Acquiring quantification
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*How children use pragmatics to constrain meaning*

### 5.1 Introduction

This chapter addresses children’s understanding of the weak quantifier *many* and, in particular, their understanding of the context dependent meanings of *many*. Recently, it has been proposed that the way in which children interpret universal quantifiers may initially be rather similar to the way they interpret *many* (cf. Drozd and Van Loosbroek, 1999), c.q. in a strongly context dependent way (Geurts, 2003). However, there are only few results to date of children’s understanding of quantifiers like *many* and their context dependence (with the exception of Krämer, 2005a and 2005b). *Many* allows different kinds of cardinal and proportional readings. Context plays an important role for all these readings of *many*. The possible interpretations of *many* point at the necessity to characterize (implicit) domain restriction in terms of the interplay between syntactic, semantic and pragmatic constraints (cf. Hendriks and De Hoop, 2001). This chapter aims to characterize the acquisition of *many* in terms of the interplay between these constraints and to establish how this differs from the way these constraints interact in adult language.

By investigating the hypothesis that the acquisition of quantification is a matter of fine-tuning the interplay between constraints of various nature (cf. chapter 3) for *many*, I test the prediction that arises from the work by Drozd and Van Loosbroek (1999) that children use pragmatics to restrict a quantifier domain. I will take into account the semantic and pragmatic characteristics of *many* and investigate English learners’ understanding of this quantifier. I compare their understanding of *many* to their understanding of the universal quantifiers *all* and *many of*.

This chapter proceeds as follows. I start with discussing the many interpretations of *many* in adult language in section 5.2. After presenting various solutions that

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have been proposed in the literature to account for the context dependence of quantification in general and all and every in particular in section 5.3, section 5.4 applies these different solutions to the case of many and presents a new, pragmatic account of this quantifier in terms of bidirectional optimality theory (Blutner, 2000). Section 5.5 discusses the relevance of many from an acquisition viewpoint. In section 5.6, I derive a hypothesis from this account about children’s understanding of many and discuss the predictions, focusing on the context dependence of many. Section 5.7 presents the experiment testing these predictions. Section 5.8 discusses the main results and conclusions.

5.2 The many meanings of many and domain restriction

In Generalized Quantifier Theory (Barwise and Cooper, 1981, Zwarts, 1983, Van Benthem, 1986), quantifier domain restriction is described in terms of the notion of conservativity. The notion of conservativity enables us to characterize the many meanings of many.

In Generalized Quantifier Theory (GQT), a determiner relates two sets: A and B, which are both subsets of the universe U. The notion of conservativity holds that every quantified expression relates two sets to each other in such a way that only the quantifier’s first argument set (set A) and the intersection of this set with B (the quantifier’s second argument set) need to be inspected to determine the truth value of the quantified expression. Conservativity is defined in (1).

(1) **CONSERVATIVITY:**

If A,B ⊆ U, then Q_U(A,B) ⇔ Q_U(A, A ∩ B)

For a conservative determiner, one must determine whether the members of the set denoted by the common noun phrase (the quantifier’s first argument set A) have the property that is denoted by the verb phrase (the quantifier’s second argument set B). Hence, it suffices to evaluate just the members of A in relation to the members of set B; individuals that have properties denoted by the verb phrase B but are not in the denotation of the common noun A, are irrelevant.

For example, take a look at figure 5.1. In this figure, five parrots, one dog and one monkey are wearing a hat. Twenty parrots are not wearing a hat, nor are five dogs and five monkeys. The notion of conservativity says that, to judge sentence (2) as false, one only has to look at the set of all parrots (those that are wearing a hat plus the ones that are not). The set of hat-wearers that are not parrots (i.e. the dog and monkey that are wearing a hat) is irrelevant.

(2) All parrots are wearing hats

The quantifier many is different, because the notion of conservativity as defined in (1) does not hold for all its readings (a proportional reading, a cardinal reading and Westerståhl’s reading). To start with the proportional reading of many and why
The many meanings of *many* and domain restriction

Figure 5.1: All parrots are wearing hats

conservativity does not hold for this reading, consider the following sentence (the example and the discussion below is based on Westerståhl, 1984):

(3) Many farmers attended the workshop on language acquisition

In (3), what counts as many (i.e. whether the sentence is true or false) is context-dependent. If next to 20 undergraduates, 10 farmers attended a workshop on language acquisition, 10 would count as many, because farmers typically do not attend such workshops, and, as a result, (3) turns out to be true. Compare this to (4).

(4) Many people in the class are right-handed.

Example (4) will be judged false in a situation of ten right-handed undergraduates and twenty left-handed undergraduates. In this latter case, our expectation is contradicted that, usually, more people are right-handed than left-handed and so ten is not many. The proportional interpretation of *many* in (3) and (4) involves comparing the numbers of *two* sets (and hence violates conservativity). Crucially, what counts as many depends on the context.

A second reading of *many* is the cardinal one, exemplified in (5). (5) is considered to be true if more than an arbitrary number of bikes are parked in front of the train station (e.g. if more than six hundred bikes are parked in front of the train station in Groningen, this sentence is true). However, note that for this cardinal reading, context also can affect the truth value of a sentence. Using the very same criterion for what counts as *many*, is (5) true or false, given two hundred bikes parked in front of the train station in Barneveld (note that Barneveld is a significantly smaller town than Groningen, having no university, and hence, two hundred bikes does
count for the station in Barneveld)?

(5) Many bikes are parked in front of the train station.

Westerståhl (1984) describes a third reading of *many*. This reading is exemplified in (6) (example from Westerståhl, 1985:403).

