Acquiring quantification
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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2010

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):

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The meaning and acquisition of quantifying expressions

2.1 Introduction

In the past four decades, the acquisition of quantification received attention in various academic disciplines. Originating from a psychological interest in the development and growth of logical thinking in the child (cf. the groundbreaking work of Inhelder and Piaget (1958, 1959, 1964)), the study of children's surprisingly non-adult-like interpretations of quantified sentences during the seventies and eighties was in the hands of the psychologists Donaldson and Lloyd (1974), Bucci (1978) and Freeman, Sinha, and Stedmon (1982). Since then, the study of the acquisition of quantification shifted more and more to the field of linguistics and has been used to illustrate universal syntactic, semantic and pragmatic constraints in various languages.

Although Freeman et al. (1982) already pointed at the potential of the subject of quantification to acquire insights into the course of language development due to its relatively circumscribed domain and the cross-disciplinary approach it allows, the study of the acquisition of quantification resulted in a deadlock in subsequent years. Opposite claims were made concerning the nature of the child's quantifier system, depending on the particular discipline the subject was studied from. Crain, Thornton, Boster, Conway, Lillo-Martin, and Woodams (1996) claim that, if the right methodology is used, children do not show any non-target-like behavior at all. And despite the possibility of joint research into the psychological foundations of logical operators in language, the acquisition of quantification continues to be studied in each discipline separately.

In this chapter, I aim to show that only by taking both linguistic and psychological work into account, we are able to break the deadlock and to gain more insight into the child's actual understanding of quantifying expressions. Before turning to an overview of previous studies and drawing this conclusion, I will first address two characteristics of quantifying expressions that play a key role in this debate and
introduce some terminology that will be used throughout this thesis to refer to the semantics of quantifying expressions.

2.2 The meaning of quantifying expressions

As a first characteristic, quantification allows one to state generalizations. In English, for example, it is possible to apply a predicate not just to a particular individual as in (1) but, by means of words like all, every and many, to a set of individuals. To express, for example, that not only John is riding a horse, but all cowboys are, one could say (2).

(1) John is riding a horse
(2) All cowboys are riding a horse

In (2), the quantifier all ranges over the set of cowboys. The verb phrase contains the generalization itself, i.e. the predicate to ride a horse. The quantifier and its range (i.e. the determiner phrase all cowboys) express for which individuals this predicate holds. If (2) is true, it holds for all cowboys that they are riding a horse. Moving towards a more fine-grained definition of quantification that will function as a starting point for the remainder of this thesis, I will now discuss the nature of quantification from various perspectives. First, I will introduce the functional perspective taken on quantification in Generalized Quantifier Theory (Barwise and Cooper, 1981) and illustrate the close parallel between the meaning of a quantified statement and its syntactic structure. Although different at first sight, this mirrors the approach taken by Heim (1982) and Diesing (1992) I will introduce subsequently. Second, I will discuss how a quantifier like all differs from a quantifier like some.

In Generalized Quantifier Theory (henceforth GQT, Barwise and Cooper, 1981), the quantified expression (i.e. the quantifier together with its range) is argued to take the predicate and this results in a sentence. Moreover, in GQT, it is assumed that, before the quantified expression (called a generalized quantifier1) takes the predicate, the quantifier first combines with a common noun. Whether the sentence is true or false, depends on whether the property of riding a horse applies to every single cowboy or not, or, to put it differently, whether or not the denotation of the predicate is part of the denotation of the generalized quantifier. In this sense, the quantifier is taken to be a function that takes the predicate as an argument, resulting in a quantified statement.

This functional perspective taken in GQT on quantification, (but cf. also earlier work by Mostowski (1957) and Montague (1973)) mirrors the syntactic structure of

1In GQT the quantifier together with its range c.q. common noun is called a generalized quantifier. However, in much work on quantification and likewise in this thesis, the term ‘quantifier’ is used to refer to both the quantified expression (quantifier and common noun) as in ‘generalized quantifier’ in GQT and to the quantifier itself. To avoid confusion, I will refer to the quantifier itself with the term ‘quantificational determiner’ whenever the distinction matters.
quantified expressions

In (3), the DP combines with the VP. This crucially differs from a standard logical representation of (2) as in (4) in which *all cowboys* is not treated as one syntactic constituent and so this representation does not mirror the syntactic structure of the quantified sentence.

\[
(3) \quad S \\
\quad \text{DP} \quad \text{VP} \\
\quad \text{D} \quad \text{NP} \quad \text{are riding a horse}
\]

\[
(4) \quad \forall x (\text{cowboys } x \rightarrow \text{riding a horse } x)
\]

In this thesis, I follow the approach taken in GQT and take the syntactic structure represented in (3) to account for the meaning of quantified sentences. For (2), this means that the generalized quantifier *all cowboys* is taken to denote a set of predicates (sets of individuals that share the characteristic of being a cowboy).

