s (2009) experiment (also including results for the cumulative interpretation) can be found in Chapter 4.

Musolino (2009) argues that these differences in acceptance between adults and children might be explained by Geurts’ (2003) weak-strong account. Adults presumably reject a distributive interpretation of (12), because they interpret (12) as a situation in which all three boys must hold each balloon, which is clearly not the case in a distributive situation. Please note that this interpretation results from each taking wide scope, with balloons as the restrictor set. Children, on the other hand, almost fully accept the distributive interpretation. Musolino (2009) claims that this could be explained by the weak-strong account. According to this proposal, children will treat the strong quantifier each as if it were weak, leaving the restrictor set underspecified. In the case that the set of boys and not balloons ends up in this underspecified restrictor set, the sentence will be interpreted so that for each of the three boys there is a balloon that that boy is holding. This interpretation is true for a distributive situation and might thus explain why children accept the distributive interpretation to such a high degree (91%), contrary to adults. But how does the set of boys become the restrictor set for children? According to Geurts (2003) this is determined via pragmatics. It could for example be the case that the boys are more salient to children than the balloons. Musolino (2009), however, does not discuss this issue any further.

The results of Musolino (2009) indeed seem to be consistent with the predictions following from Geurts’ account (2003). Geurts’ (2003) weak-strong account, however, cannot account for all the interpretation differences between adults and children. This will be discussed further in Chapter 4, where Musolino’s (2009) account will be examined in more detail.

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5 A strong quantifier like each has a strong tendency to take wide scope with respect to other expressions.
Because children’s distributivity preferences and spreading errors are both related to understanding the semantics of quantifiers and both occur until quite late in children’s language development, it is conceivable that they share a similar origin. A disadvantage of such an account, however, is that it cannot explain the adult collective preference. Musolino’s processing account (2009) might explain the fact that both interpretations are equally accessible to children, but it cannot explain the degraded status of the distributive interpretation for adults. One account that aims to explain both the adult and the child interpretation pattern is of a pragmatic nature. This pragmatic account argues that the adult collective preference is a result of a pragmatic implicature. The pragmatic account will be discussed in the next section.

2.3 The Pragmatic Account

The pragmatic account was first proposed by Dotlačil (2010). He argues that the degraded status of the distributive interpretation is a case of the division of pragmatic labor (Horn, 1984). This means that if two expressions can express the same two meanings, where one meaning is more marked than the other, then the expression that is marked goes with the marked reading and the expression that is unmarked goes with the unmarked reading. Dotlačil based this proposal on two facts:

(i) There are other interpretations apart from the distributive interpretation, that group-denoting plurals can give rise to (namely collective interpretations), and

(ii) There are other expressions apart from group-denoting plurals that can give rise to the distributive interpretation (namely distributive quantifiers).

Following these facts and the division of pragmatic labor, the degraded status of the distributive interpretation in combination with group-denoting plurals simply stems from the fact that there is a more specific form that precisely expresses the distributive interpretation, namely the distributive quantifier each. In his dissertation, Dotlačil (2010) formalized his account by considering two approaches, namely that of Bidirectional Optimality Theory (see Blutner, 1998, 2000) and Game Theory (as in Parikh, 2000). Later work (e.g., Pagliarini et al., 2012) attributes the degraded status of the distributive interpretation to the calculation of a conversational implicature (cf. Grice, 1975), to be more precise a scalar implicature, abstracting away from differences between Bidirectional Optimality Theory, Game Theory and Gricean pragmatics.

Scalar implicatures, first introduced by Horn (1972), are a type of conversational implicature and are based on Grice’s maxim of quantity. Grice noted that conversations are usually to some degree cooperative enterprises. On the basis of this view he formulated the cooperative principle: “Make your conversational
contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged” (Grice, 1975, page 45). He defined the notion of cooperativity on the basis of four maxims that a speaker is expected to fulfill. One of these maxims is the maxim of quantity. This maxim states that speakers should make their contribution as informative as is required and no more informative than is required. Scalar implicatures are pragmatic inferences that can be understood in terms of Grice’s maxim of quantity. A scalar implicature is a type of inference that can be worked out on the basis of the literal meaning of an expression together with the assumption that the speaker should be as informative as possible (maxim of quantity).

The prototypical example of a scalar implicature is the ‘some-all’ implicature. The literal meaning of some can be paraphrased as at least one and possibly all. However, if someone utters a sentence like (13) it is most likely interpreted as a situation in which at least one but not all children received a trophy.

(13) Some children received a trophy.

The utterance in (13) does not lead to a literal interpretation of some, which is also compatible with all, because there is a more informative way to convey that all children received a trophy, by simply using the quantifier all (14).