(6) Many Scandinavians have won the Nobel prize in literature

   a. “Many of the inhabitants of Scandinavia have won the Nobel prize in literature”
   b. “Many winners of the Nobel prize in literature are Scandinavians”

In order to determine the truth value of (6), we have to inspect the set of Scandinavians and the set of Nobel Prize winners. Taken literally, as in the reading paraphrased in (6-a), (6) is obviously false; it is not the case that many of the Scandinavians have won the Nobel prize in literature. Westerståhl points out a different, and in this case preferred reading, he argues, paraphrased in (6-b). On this reading, (6) might be true. The reading exemplified in (6-b) involves ratios: the number of Scandinavians that have won the Nobel Prize in literature as compared to the number of Nobel Prize winners from other countries (in view of the number of inhabitants in those countries). Given that there were 14 Scandinavians out of 81 winners in the years up to 1984 (the year Westerståhl came up with this example), 14 might be viewed as many and, as a result, (6) is true under the (b)-paraphrase. In the remainder of this chapter, I will refer to this reading as the ‘Westerståhl reading’. The Westerståhl reading is yet another example of the context dependence of quantifier domain restriction (cf. Westerståhl, 1984).

So for all three readings of *many*, context plays an important role. In the literature, this context dependence has been represented by way of different truth conditions of the different readings (cf. Westerståhl, 1984; Partee, 1989; Partee, Ter Meulen, and Wall, 1993). As for the proportional reading of *many*, context dependence can be represented by adding a contextually provided restriction that specifies what counts as *many*. In this way, one can account for the fact that (3) is true if 10/30 people are farmers and (4) is false if 10/30 people are right-handed because per context, one needs to determine what counts as *many*. This has been formalized in the following way (from Partee, 1993:394; but cf. among others Westerståhl, 1984):

(7) PROPORTIONAL READING OF *many* - PRELIMINARY VERSION

\[
\text{many}_E^1(A)(B) = \text{many}^1 A(A \cap B) \text{ where } |(A \cap B)| > c \cdot |A|
\]

*Many* in (7) obeys conservativity and relates its first argument set to the intersection of the first argument set with the second argument set. The restriction is added that

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1Recently, Cohen (2001) labeled this reading the ‘relative proportional reading’ whereas Herburger (1997, 2000) calls it the ‘switched reading’. In the current chapter, it does not concern us how to label this reading but rather why adults allow such a reading in the first place.
5.2. The many meanings of many and domain restriction

A sentence containing *many* can only be true if the cardinality of the intersection of the first and second argument is bigger than the cardinality of the first argument set in a particular context (*c* in (7)).

Such an approach violates compositionality and runs counter to the idea that a speaker is able to determine the meaning of a sentence based on the interpretation of its elements. In the case of *many*, one obviously has to do something more, and this varies per context. Per context, the hearer has to determine what the standard of comparison is that the speaker presupposes. As Westerståhl (1984) and Partee (1989, 1993) point out, this problem can be solved by replacing the formula in (7) with the one in (8). In (8) (from Partee et al., 1993:394), the frequency of A is not dependent on the context, but rather depends on the frequency of the first argument set relative to the frequency of the second argument set in the universe of interpretation (U).

\[(8) \text{ PROPORTIONAL READING OF many - FINAL VERSION} \]

\[\text{many}^1_I(A)(B) = \text{many}^1_A(A \cap B) \text{ where } |(A \cap B)| > \left| \frac{|B|}{|U|} \right| \cdot |A| \]

In (8), the meaning of *many* is not expressed in terms of a context variable *c* but in comparison to the universe of interpretation. This means, however, that conservativity is violated. Instead of restricting the domain of quantification to the first argument set and its intersection with the second argument set, one now has to take the entire second argument set into account. For example, in order to determine the truth value of sentence (2) given figure 5.1, one has to take the entire set of hat-wearers into account.

As for the cardinal reading, a sentence containing *many* is true if the cardinality of the intersection of A and B is more than a certain value. This cardinal reading is defined in (9):

\[(9) \text{ CARDINAL READING OF many - PRELIMINARY VERSION} \]

\[\text{many}^2_I(A)(B) = \text{many}^2_A(A \cap B) \text{ where } |(A \cap B)| \geq n \]

As Partee et al. (1993) points out (cf. Westerståhl, 1984), this reading obeys conservativity but again raises the question what determines the value of *n*. Is the value of this variable context dependent like the value of *c* in (7)? As example (10) shows, a cardinal reading can indeed be contextually dependent.

\[(10) \quad \text{a. I saw many women in traditional costumes in Groningen last week} \]
\[\text{b. I saw many women in traditional costumes at an open-air folk museum last week.} \]

For a cardinal reading of (10), world knowledge determines what counts as many for each location: the chance you meet a woman in a traditional Dutch costume at an open-air folk museum is bigger than that you meet one in Groningen. So (10-a) might be judged as true and and (10-b) as false if there were, say, three women in traditional costumes.
Hence, it is also necessary to account for the context dependence of the cardinal reading of many. Westerståhl (1984) and Partee et al. (1993) replace the definition of the cardinal reading in (9) with (11), mirroring the definition of many’s proportional reading in (8) (adapted from Partee et al., 1993: 393):

\[ \text{CARDINAL READING OF } many - \text{ FINAL VERSION} \\
m_{U}^{2}(A)(B) = many^{2}A(A \cap B) \text{ where } |(A \cap B)| \geq f(|U|) \]

In (11), the standard of comparison is not a given, context-independent number (e.g. many is ‘equal to more than three’), but some minimum number fixed by the size of the universe of interpretation U. Again, this reading of many violates conservativity.