The question rises how this approach works if the object is being quantified over as in (5) or if the quantifier does not directly follow the common noun, as with the so-called floating quantifier *all* in (6).

\[
(5) \quad \text{The cowboy sold all horses}
\]

\[
\begin{align*}
\text{a. } & \# \text{“All cowboys sold the horse”} \\
\text{b. } & \text{“The cowboy sold all horses”}
\end{align*}
\]

\[
(6) \quad \text{The cowboys are all feeding the horses}
\]

Floating quantifiers do not directly precede their range, but rather are ‘floated’. Crucially, however, only the noun phrase c-commanding the quantificational determiner can form the quantifier’s restriction. For example, the range of the floating quantifier *all* in (6) is the set of cowboys; the noun phrase *the cowboys* c-commands the quantificational determiner. The noun phrase *the horses* does not c-command *all* and cannot be the quantifier’s range here. Clearly, more is needed than the syntactic structure in (3) to cover the nature of quantified expressions. How does the syntactic structure relate to the meaning of a quantified expression?

Diesing’s (1992) Mapping Hypothesis provides a solution to this problem. Starting out from a different perspective on quantified sentences, but one that is compatible with the functional perspective taken in GQT (Heim and Kratzer, 1998), she takes quantifiers (in line with Heim’s (1982) tripartite structures) to denote relations between two sets (cf. Barwise and Cooper, 1981; Zwarts, 1983; Van Benthem, 1986). In such a relational perspective, which goes back to Aristotle, quantified sentences are represented as tripartite structures in which the quantifier (the operator) establishes a relation between its first argument (called its “restrictive clause” in Heim,
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1982) and second argument (called its “nuclear scope” in Heim, 1982) (Heim, 1982; Kamp, 1981). For example, (2) can be represented as in (7) in which the noun phrase cowboys is the restriction of all (also called its first argument or A set) and the predicate to ride a horse its nuclear scope (or the quantifier’s second argument or B set).

(7)

Diesing’s Mapping Hypothesis states that material from the VP is mapped onto the nuclear scope and material from the NP outside the VP is mapped onto the quantifier’s restriction. In the case of quantification over the object as in (5), Quantifier Raising along the lines of May (1985) applies at LF and the object raises to the beginning of the sentence as in (8-a). According to Diesing’s mapping hypothesis, this is then mapped onto a tripartite structure as in (8-b). In the case of subject quantification, the subject raises in a similar way to the beginning of the sentence.

(8)  a. [all horses_{NP}], [the cowboys are feeding {e}]_{VP}
    b. S

A second characteristic of quantifiers is that they differ in relating their restriction and nuclear scope. Consider the quantifier all in (9) and some in (10).

(9) All boys are playing outside
(10) Some boys are playing outside

To determine the truth value of (9), we have to check whether or not the set of boys that are not playing outside is empty; if there are boys that are playing inside instead of outside, this sentence turns out to be false. Using a Venn-diagram in figure 2.1

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As will turn out to be important in the next section, along the same lines and by assuming an event variable, temporal quantification as in (i.) can be represented with a tripartite structure. For (i.), the adverb always is the operator quantifying over event variables, x are cowboys as the operators’s restriction and x is riding a horse at event e as its nuclear scope (see Lewis, 1975).

(i.) The cowboys are always riding a horse
below where A is the set of boys and B the set of individuals playing outside, this means that the sentence is false if the highlighted part is not empty (i.e. if there are boys who are not playing outside). Conversely, if the grey area (i.e. the set of boys that are not playing outside) is empty, the sentence is true; all boys indeed turn out to be playing outside. The denotation of the quantifier’s restriction (A) minus the intersection of this set with the quantifiers nuclear scope (B), is important in the interpretation of this universal quantifier.

On the other hand, to evaluate the truth of (10), one has to consider whether the set of boys that are playing outside (i.e. the intersection of the set of boys and the set of players outside) is empty or not. In terms of the Venn-diagram in figure 2.2 where A is the set of boys again and B the set of individuals playing outside, this means that the sentence is true if the highlighted part in 2.2 is not empty. For this existential quantifier, it is the intersection that matters.

In sum, the relation that all and some establish between their restriction and nuclear scope is expressed in (11) and (12). Whereas all requires its restriction to be a subset of its nuclear scope, some only requires that the intersection of restriction and nuclear scope is not empty.

\[
(11) \quad \text{All}(A,B) = 1 \text{ iff } A \subseteq B \\
(12) \quad \text{Some}(A,B) = 1 \text{ iff } A \cap B \neq \emptyset
\]

Milsark (1979) showed that the difference between some and all in the way they relate their arguments to each other also manifests itself syntactically. He observed that some quantifiers are allowed in existential there-sentences, e.g. some, several, many, whereas others are not, e.g. all, every, most. This is illustrated in (13).

\[
(13) \quad \text{a. There are some/many/several men that are crazy about green old-timers.}
\]
Milsark (1979) called this the ‘weak-strong distinction’ and labeled quantifiers that can occur in an existential there-sentence ‘weak’ and those that can not ‘strong’. In the terminology of Keenan (2002) (cf. Barwise and Cooper, 1981), the difference between these two kinds of quantifiers is seen as that between, respectively, co-intersective and intersective determiners: “Co-intersective (generalized universal) Dets depend on A - B, the A’s that are not Bs, just as intersective Dets depend on A ∩ B” (Keenan 2002: 633). Since an existential sentence introduces an intersection of two sets with there are ... and only weak quantifiers present such an intersection, strong quantifiers are blocked from this construction.