(14) All children received a trophy.

The quantifier some evokes a lexical scale <some, all>, with some implying the negation of the more informative form all, resulting in the inferred meaning some but not all. The inferred meaning results from the fact that listeners expect the speaker to fulfill the maxim of quantity: speakers should be as informative as possible. In other words if a speaker would want to refer to a situation in which all children received a trophy, they should have used all and not the less informative some. By reasoning about more informative alternatives a listener can then infer that the speaker probably did not intend to convey the situation that all children received a trophy. In short this means that scalar terms like some evoke a comparison between what was said and what could have been said. A listener draws an inference on the basis of an alternative, more informative, option that could have been used by the speaker.

Dotlačil (2010) argues that the adult collective preference (in other words: the degraded status of the distributive interpretation) arises due to the calculation of such a scalar implicature. This proposed implicature is driven by the semantics of each. The reasoning is as follows: listeners prefer to interpret group-denoting plurals, such as (15), as collective because if speakers intended distributivity they would have used (16) with the more informative distributive marker each.
The absence of distributive marking means that the collective interpretation is intended. The group-denoting definite plural *the* thus evokes the following scale: <the, each>.

(15) The children received a trophy.
(16) Each child received a trophy.

The pragmatic account aims to explain the degraded status of the distributive interpretation for adults by attributing it to a conversational implicature. But can this account also explain the differences between adults and children?

The pragmatic account assumes that the implicature calculation is driven by the lexical-semantic development of *each*. This entails that children first have to learn that *each* is distributive before they can use its absence to draw an implicature, which leads to a collective preference for group-denoting plurals. Children who have not yet learned the lexical semantics of *each*, will give similar interpretations to group-denoting plurals and plurals modified by *each*. Only when they realize that *each* is semantically distributive, can they reason that its absence is meaningful. In short, only after children have a complete understanding of *each* will they be able to calculate the predicted implicature that underlies the adult collective preference for group-denoting plurals.

### 3 Summary

This background chapter gave an overview of the literature examining the collective and distributive interpretations in both adults and children. This overview and the direct comparison between the child and adult interpretations demonstrated that children, unlike adults, seem to be insensitive to the different types of plural expressions. For adults the distributive interpretation seems to be acceptable to different degrees for different types of plural expressions, in line with Dotlačil’s distributivity acceptability scale.

Several theoretical accounts have been discussed that aim to explain the acceptability of the distributive and the collective interpretation for different types of plural expressions. The semantic ambiguity account claims that the distributive interpretation is a result of a distributive operator. Predicates are interpreted as collective by default and an extra operation is necessary to reach a distributive interpretation. This account however has its limitations, since it cannot account for intermediate cumulative readings and cannot explain the acquisition data. Young children have shown to fully accept and even prefer the distributive interpretation, which is unlikely if the collective interpretation is indeed the default and the distributive interpretation is reached via a more complex operation. The semantic
underspecification account, on the other hand, can deal with intermediate cumulative interpretations and can explain the acquisition data.

The underspecification account argues that the different interpretations arise due to the application of different covers. Covers create different partitions of a main set and these different partitions result in different interpretations. Which cover needs to be applied is suggested to be dependent on pragmatics. The underspecification account seems to be a better fit to explain children’s interpretation pattern. Under this account, the development of the adult interpretation pattern depends on children’s development of pragmatic reasoning.

The processing account tries to explain the difference between the child and adult interpretation pattern by expanding an existing account that explains another error in child language: children’s spreading errors. This existing account argues that children’s spreading errors are a result of their processing limitations. Expanding this existing account to also explain children’s distributivity interpretations therefore suggests that children’s spreading errors and non-adult-like distributivity interpretations should disappear with the development of their cognitive resources. A limitation of the processing account is that it can only explain the differences between children and adults, but it cannot explain the degraded status of the distributive interpretation for adults.

The pragmatic account, on the other hand, is able to explain both the child interpretation pattern and the adult interpretation pattern, as it attributes the degraded status of the distributive interpretation to a pragmatic process: a conversational implicature. Under this account, children’s non-adult-like distributivity interpretations are explained by the fact that children first have to learn the lexical semantics of each before they can start to calculate the proposed implicature and reach the adult collective preference.

The remaining chapters of this thesis are dedicated to the investigation of the different theoretical accounts that aim to explain the interpretation patterns of both adults and children. The focus will mainly be on the processing account and the pragmatic account by empirically testing the predictions made by both accounts. The results obtained in the next chapters, however, can also shed light on the plausibility of the semantic accounts.