The Westerståhl reading points at a third way to represent the context dependence of many. This can be characterized as follows (from Partee et al., 1993:395, their many^4):

\[ \text{Westerståhl reading of } many \\
m_{U}^{3}(A)(B) = many^{3}A(A \cap B) \text{ where } |(A \cap B)| > c \cdot |B| \]

In (12), many quantifies over two sets (e.g. for (6), the set of Scandinavians and the intersection of A and B, i.e. Scandinavian Nobel prize winners). For (12) to be true, the cardinality of the intersection of set A and B has to be bigger than the cardinality of the B set times a certain contextually given value (c in (12)). This interpretation of many also violates conservativity since inspection of the entire B set is necessary.

In conclusion, for all three readings of many, context plays a role. As to how to represent this in the truth conditions of many, this differs from reading to reading. And so the question remains how to exactly define the relation between quantifier domains and context. These questions have been answered differently in the literature. In the next two sections, I will discuss some answers. The starting point for this discussion is that many is ambiguous between three readings (a proportional reading, a cardinal reading and a Westerståhl reading); what counts as many differs from context to context. Partee points out (cf. the quote below) that it is this context dependence that blurs the picture whether many is really ambiguous:

‘It is a familiar fact that many is a vague, context-dependent quantifier. How many counts as many is context-dependent. ... In this respect, many shares properties with relative adjectives like big and small. The puzzling question is whether many is also ambiguous. In particular, is many ambiguous between a cardinal and a proportional reading? What makes the question challenging is that if they are ambiguous, each reading is still undoubtedly vague, and that vagueness obscures the kinds of evidence that normally would be used to help settle the question whether many is ambiguous.’ (Partee, 1989:383)
5.3 Semantic holes, incomplete quantifier domains and pragmatic reasoning

Westerståhl (1984) (cf. Westerståhl, 1985) introduces the notion of ‘restriction’ into GQT to account for the context dependence of *many*.\(^2\) Positing that the context assigns a value to a so-called ‘context variable’ attached to a determiner (C in (13)), he accounts for the observation that the domain of *many* is restricted by the context. The contextually given set intersects with the quantifier’s first argument set A, forming the quantifier’s domain. According to the definition of restriction in (13) (from Westerståhl, 1984:56), this means that in (6), repeated here as (14), the quantifier’s first argument set A intersects with a context set C. For (14), A is the set of Scandinavians and B is the set of Nobel Prize winners. The context set C is the set of contextually relevant Scandinavians. This leads to interpretation (14-a).\(^3\)

\[(13) \quad \text{Restriction:} \quad D_C^A,B \leftrightarrow D_C^((C \cap A),B)\]

(14) Many Scandinavians have won the Nobel prize in literature

a. “Many Scandinavians have won the Nobel prize in literature, compared to Nobel prize winners from other countries”

Similar approaches to represent the context dependence of quantifier domains in terms of a context-variable can be found in Von Fintel (1994) and more recently in a series of articles by Stanley (2000, 2005) and Stanley and Szabó (2000). All these accounts postulate a context variable that needs to be filled in by the context.\(^4\) Since what counts as *many* differs from context to context, this context variable is filled in differently per context. Defining context variables in this way should be understood, as Von Fintel points out, as “a typical tool in isolating the points

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\(^2\)The context dependence of quantifier domains is not taken into account in GQT (Barwise and Cooper, 1981). Barwise and Cooper presuppose a fixed context assumption.

\(^3\)Note that Westerståhl (1985) does not apply his notion of restriction to this special case of *many*.

\(^4\)They differ in where and how to represent this context variable. For example, Von Fintel (1994) follows Westerståhl (1984) and proposes a similar account of the context-dependence of *many* in terms of, what he calls, resource domains (Westerståhl’s context sets): in a similar way as in (13), Von Fintel assumes an extra index on the determiner which is a free variable whose type needs to be supplied by the pragmatics. This context variable (C) also intersects with the common noun argument. Whereas Westerståhl and Von Fintel take the context variable to be attached to the quantificational determiner, Stanley and Szabó (2000) (cf. Stanley, 2005) argue that the contextual variable is attached to the noun phrase following the quantificational element. They assume that two indexes are connected to the noun phrase: a function index \(f\) and a variable index \(i\). The function index should be understood as taking, relative to a context, objects from the context to properties, and the argument index as an object (Stanley, 2005:28). To get the preferred reading of *many Scandinavians* in (14) as *Many winners of the Nobel prize in literature are Scandinavians, Scandinavians* gets intersected with the set denoted by \(f(i)\), i.e. the function that takes Scandinavians to the property of being a Scandinavian candidate for the Nobel Prize in literature. For current purposes, it only concerns us that context dependent quantifier domains clearly point at the need for a theory that underlines the interaction between semantics and pragmatics. More details on the issue where this interaction needs to be represented in the semantic structure can be found in the work of e.g. Giannakidou (2004) and Neale (1990).
of contact between semantics and pragmatics. These free variables are holes in the semantic structures which will be filled by the pragmatics.” (1996:35). Restricting the quantifier domain by means of a context variable, is one possible way to account for the context-dependence of many. Von Fintel (1994) ultimately aims to model the interaction between semantics and pragmatics.