In conclusion, quantifiers relate two sets to each other, respectively called their domain restriction and nuclear scope. The relation quantifiers establish between these sets differs per quantifier type. Different labels have been proposed to distinguish quantifiers (weak versus strong, intersective versus co-intersective). Throughout this thesis and following Milsark, I will label a quantifier that establishes an intersective relation “weak quantifiers” and quantifiers that establish a subset relation between domain restriction and nuclear scope “strong quantifiers”.

2.3 The acquisition of quantification

2.3.1 Logical reasoning in child language

Inhelder and Piaget (1958, 1959) present the first data on children’s interpretation of quantified sentences. They asked children whether, for example, all circles are black.

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As will become clear in subsequent chapters, it is important to distinguish the form and the meaning of a quantifier. The quantifier many for example is traditionally called a weak quantifier, but allows both an intersective and a subset relation between its arguments. I will return to this issue in chapter 5.
in cases like the one depicted in figure 2.3. Children between four and seven years of age answered “no, there are two black squares”. Similar non-adult-like answers were given when they asked the children whether all squares are white (child answer: “no, because there is a black one”) or whether all circles are black in a situation in which there are five black circles and three white squares (child answer: “no, because there are white ones”).

Inhelder and Piaget explained the children’s answers in terms of class inclusion. They argued that, until the age of seven, children are unable to grasp the idea that sets can be a subset of other sets and, as a result, are unable to get an adult interpretation of a sentence containing all. They suggested that children apply all to both the subject (circles) and the predicate set (black entities). This would lead the child to interpret “Are all the circles black” as (14-a) instead of the adult interpretation (14-b). Inhelder and Piaget called the child’s interpretation (14-a) false quantification over the predicate.

(14) Are all the circles black?
    a. “Are all of the circles all of the black (things)?”
    b. “Are all of the circles some of the black things?”

Whereas Inhelder and Piaget pointed at children’s lack of the notion of class inclusion, Donaldson and Lloyd (1974) take a different perspective on the matter and approach children’s understanding of quantified sentences in the context of mapping linguistic form to the world. Does a child understand a quantified sentence as a description of a particular situation? Being one of the first to use the by now well-established truth value judgment task, they asked children to judge quantified
sentences as true or false given a particular situation. In particular, they asked children to press a bell if a doll said something right and to press a buzzer if the doll said something wrong. They asked children whether a sentence such as (15-a) correctly describes situations like the one in (15-b).

(15)  
   a. All the cars are in the garages  
   b. 3 cars in garages, 1 garage empty

Their findings show that children, when they encounter a situation with two sets, they have difficulties determining which set is quantified over. The most common response pattern they find is that, in the case of (15), children reject the sentence. If, conversely, they are shown a situation in which all garages are filled with cars and there are no extra garages, they accept the sentence target-like. Note that also in this latter case, the child has to quantify over two sets (cars and garages).

Donaldson and Lloyd propose a three-step account of what occurs when a child is faced with a situation like (15-b) and is asked to make a true/false judgment. First, they argue, the child looks at the physical array of objects and determines what it is all about. Second, the child hears the question and interprets this question. Crucially, Donaldson and Lloyd take this interpretation to be deviant from the adult one; instead of being constrained by the syntactic structure, they take the child to only derive a general theme from the sentence. As they put it: “linguistic considerations leave open to them certain options which the adult analysis would disallow” (1974:82). For (15), this means that the child takes the sentence to be about cars, garages, one being in the other and all. As a third step, they argue, the child tries to reconcile the physical array with the sentence. But then “the physical array disposes him, by virtue of its own form, to certain modes of structuring it” (1974:82). For (15), they take this to mean that the emptiness of one of the garages attracts the child’s attention. Due to the lack of a decisive linguistic structure, the structuring of the physical array would then determine the child’s answer. As Donaldson and Lloyd put it, a quantified statement is difficult to judge for a child because:

“(a) if the linguistic constraints are not fully observed, the statement admits of more than one interpretation as regards the relations involved and (b) the physical array disposes the subject to favor the wrong interpretation.” (1974:83)

Bucci (1978) arrives at a similar conclusion. Taking the findings of Inhelder and Piaget to indicate children’s preference for a structurally neutral interpretation of quantified sentences, she claims that children lack a subject-predicate distinction in sentences of the form exemplified in (16-a). This results in a default, structurally neutral interpretation of universally quantified sentences of the form exemplified in (16-b).