However, postulating such covert variables raises several problems. For example, how many context variables do we have to assume in order to get the meaning intended by the speaker if we take all possible factors on the quantifier’s domain into account, e.g. the effect of focus, and introduce for each factor a new context variable (Hendriks and de Hoop, 2001, Roberts, 2004)? Moreover, the question remains unanswered how values are assigned to these context variables and what kind of role context plays in this respect (Roberts, 2002). Maintaining the viewpoint that such implicit domain restriction operates at the intersection of semantics and pragmatics, an alternative solution comes to mind: the context-dependence of many is a pragmatic matter, rather than a semantic one. Bach (1994, 2000, 2001, 2005) proposes this alternative account.

Bach (2000) argues that incomplete quantifier domains are pragmatically restricted by the audience in the context\(^5\), which has nothing to do with the syntactic or semantic structure of a sentence, he argues (contra the approaches that use context-variables discussed above). According to Bach, a distinction should be made between two kinds of contextual information. One kind is semantically motivated. This so-called semantic context provides, together with linguistic information, the information that is needed to determine what is said. For example, for indexicals like the pronoun I in (15) and for tense with before in (16), the semantic context is crucial to determine the truth value.

(15) I am the Queen of The Netherlands
(16) John did not finish his thesis before he went to the USA

If (15) is uttered by Beatrix, the sentence is true. Similarly, if John did not finish his thesis before September 2007 (i.e., the moment he went to the USA), (16) is true. Semantic context provides information about the speaker’s identity and speech time, without which the truth value of (16) nor the truth value of (15) can be determined.

Another kind of contextual information, Bach argues, is pragmatic in nature. Pragmatic context is the “mutually and readily accessible information that speakers can count on each other to count on in figuring out what they mean when they say what they say” (2000:272). Bach argues that context dependent domain restriction operates at the pragmatic level of what is being communicated, not at the syntactic/semantic level what is being said or interpreted.\(^6\)

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\(^5\)As Neale (2000) points out, the label ‘incomplete’ is probably due to Sellars (1954:199), addressing “utterances . . . [that] are not complete and are only made complete by the context in which they are uttered” (cited in Neale, 2000:284).

\(^6\)In fact, Bach argues that Stanley and Szabó’s claim that meaning is determined by context is too
For a quantified sentence like (17), this means that, at a pragmatic level, the domain is restricted to the set of bottles that the speaker, for example, just bought. Bach represents the proposition that is expressed and interpreted in (17) as in (17-a). However, the proposition that is communicated is the one expressed in (17-b) (italics marks it as the proposition communicated). Moreover, Bach argues that sentences (17) and (18) involve distinct propositions. What the speakers are communicating, however, is the same.

(17) Every bottle is empty
   a. $[\forall x: \text{bottle } x](x \text{ is empty})$
   b. *Every bottle I just bought is empty*

(18) Every bottle I just bought is empty

Bach calls (17) a case of a *conversational implic-i-ture* (as opposed to Grice’s *conversational implic-a-ture*) (see Bach, 1994, but also Bach, 1994, 2000, 2001, 2005). In the case of a conversational implic-a-ture, the speaker means something different than he actually says (i.e. in everyday speech, (19) is understood to mean (19-b)), but in the case of an implic-i-ture, Bach argues “one says something but does not mean that; rather, what one means includes an implicit qualification on what one says, something that one could have made explicit but didn’t.” (Bach, 2001:257).

(19) a. If it rains, a linguist goes for a beer
   b. ‘Only if it rains, a linguist goes for a beer (if it does not rain, he is at work)’

The controversy about the role of context in determining a quantifier’s domain thus boils down to the question whether the matter concerns a semantic or a pragmatic problem. Westerståhl (and Von Fintel, Stanley and Stanley and Szabo) argues that it is a matter of, using Bach’s (2000) terms, semantic context and solves the problem by adding a context variable to the semantic representation of a quantified sentence. Bach on the other hand argues that pragmatic context is involved and, making a distinction between the proposition expressed and the proposition communicated, claims that the pragmatic context is only related to the latter kind of proposition. Put differently, the question how to represent the role of context for determining the domain of a quantifier boils down to the question whether filling in an incomplete quantifier domain concerns the proposition being expressed as in the semantic approach with a context variable or the proposition being communicated as in Bach’s pragmatic approach. How can we test these opposite claims?

Bach relies on Grice’s (1975) cancellability test to check whether something is part of the proposition being expressed or communicated. When a speakers utters a strong and that there is not such a thing as contextually determined quantifier domains (since it happens at a pragmatic level.)

7This is reminiscent, as Bach (2006) points out, of what in Relevance Theory (Noveck and Sperber, 2004) is called an *explicature*. See Bach (2006) for minor differences between the two notions.
sentence S and the hearer concludes that the speaker implied P, the cancellability test checks whether the hearer’s conclusion P can be explicitly ‘cancelled’ by adding *but not* P to the uttered sentence S. If this results in a contradiction, P is part of the proposition expressed; if this does not result in a contradiction, P is only implicated and therefore part of the proposition communicated. Consider (19-a) again. Strictly speaking, the speaker did not say that *only* if it rains, a linguist goes for a beer. However, a hearer infers that the speaker means (19-a); had the speaker not meant (19-a), she should/could have been more explicit. Applying Grice’s (1975) cancellability test, explicitly negating the hearer’s conclusion that a linguist goes for a beer only if it rains does not result in a contradiction and shows that the implicature that a linguist only goes for a beer if it rains is part of the proposition communicated and not part of the proposition expressed.

(20) If it rains a linguist goes for a beer, but not only if it rains, a linguist goes for a beer.

Contrast this to the cases that Bach takes to illustrate the effect of semantic context on interpretation, like (21-a): if uttered by Beatrix, adding *but Beatrix does not* results in a contradiction. This shows that the reference of *I* is part of the proposition expressed.