(16)  
   a. All circles are black  
   b. All, circles, black
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The child’s preference for this structurally neutral interpretation illustrates, according to Bucci, the existence of a pragmatic processing mode. In this mode, she claims, children do not determine the meaning of a quantified sentence by means of its grammatical structure but by means of “previously known factual relations between the things which the words represent” (1978:55).

This pragmatic mode would lead the child to prefer a structurally neutral interpretation of a quantified sentence of the form ‘All the objects are F and G’. This explains Inhelder and Piaget’s findings that children answer “no, not that one” for *Are all the circles black?* with respect to figure 2.3; children would interpret this sentence as ‘Are all the objects a circle and black?’.

However, as Braine and Rumain (1983) point out in their detailed overview of the development of logical reasoning, such an analysis raises the question why children would prefer a structurally neutral interpretation like (16-b). In theory, a structurally neutral interpretation would result in four possible interpretations (adapted from Braine and Rumain, 1983):

\[(17)\]
\[\begin{align*}
a & : \text{All the objects are circles and black} \\
b & : \text{All the circles are black objects} \\
c & : \text{All the black objects are circles} \\
d & : \text{All the circles are black objects and all the black objects are circles}
\end{align*}\]

Bucci’s account, Braine and Rumain point out, crucially needs experimental support showing that children prefer interpretation (17-d) above the other interpretations. If children indeed pay less attention to the syntactic structure than adults, they point out, does this mean that they randomly pick one of the four interpretations in (17)?

Freeman, Sinha, and Stedmon (1982) (and Freeman and Stedmon, 1986) showed that, by manipulating various variables in the experimental setting (such as showing more than just one empty garage to the child or making one garage odd-colored), the child answers become more often target-like because a target-like answer becomes more plausible in these two manipulations. They take this to mean that the child’s language system does not differ much from the adult system in its formal characteristics, but rather that it is less flexible and that children have problems determining what the sentence is actually about, or in their terms, “coordinating quantification with reference” (1986:47). Taking the sentence to be about a violation of a one-to-one relation, children answer as reported by e.g. Inhelder and Piaget.

Unfortunately, their data does not allow them, as they point out themselves, to make any further predictions regarding the exact interaction between reference and children’s interpretations of quantified sentences. This then, they take to be the challenge for further research. As they put it:

For the next round of research, it will be necessary to take a wider view of reference, and to use psychologically more expensive concepts,

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4In fact, Bucci’s account is a theory which states that, for children, syntax is ruled over by pragmatics. This idea returns in a more fine-grained version in my hypothesis in chapter 3.
such as topic-setting cues available in discourse. (Freeman and Stedmon, 1986:47)

Summing up, various psychological accounts argue that children pay less attention to the syntactic structure than adults to determine the quantifier domain. The psychological field moved away from Inhelder and Piaget’s conclusion that children have non-target-like understanding of class inclusion. New experimental work emerged on the interaction between syntactic structure and the mapping from world to language, investigating the question how children interpret a quantified sentence if they do not do it with the syntax. This received much attention in the field of linguistics and gave rise to a body of research on children’s understanding of quantification from, first, a mainly syntactic and semantic point of view and later a pragmatic point of view. Taking the conclusion that children do not use syntax as a starting point, children’s non-adult-like understanding of quantified sentences was subsequently used to illustrate either that children lack certain aspects of syntax or that linguistic principles are innate (and adult-like) and the experimental methodology used causes non-target-like behavior. In recent years, Freeman et al.’s (1986) conclusions regarding the discourse characteristics of quantified sentences received attention again. In the next section, I present an overview of these different linguistic accounts.

2.3.2 Children’s structures of quantified sentences

2.3.2.1 Roeper and De Villiers (1991) - a syntactic account

Roeper and De Villiers (1991) explore the hypothesis that children detach a quantifier from the noun it appears with (a process they call ‘Q-spreading’). Raising the question what the linguistic boundaries are for children to apply the quantifier to all noun phrases in a clause, Roeper and De Villiers (1991) report that children also give non-adult-like answers when the sentence involves quantification over the object as in (18), a barrier like a relative clause as in (19) or an implicit object in an intransitive sentence as in (20) (cf. Takahashi (1991), examples from Roeper and De Villiers, 1991:247).

(18) A cat is on every chair
(19) Every whale that is lifting a boat smiled
(20) Every dog boy was driving. A truck was broken.

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5The label ‘Q-spreading’ goes back to the work of Roeper and Matthei (1974) who found that children interpret (i.a) as (i.b) and concluded in a similar way that children detach the quantifier from the noun it syntactically combines with.

(i.) a. Some of the circles are black
   b. Some of the circles are some black
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If there were any linguistic boundaries on Q-spreading, children would give adult-like answers in these cases, Roeper and De Villiers point out. For example, in (18) there is no c-commanding relation between *every* and *a cat* in contrast to *Every cowboy is riding a horse*, and if it is this c-commanding relation that causes children to give non-adult like answers, children are predicted to give adult-like answers for (18). However, this is not the case, Roeper and De Villiers report. If the presence of an object is a trigger for the child to give non-adult-like answers, no such answers are predicted for (19) and (20) which have no object. However, also for (19) and (20), Roeper and DeVilliers report Q-spreading. Neither a c-commanding relation or the mere presence of an object causes children to give non-adult-like answers. Roeper and DeVilliers point out that this might suggest that the phenomenon is linguistically unconstrained. However, referring to Takahashi (1991), they argue that this is not the case. Takahashi (1991) found that children interpret intransitive sentences adult-like. The linguistic difference between intransitive sentences and transitive sentences and the finding that children interpret the two constructions differently, suggests that Q-spreading is linguistically constrained.

Pointing at the characteristics of adverbs, they take this all to mean that children interpret quantificational determiners as adverbs; adverbs quantify in a similar way over the whole sentence. As they formulate their hypothesis (Roeper and De Villiers, 1991:248):

(21) a. Quantifiers are analyzed as adverbs
   b. Adverbs can be given sentential scope
   c. Therefore all NPs within a clause are modified by the adverb

Roeper and De Villiers’ (1991) account should be understood in a broader acquisition theory that (some) syntactic categories are delayed in the course of language development, specifically the Determiner Phrase. Lacking the internal structure of a DP means that the quantificational determiner remains unattached and therefore has all the variables in the entire sentence in its scope.

2.3.2.2 Philip (1995) - a semantic account

Philip (1995), presenting the first full-range set of linguistic data on children’s understanding of quantified sentence, takes up Roeper and De Villiers’ idea and reformulates it in terms of event quantification. In line with Inhelder and Piaget (1959, 1964), Philip (1995) presents experimental data of children quantifying over the horse not being ridden (the so-called *extra object*) in figure 2.4 and the walking man in figure 2.5 (the so-called *extra-subject*) for (22). For both pictures, this resulted in a “no, not that one” answer which is correct for figure 2.5, but not for figure 2.4.

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6This conclusion would furthermore be supported by the fact that all languages have some way to quantify over events. Quantification over entities, however, does not seem to be a universal characteristic of language. This suggests, Roeper and De Villiers argue, that adverb quantification is the basic case, therefore easier and hence the null stadium in acquiring a language (cf. Roeper et al., 2006).
Following Philip (1995), here and in the remainder of this thesis, I label the “no, not that one” answer with respect to figure 2.4 the symmetrical answer.

(22) Every cowboy is riding a horse

Figure 2.4: Extra-object situation for test sentence Is every cowboy riding a horse?

Philip’s Event Quantificational Account (EQA) claims that children interpret universal quantifiers as quantifying over event variables. As Philip puts it, children restrict the quantifier domain to “the set of minimal events $e'$” if such a minimal event meets one of two criteria. The first criterion is that the minimal event is “a subevent of $e$ that has a participant object of the same type as the distinguished participants of $e$” (from Philip, 1995:68). The second criterion is that “the minimal event is a subevent of $e$ that has a participant object of the type denoted by some referring expression in $S$” (from Philip, 1995:68). Representing this by means of a tripartite structure (Heim, 1982, see also section 2.2 above), the child’s symmetrical answer for (22) is represented by Philip as follows:

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7 Additionally, Philip (1995) reports the exhaustive answer; so-called perfectionist children also answer “no, not that one” for a picture in which the extra man is replaced with, for example, a donkey. Children then point at this donkey and explain that the donkey is not being ridden. This answer, however, lies outside the scope of this thesis. This also applies to another child-answer which Freeman and Stedmon (1986) argue to be due to an “underexhaustive search” applied by the child; some children answer “yes” to the question whether all cowboys are riding a horse and picture 2.5. However, following Hollebrandse and Visser (2006) and taking this last answer to indicate some kind of prequantificational stage, I will not address this fourth answer in more detail either.
In this representation, *events* are indicated by the variable $e_1$, $e_2$. The quantifier *every* is argued to quantify simultaneously over all those events that are a subevent of a cowboy-riding-a-horse event and those in which both a cowboy and a horse are a participant. This explains why children answer “no, not that one”; there is one subevent (i.e. the horse not being ridden) in which only the horse is a participant and not both a cowboy and a horse.\(^8\)

In sum, Philip proposes that children differ from adults in the type of variable they quantify over (i.e. an event variable instead of an individual variable) and,

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\(^8\)The exhaustive answer (see footnote 7) is explained in a similar way. In addition to the cowboys and horses, the child would also take a perceived object to be part of the quantifier’s restriction. See Philip (1995) for a more detailed account of the exhaustive answer (cf. Roeper et al., 2006).
moreover, they take the quantifier to quantify over the event variable which includes event participants and therefore quantifies over ‘everything’ in the sentence. Addressing the question why children would prefer such an interpretation over an adult one, he points at two possibilities. On the one hand, quantification over event variables would be easier than quantification over individual variables. On the other hand, children would have problems with deriving the correct logical form.