(21) a. Beatrix: I like hunting
b. Beatrix: I like hunting but Beatrix does not

At this point, the question arises when exactly pragmatic context comes into play. Bach claims that sentences for which the quantifier domain needs to be determined by the context involve a non-literal sense, and it is crucially the hearer who needs to spot these implicit quantifier domains. Consider the following lengthy quote from Bach (2001) (italics added):

“As with any nonliteral utterance, with sentence nonliterality the audience is to recognize that the speaker couldn’t plausibly be taken to mean exactly what he said. Assuming that the speaker is trying to communicate something and is therefore trying to make what he means evident, the audience has to find some salient connection between what is said and what is meant. Generally speaking, that involves finding some way of taking the utterance that is pertinent to the current purposes of the conversation . . . Of course, this is not to say precisely how, in any given case, the hearer figures out just what that is. That is a difficult and unanswered question for the psychology of communication.” (Bach, 2001:256)

Bach thus redirects the question as to when context affects the domain of quantification to the field of, what he calls, “psychology of communication”. I will now take up this question in order to model the implicit domain restriction of *many*. Are the
different readings of many discussed in section 5.2 all illustrations of Bach’s notions of implic-i-ture? In the next section, I analyze the role of context on the domain restriction of many: does it involve semantic or pragmatic context? I will then argue that the framework of bidirectional Optimality Theory Semantics provides a way to define the interplay between syntax, semantics and pragmatics in the case of implicit quantifier domains.

5.4. Accounting for the many meanings of many

5.4.1 Semantic or pragmatic context?

When exactly does contextual information play a role in determining the domain of many? Or rather, what kind of contextual information plays a role in setting the truth value of a sentence containing the quantifier many? Following Bach, I will use Grice’s cancellability test to answer this question. Consider the different readings of many discussed in section 5.2 again, respectively illustrating the proportional and cardinal reading of many, in the (c) sentences now conjoined with a clause in which a (potentially) implied domain of many (cf. the (b) sentences) is canceled:

(22) a. Many students passed the exam
   b. Many students that attended my class passed the exam
   c. Many students passed the exam but many students who attended my class did not pass the exam

(23) a. I saw many women in traditional costumes in Groningen last week
   b. I saw many of the women that you normally see in traditional costumes in Groningen last week
   c. Last week, I saw many women in traditional costumes in Groningen but I did not see many of the women that you normally see in traditional costumes in Groningen

Adding the extra clause to (22-a) and (23-a) does not result in a contradiction (cf. (22-c) and (23-c)). This shows that the implicit domain of many for a proportional and a cardinal reading is part of the proposition communicated rather than the one expressed. So pragmatic context rules in these cases. Does this also holds for the Westerståhl reading of many?

The intended domain of many Scandinavians in (24) (i.e. the Scandinavians that are relevant to the Nobel price in literature as compared to the number of people per country that have won the price in the past years) is negated in the conjoined sentence (to make things clear, Scandinavians is replaced with inhabitants of Scandinavia). Similarly as in (22-c) and (23-c), this does not result in a contradiction (however, the sentence does turn out to be obviously false). Again, Grice’s cancellability test is passed. This shows that the implicit domain of many in (24) (i.e.
the set of winners of the Nobel prize in literature) is part of the proposition being communicated.

(24)  a. Many Scandinavians have won the Nobel price in literature
     b. Many Nobel price winners are Scandinavians
     c. Many inhabitants of Scandinavia have won the Nobel price in literature
     but not many Scandinavians that are relevant to the Nobel price in literature compared to the number of people per country that have won the price in the past years, have won the Nobel price in literature.

All sentences with many pass Grice's cancellability test; the context-dependent domain of many is clearly restricted by means of the pragmatics, instead of on the basis of the semantics alone (as would be the case if the sentences would not pass the cancellability test). The implicit domain of many is thus not determined at a semantic level but rather by the speaker at a pragmatic level. Taking such a pragmatic approach to the many meanings of many, there is no need to postulate the existence of a covert context-variable which is then filled with contextual information.

In sum, and answering the question I started this section with, many allows several context dependent readings when there is a mutual understanding between speaker and hearer that the hearer has to fill in the domain of the quantifier on the basis of the shared knowledge between them. Or, to put it in terms of a bi-directional view on language (Blutner, 2000), the speaker's optimal expression of a meaning depends on the hearer's optimal interpretation (and vice versa) in a particular context. Taking such an optimization view on interpretation, I will argue in the next section, is the key to account for the role pragmatics plays in the case of quantified expressions.

5.4.2 Many in bi-directional Optimality Theory

De Hoop, Hendriks, and Blutner (2007) present an optimization approach to language in order to deal with the competition between a syntactically optimal interpretation and a pragmatically optimal interpretation as in (26).

(25) Most people sleep at night
(26) Most people drink at night

The interpretation of (25) is that most of the people in the world indeed sleep at night (and not during the day); most relates two sets to each other and, in this case, if the set of people that sleep at night is bigger than the set of people that do something different than sleeping at night, this sentence is indeed true. However, for (26), world knowledge c.q. context comes into play and, Blutner et al. argue, outranks lexical meaning. Since it is implausible that most of the people in the world drink at night (and not during the day), a different interpretation comes into play and at night in (26) is generally understood as modifying the A set of the quantifier (most
5.4. Accounting for the many meanings of *many*. This results in the reading of (26) that most of the people at night drink (alcohol). For this interpretation, (26) is true if most of the people who drink alcohol, drink at night; the interpretation is such that the set of people intersects with the generalized union over the set of alternatives for the set of drinkers at night (De Hoop and Solà, 1995). World knowledge outranks the lexical meaning of the sentence. This ‘suboptimal’ interpretation (suboptimal if syntax prescribes the optimal interpretation) provides the solution for the conflict that arises between the information provided by the syntactic structure and the information provided by our world knowledge. This explains why (25) and (26) get a different interpretation despite of their parallel syntactic structure.