In this acquisition stage, Philip claims, the child “often does not apply the linguistic principles that govern an adult-like reading of a determiner universal quantifier but rather assigns a meaning to a universally quantified sentence that is similar but semantically and truth-conditionally distinct from that which an adult assigns” (1995:3). It is especially this latter claim, i.e. that children do not apply, or are even unable to apply, linguistic principles, that encountered fierce criticism from Crain et al. (1996).

Crain et al. (1996) ask why a child would prefer such an event quantificational analysis. Quantification over the event requires a more difficult mapping from syntax to semantics than quantification over objects, Crain et al. argue. And even if Philip’s event quantificational account is right, they continue, three questions arise. First, why is the child’s analysis of quantifiers more difficult than an adult analysis of events? The logical form of the symmetrical child is more complex, Crain et al. argue, than the representation of event quantification in the adult grammar (with only one restriction). According to Philip’s EQA, either the subject or the object is within the restrictor of every, cf. (23) above. Since this is not the way adverb quantification takes place in the adult grammar, it is unlikely, Crain et al. argue, that children analyze every in this way. Moreover, mapping a real adult analysis of adverbs onto every would result in a reading of (22) for which the restrictor is the set of events in which there is a cowboy riding something, or in which there is a cowboy and a horse or there is someone riding a horse (Crain et al., 1996). This means that children will judge (22) with respect to figure 2.4 as true, contrary to Philip’s own findings. Second, Crain et al. take Philip’s EQA to imply that the children’s grammar has to change enormously in order to reach an adult state. But how can that be, they point out, if children, next to the symmetrical answer, also give adult-like answers? Third, if children restrict a quantifier domain in a different way than the syntax prescribes, they differ from adults and have to unlearn this option. This means, Crain et al., claim, that the child’s grammar is not compatible with the principles of UG, something that they take to be impossible.

Crain et al. (1996) argue that the child’s grammar does not have to do change at all, simply because the child’s grammar does not deviate from the adult grammar. They explore an alternative hypothesis to account for children’s non-target interpretation of quantified sentences.
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2.3.2.3 Crain et al. (1996) - a methodological explanation

Crain et al. (1996) argue that the experimental setup used by Philip (1995) and others (cf. the psychological literature discussed above) might have caused the child to restrict the quantifier domain in a non-adult way. Alternatively, they claim, they should have used the Truth Value Judgment (TVJ) Task.

The TVJ task is a task in which puppets perform actions and talk ‘through’ an experimenter. The child is asked whether the puppet describes a picture the right way or the wrong way. By using the puppet, the task minimizes the possibility that children answer yes or no by means of other mechanisms than linguistic competence; it is more likely that the puppet says something the right way or the wrong way, than an adult (according to the possible reasoning of the child that an adult knows when something is said the right or wrong way, so there is no reason for an adult to ask such a question if the sentence is indeed correctly describing a picture).

In this respect, an experimenter should first of all consider whether the test sentence is true or false on the interpretation under investigation or under any other interpretation (by means of world knowledge etc.). Second, one should be able to analyze a test sentence into the components background, assertion, possible outcome and actual outcome. Crain et al. explain the terms background and assertion in terms of respectively a function and its argument. For a test sentence Every farmer is feeding a donkey, the background is that every farmer is feeding something, the assertion is ‘a donkey’. The possible outcome is a possible alternative to the assertion, e.g. that the farmer is feeding a horse, whereas the actual outcome is that the farmer is feeding a donkey. Third, the Condition of Plausible Dissent and the Condition of Plausible Assent should be met in each experiment. The Condition of Plausible Assent makes sure that the test sentence is actually a possible outcome during the experiment. This condition mirrors the Condition of Plausible Dissent, stating that some outcome other than the one corresponding to the target-like meaning of the test sentence should be possible. Crain et al. argue that both conditions are met when the TVJ task is used.\footnote{In subsequent years, the Truth Value Judgment (TVJ) has become a standard methodology in the field of first language acquisition to elicit children’s interpretations of sentences (cf. also Gordon (1996)) with respect to pictures. However, see Drozd (2004a, 2004b) and others for criticism against the methodology and starting points of Crain et al., 1996.}

For (22), this means that it should be felicitous in the experimental setup to either answer with Yes, every cowboy is riding a horse or No, not every cowboy is riding a horse. Crain et al. (1996) argue that the children in Philip (1995) were asked such a question in a context in which only the “yes” answer was felicitous (there was no reason provided during the experiment why the sentence would not be true and hence a “no” answer was not felicitous). At that point, the children did not know why such a yes/no question was asked; only one answer is possible. Children would then infer a context in which a yes/no question is felicitous, resulting in an interpretation of the question as Is there a one-to-one relation between cowboys and
Crain et al. carried out seven experiments, using the methodology as described above, and aimed to replicate the findings of Inhelder and Piaget (1964) to Philip (1995) and to address their hypothesis that children do not miss any linguistic principles but that the experimental setup used in Philip (1995) and earlier research caused non-target-like behavior. Their results show that children give relatively few (i.e. 12%) symmetrical answers if the felicity conditions discussed above are met. They take this to show that Philip’s experiments indeed were not designed properly; his experiments would not satisfy the Plausible Assent condition and, hence, children took the test sentence to be about a one-to-one relation between farmers and donkeys. Children’s symmetrical answers would all be “errors due to flaws in experimental design” (Crain et. al.; 1996:109). Crain et al. conclude that children have full linguistic competence and apply the same linguistic constraints as adults do. Until proven otherwise, they argue, this hypothesis is on the right track; reasons to assume that childern’s adult-like answers are due to the introductions used in their experiments as a result of which the quantified sentences are easier to understand for them, are not reasonable to accept without further arguments. However, recently, various people underline exactly the pragmatic effects of context on children’s non-adult-like interpretations (cf. Drozd, 2001; Drozd and Van Loosbroek, 2006; Geurts, 2003). These pragmatic approaches are the subject of the next section.

### 2.3.2.4 Drozd (2001) and Geurts (2003) - two pragmatic accounts

Both Drozd (2001) (also Drozd and Van Loosbroek, 2006) and Geurts (2003) analyze children’s symmetrical answers in terms of a mapping problem between the different modules of the language faculty (i.e. pragmatics (discourse), semantics and syntax). Drozd (2001) and Drozd and Van Loosbroek (2006) propose an account in which the influence of pragmatic factors like context explains their non-adult behavior. Drozd and Van Loosbroek (2006) labeled Drozd’s proposal the Weak Quantifier Strategy (WQH). In a similar way, Geurts’ (2003) Weak Processing Strategy (WPS) underlines the effect of pragmatic factors on children’s interpretations of quantified sentences. I will now discuss these two accounts in more detail.

Drozd (2001) argues that children have difficulties constructing the restriction and nuclear scope which are presupposed for interpreting universally quantified sentences. The so-called Westerståhl-sentences (Westerståhl, 1985) are central in his account. Consider (24).

(24) Many Scandinavians have won the Nobel price in literature
    a. There are many Scandinavians that have won the Nobel price in literature

10 Of course, the question remains *why* they infer this interpretation. As will become clear, this will be a central question throughout the remainder of this thesis.
b. There are many winners of the Nobel price in literature that are Scandinavians

Sentence (24) can either be interpreted as (24-a) or (24-b). The difference between those two readings is the presupposed set of Nobel price winners: either a presupposed set of Scandinavians is the restriction (in the case of (24-a)) or a certain expected frequency of Nobel price winners (in (24-b)) (see chapter 5 for a more extensive discussion of this example). Drozd claims that children interpret sentences containing a universal quantifier such as *every*, as if they contain a weak quantifier (in the sense of Milsark, 1979). A sentence as *Is every cowboy riding a horse* is then interpreted similarly to (24-b) and an expected or ‘normal’ number of horse-riders is presupposed. When such a question is asked with respect to an extra-object situation (cf. figure 2.4 displaying four horses of which only three are being ridden by a cowboy), the answer will then be “no, not that one” because they miss a horse-rider on top of the horse not being ridden. In this way, children treat strong quantifiers as weak ones, since adults only use domain presuppositions to restrict the domain of a weak quantifier as in (24).  

Crain et al. (1996) presented the child with a situation in which an extra horse-rider (next to the ones displayed in the figure) is already presupposed. Drozd argues that this explains why they found fewer symmetrical answers. Rather than the satisfaction of the condition of Plausible Dissent, Drozd concludes that offering a context which makes it easier to resolve domain presuppositions (and not satisfying the Condition of Plausible Dissent) will improve the child’s interpretation in an adult way.

Geurts (2003) also points at the weak-strong distinction. Referring to the processing work of Just (1974) and Meyer (1970), he takes the null hypothesis to be that weak quantifiers are easier to process because they impose an intersection relation between their arguments (see section 2.2):

“I assume that the distinction between weak and strong quantifiers is not just a linguistic curiosity, but is directly relevant to the ways quantified expressions are processed. This assumption is at the heart of the analysis […] , according to which strong quantifiers must be represented by relational structures, while weak quantifiers give rise to non-relational representations by default; a weak quantifier calls for a relational representation only if it triggers a domain presupposition.”