In the bi-directional OT framework of De Hoop et al. (2007), it is assumed that the context of the hearer is the same as the context of speaker: “If a form is associated with a certain interpretation within a certain context by a hearer, then with that same context, the same meaning would have been expressed by the same form if the hearer would have been the speaker” (2007) Moreover, a leading principle for the speaker to state his message is the principle of recoverability; the speaker is only allowed to leave those elements unpronounced that are recoverable from the local context. In the case of example (26) and its pragmatically optimal interpretation that most people who drink alcohol, drink at night, this means that the domain of *most people* is tacitly assumed by the speaker to be recoverable from the context (world-knowledge) to *people who drink*. This allows the speaker to leave the domain of the quantifier implicit, despite of the fact that the hearer cannot derive the meaning intended by the speaker by just combining the constituents as the syntax prescribes (see also Blutner, De Hoop, and Hendriks (2006) and the discussion of (26) in chapter 3 and Geurts’ (2003) examples (53) and (54) in section 5.5).

The view on interpretation of De Hoop et al. (2007) is the starting point for accounting for the many meanings of *many*. As discussed in section 5.4, the context dependence of *many* is a pragmatic matter and crucially involves the assumptions of the hearer the speaker is talking about on the one hand and on the other hand the assumptions of the speaker as to what he takes to be shared knowledge (e.g. the context) between him and the speaker. In addition to this, Blutner (2000) argues that

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8Bach (2000), not working within a OT framework, claims that it is not the implausibility of the literal meaning, but rather the lack of relevant specificity, that causes the hearer to take a pragmatically preferable interpretation. However, for current purposes, what gives rise to a pragmatic interpretation, is irrelevant.

9Note that this reading gets even more plausible if the NP is focused, as Blutner et al. point out, “if intonational information is available, then the constituent that gives rise to this set of alternatives is the syntactic argument containing the focus (where focus is marked by sentential accent)”. De Hoop and Solà (1995) argue that this relevant set of alternatives, called the C-set in Rooth’s alternative semantics, is the generalized union over the set of alternatives of a focused constituent. It is this generalized union then that can be used to determine the context variable which is always associated to the quantifier’s first argument set (cf. Westerståhl’s (1985) notion of restriction). I will address the mechanism how to restrict an implicit quantifier domain later in this section, but the effect of focus, however, falls outside the topic of this chapter.
speaker’s and hearer’s optimizations are computed simultaneously. This means that interpretation and production both involve mapping form to meaning and mapping meaning to form. Using language to convey a message does not only mean that you utter a sentence in a way you think is the correct way of stating your message, but crucially also that you consider the possible ways the hearer can understand your message (and vice versa). This mechanism, I will show in this section, enables me to account for the many meanings of many; the different interpretations of many are the result of different assumptions the speaker makes about the recoverable information from the context and the possible ways the hearer can interpret this.

Now, how does this all work? If a form is associated with a certain interpretation within a certain context by a hearer, then within that same context, the hearer would have used the same form to express that meaning if he/she were the speaker. Both meaning and form are subject to soft, i.e. violable constraints. In a bi-directional OT framework (in contrast to a uni-directional OT framework like the one presented in chapter 4, form-meaning pairs are evaluated against these constraints. Form-meaning pairs are ordered depending on whether there exists a more optimal (a so-called ‘super-optimal’) form-meaning pair (i.e. the form-meaning pair which violates the least number of constraints). A form-meaning \langle f, m \rangle is called super-optimal “if and only if there is no other super-optimal pair \langle f', m \rangle such that \langle f', m \rangle is more harmonic than \langle f, m \rangle and there is no other super-optimal pair \langle f, m' \rangle such that \langle f, m' \rangle is more harmonic than \langle f, m \rangle” (Blutner, 2000).

Crucially, there can be more than one super-optimal pair. In (27), there are two super-optimal pairs; \( f^2 \) is not an optimal form and \( m^2 \) is not an optimal meaning and \( \langle f^1, m^1 \rangle \) and \( \langle f^2, m^2 \rangle \) are the two super-optimal pairs. The arrows in (27) represent how to determine these two form-meaning pairs; \( \langle f^1, m^1 \rangle \) is more harmonic than \( \langle f^1, m^2 \rangle \) etcetera.

\[
\begin{align*}
\langle f^1, m^1 \rangle & \quad \leftarrow \quad \langle f^2, m^1 \rangle \\
\langle f^1, m^2 \rangle & \quad \leftarrow \quad \langle f^2, m^2 \rangle 
\end{align*}
\]

(27)  

The two candidates \( \langle f^1, m^2 \rangle \) and \( \langle f^2, m^1 \rangle \) are not super-optimal, because they are both blocked by the other super-optimal pair \( \langle f^1, m^1 \rangle \). The pair \( \langle f^2, m^2 \rangle \) is also super-optimal.

Regarding the many meanings of many, I identified three possible meanings (the cardinal reading, the proportional reading and the Westerståhl reading). This leads to six possible form-meaning pairs. In order to determine the super-optimal pair(s), these six pairs then need to be considered against several constraints.