(Geurts, 2003:12)

Geurt’s account bears crucially on the formulation of the weak-strong distinction as a distinction between quantifiers that are inherently relational (i.e. strong quantifiers) and those that are not (i.e. weak quantifiers). Compare the following sentences with a strong quantifier (25) and a weak quantifier (26).

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11 For Drozd’s WQA, see also chapter 5.
(25) Most academics are absent-minded
(26) At least five academics are absent-minded

In (25), it is expressed that most of all academics are absent-minded; the strong quantifier relates the set of absent-minded academics to the set of non-absent-minded academics with respect to all the academics, let us assume in this case, in the world. However, (26) means that either five academics are absent-minded or even more than five; the weak quantifier is not relational with respect to some other set of academics (cf. the discussion of weak and strong quantifiers in section 2.2). Because interpreting a strong quantified expression would be harder, children map the grammatical form of a weak quantifying expression onto the structure of a strong quantifying expression.

For *Every cowboy is riding a horse*, this Weak Processing Strategy results in a representation in which *every*’s domain restriction is not filled with the set of cowboys, but rather is left empty (mirroring adults’ interpretation of weak quantifiers). This mismapping between syntactic form and semantic representation would explain why children resort to non-adult-like answers; because the domain of *every* is undetermined. ‘Pragmatic inferencing’ in terms of determining the most salient discourse entity given the sentence focus and background assertions, would force a reading in which either the horses or the cowboys are backgrounded. Depending on the set that ends up in the restrictor by means of this pragmatic inferencing, the child gives a symmetrical or an exhaustive answer.\(^\text{12}\)

### 2.4 Summary and concluding remarks

In this chapter, I discussed two characteristics of quantifiers: they relate two sets to each other and do this in different ways (cf. the difference between weak and strong quantifiers). Both have played an important role in the literature on children’s understanding of quantified expressions. Inhelder and Piaget explain children’s non-target-like answers in terms of their inability to recognize the subset relation a quantifier like *all* establishes between its nuclear scope and domain restriction. Donaldson and Lloyd (1974) (and also Bucci, 1978) argue that children are unable to determine which sets constitute the quantifier’s domain restriction and nuclear scope and, hence, children choose for a structurally neutral interpretation. Linguistic accounts hypothesize that children are unable to quantify over the target-like (type of) variable (Roeper and De Villiers, 1991; Philip, 1995). Recent pragmatic accounts take yet another perspective and point at the difference between weak and strong quantifiers and their differences (Geurts, 2003) or the role that context plays in their interpretation (Drozd, 2001 and Drozd and Van Loosbroek, 2006). Finally, Crain et al. (1996) argue that the methodology used in previous experiments on children’s understanding of quantifiers

\(^{12}\) Geurts (2003) accounts for the *perfectionist* answer in terms of quantification over all animate individuals in the scene, resulting in a representation in which the set of all animals functions as the domain of the quantifier (Geurts, 2003:16).
understanding of quantified sentences caused them to interpret quantified sentences in a non-adult-like way and showed that children are target-like with an improved setup (cf. also Freeman et al, 1982).

The overview presented in this chapter shows that there is no consensus regarding children’s understanding of quantified sentences. Various psychological and linguistic accounts compete with each other and explain children’s non-adult-like interpretations of quantified sentences in different ways. An account is needed that can explain the findings reported in literature and reconcile these different perspectives on the acquisition of quantification. Crain et al.’s criticism (cf. also recent work by Meroni, Gualmini, and Crain, 2006) against all other accounts that claim that children restrict a quantifier domain by other means than syntax (because this would run counter to the principles of universal grammar), provides a challenge to explore alternative hypotheses. The alternative hypothesis that I will explore in this thesis is that children use other means than syntax to restrict a quantifier domain (even if an experiment is set up along the principles they advocate). Crucially, I will argue that children attribute different weight than adults to the various factors that determine the meaning of quantifiers. It is a particular interplay between syntactic, semantic and pragmatics constraints that children have to master in order to interpret quantified sentences target-like. In contrast to previous studies, I will take all these constraints into account. Moreover, recent work on adults’ interpretations of quantified sentences legitimates such an approach (cf. Hendriks and De Hoop, 2001; De Hoop, Hendriks, and Blutner, 2007). Without disregarding any of the principles discussed in section 2.2 concerning the meaning and syntactic structure of quantified sentences, these theories crucially explain adults’ interpretations of quantified sentences in terms of an interaction between syntax, semantics and pragmatics. Moreover, and crucial for current purposes, these theories allow us to model children’s understanding of quantified expressions, to incorporate both psychological and linguistic research and to formulate precise predictions regarding the acquisition process of quantification. Therefore, in the next chapter, I will use these theories to formulate my alternative hypothesis in more detail and to formulate precise predictions.