In chapter 3, I introduced the very general constraint \textit{Semantic Relation}, repeated below.
5.4. Accounting for the many meanings of many

(28)  *Semantic relation:
For weak quantifiers, use the discourse topic to select the set against the
background of which the interpretation of the quantified expression needs
to be determined.

Defining this constraint more precisely, *Semantic Relation* divides into two con-
straints, *Intersective* (29) and *Context Dependence* (30).

(29)  *Intersective
Strong quantifiers do not satisfy the intersective condition

(30)  *Context Dependence
For each quantified expression D(A,B) where |(A ∩ B)| > c · |C|, C is the
discourse topic

I will now discuss these two constraints in more detail.

Barwise and Cooper already concluded that only weak quantifiers satisfy the
intersective condition as defined in (31) (from Barwise and Cooper, 1981:189/190):

(31)  INTERSECTION CONDITION
D satisfies the intersection condition if for all models
M = ⟨E, ||⟩ and all X, A ⊆ E,
X ∈ ||D|| (A) iff X ∈ ||D|| (A ∩ X)

Strong quantifiers violate this condition, Barwise and Cooper (1981) argue, but
the weak quantifiers *many* and *few* give rise to a difference in opinion between the
two authors (the labels ‘weak’ and ‘strong’ are used here in the sense of Milsark
(1979), see also chapter 2). Whereas Cooper takes *many* and *few* always to satisfy
the intersection condition, Barwise takes them to violate the intersective condition
given their context dependent domains as discussed in section 5.2. Compare the
following examples.

(32)  a. Few entities that love Mary are men that love Mary
    b. Few men love Mary
(33)  a. All entities that love Mary are men that love Mary
    b. All men love Mary

Whereas (32-a) and (32-b) are logically equivalent (i.e. they express the same meaning
and hence violate the intersective condition), (33-a) and (33-b) are not (i.e. they
express a different meaning). For (34-a) and (34-b) containing the quantifier *many*, it
is not clear whether they are logically equivalent or not:

(34)  a. Many entities that love Mary, are men that love Mary
    b. Many men love Mary
Barwise takes *many* therefore to violate the intersective condition. Here and in the remainder of this thesis, I will therefore only argue that strong quantifiers do *not* satisfy the intersective condition. The case of *many* shows that weak quantifiers allow readings that are both non-intersective (i.e. the proportional and the Westerståhl reading, cf. section 5.2) and intersective (i.e. the cardinal reading). Since strong quantifiers never allow an intersective interpretation, strong quantifiers clearly never satisfy the intersective condition.

With respect to the second refinement of Semantic Relation, recall from section 5.2 that strong quantifiers presuppose their first argument set to be established in the discourse before uttering the quantified sentence, whereas weak quantifiers do not convey such a presupposition. Uttered out of the blue, (35) is odd and raises the question which students the speaker is talking about.

(35) All students passed the exam

Most of the time, it is this oddity that forces the hearer to recover a relevant set of students the speaker is talking about from the local context and interpret *students* as e.g. *students in class* . . . . (36) however, uttered again out of the blue, is felicitous and does not presuppose a set of students to be mentioned earlier in the discourse. This shows that weak quantifiers do not presuppose their first argument set to be a discourse familiar set in contrast to strong quantifiers (cf. Heim’s (1982) familiarity condition).

(36) Many students attended my class

However, in section 5.2, I pointed out that weak quantifiers can get a proportional reading in which they do presuppose the existence of their first argument set. Consider also the use of the weak quantifier *two* in (37) (from Geurts, 2007:269):

(37) Fred owns three sheep. He had two sheep vaccinated in the spring.

In (37), the weak quantifier *two* is restricted to *two of the three sheep Fred owns*. In a similar way, *many* in (38) is restricted to *many of the one hundred sheep Fred owns*.

(38) Fred owns one hundred sheep. He had many vaccinated in the spring.

This shows that weak quantifiers allow readings that do establish a discourse link with a discourse entity in the previous discourse (in this case, the set of sheep Fred owns). The constraint Context Dependence captures the observation that it does not hold that all weak quantifiers presuppose the existence of the first argument set by stating that only non-intersective quantifiers presuppose the existence of their first argument set in the previous discourse.\(^{10}\)

\(^{10}\)Examples with so-called specific and non-specific readings of indefinites illustrate the existence of similar interpretations of the same forms next to each other. Example (39) can either mean that John talked with a professor, unknown which one, or that he talked with a specific professor, e.g. Chomsky.
Two other constraints apply; on the one hand, there is the constraint Syntactic Structure (Hendriks and De Hoop, 2001) that makes sure that the N’ is chosen as the quantifier’s first argument and, on the other hand, there is the constraint Forward Directionality (Hendriks and De Hoop, 2001). The constraint Forward Directionality (FD) takes directionality as a “topic structural property of discourse” (Hendriks and De Hoop, 2001:19) and makes sure that the quantifier domain is restricted to the discourse topic.

(39) **Syntactic Structure:**
If there is an N’ that constitutes an NP together with a determiner, use this N’ to restrict the domain of quantification of that determiner. (Hendriks and De Hoop, 2001:22)

(40) **Forward Directionality:**
The topic range induced by the domain of quantification of a determiner (set A) is reduced to the topic range induced by the intersection of the two argument sets of this determiner (A ∩ B). (Hendriks and De Hoop, 2001:19)

This results in the reading of (37) that Fred vaccinated three of the sheep he owns. Syntactic Structure is satisfied since sheep is the domain of the quantifier three for both interpretations and so the N’ is used to restrict the domain. Forward Directionality is violated by the interpretation of three arbitrary sheep since the domain of many is in this case not restricted to the intersection of the set of sheep in the world and the set of sheep that Fred owns.

(i.) John talked with a professor.

I take these cases to illustrate the same role pragmatic is able to play as it is in the case of restricting the domain of many. In a similar way as pointed out in the previous section that quantified sentences with many pass Grice’s cancellability test, (38) does:

(ii.) a. John talked with a professor
b. John talked with Chomsky
c. John talked with a professor but he did not talk with Chomsky

The OT analysis of many can be easily translated to account for the specific and non-specific readings of indefinites. This, however, lies outside the scope of this thesis.

11 The constraint Forward Directionality is part of the family of constraints labeled DOAP (Don’t Overlook Anaphoric Possibilities). Whenever Forward Directionality is satisfied DOAP is satisfied. I return to the other constraints of DOAP in chapter 6.

12 In chapter 6 I return to the issue of topic setting in a discourse and define this by means of Centering Optimality Theory (Beaver, 2004).
We can now use these constraints to answer the question when each reading of *many* occurs (i.e. the cardinal reading, the proportional reading and the Westerståhl’s reading), taking as additional factors the strength and the context dependence of the quantifier, the syntactic structure and the topic of the discourse. Consider example (42).

(42) Many birds fly

This sentence can occur in a context in which either the quantifier’s first or second argument set has already been mentioned (e.g. in a context about birds, or a context about flying entities). In the OT tableaus in (43)- (44), the set mentioned in the discourse preceding the quantified statement is marked by underlining. In (42), two possible contexts in which to express *Many*(A,B) and the possible ways how to interpret *Many*(A,B) (using the definitions of these meanings discussed in 5.3) lead to six possible form-meaning pairs. For each pair *(f, m)*, the form comes before and the meaning after the semicolon. For each form, the type of the quantifiers is indicated (weak or strong, *many* is always weak given that it passes Milsark’s test, see chapter 2, and *many of* is strong) plus its two arguments and their syntactic status (N’ or VP). The meaning following each form after the semicolon follows the definition used in section 5.3 to characterize the cardinal, proportional or Westerståhl reading (i.e. a contextually determined value *(c)* considered against the universe *(U)* for the cardinal reading, the quantifier’s first argument set *(A)* for the proportional reading and the quantifier’s second argument set *(B)* for the Westerståhl reading).

I now discuss the role played by each of the constraints in (43) for each form-meaning pair and show how which pairs turn out to be the super-optimal ones. *Intersective* is satisfied in all cases, since it states that only strong quantifiers violate the intersective condition. A weak quantifier like *many* is allowed to get an intersective reading (i.e. a cardinal reading) and a non-intersective reading (i.e. a proportional or Westerståhl reading). *Context Dependence* is violated by pairs 3 and 5; the C set is not mentioned in the discourse preceding the quantified statement (i.e. the underlined noun, representing the set mentioned in the discourse preceding the quantified statement, differs from the C set that needs to be taken into account according to the interpretation in pair 3 and 5). *Syntactic Structure* is never violated since the N’ is always taken as the quantifier’s first argument set. *Forward Directionality* is violated by pairs 4, 5 and 6 because the quantifier’s first argument set *(birds)* is not in accordance with the discourse topic of the set of flying entities (cf.
5.4. Accounting for the many meanings of *many*

<table>
<thead>
<tr>
<th>Many(A,B)</th>
<th>PD</th>
<th>Syntax</th>
<th>Context Dep.</th>
<th>INTERSECTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(43)
The many meanings of *many*

To determine the set of super-optimal interpretations, two rounds of optimization take place. After the first round, it turns out that both the cardinal and proportional reading are super-optimal interpretations if the quantifier’s first argument set is mentioned in the preceding discourse; both pairs violate no constraints. A second round then takes place in which the remaining possible candidates are evaluated. All form-meaning pairs that contain a form or a meaning that is also part of the super-optimal form-meaning pairs are blocked (i.e. pair 3, 4 and 5). The Westerståhl reading in a context in which the quantifier’s second argument set is mentioned (form-meaning pair six) then turns out to be another super-optimal pair.\footnote{Note that there are other restrictions on the different readings of *many*. Whereas in (i) the quantifier *many* only allows both a cardinal interpretation and a proportional reading as respectively exemplified in (ia) and (ib.), (ii.) only allows a proportional reading (cf. (ii.a) and (ii.b); example originally due to Diesing, 1992).}

In sum, evaluating all form-meaning pairs against the four constraints results in three super-optimal pairs; a cardinal reading or a proportional reading if the discourse contains the quantifier’s first argument set and a Westerståhl reading if the discourse marks the quantifier’s second argument set as a discourse topic.

The ambiguity of *many* does not hold for strong quantifiers; strong quantifiers can only get a proportional reading. For a strong quantifier *all* or the partitive *many of*, this indeed follows from the OT model when we apply the same constraints in the same contexts as in tableau (43).

The only difference between the tableau in (43) and the tableau in (44) with the strong quantifier *many of* is that pair 1 and 4 in this case violate *Intersective; since these form-meaning pairs both contain an intersective reading (i.e. cardinal reading) and *Intersective constraints the meaning of a strong quantifier like *many of* to a non-intersective reading, *Intersective is violated. Surprisingly, table (44) shows that also strong quantifiers are predicted to allow Westerståhl readings if the quantifier’s second argument set is already mentioned in the discourse. Herburger (1997, 2000) argues that strong quantifiers do not allow a Westerståhl reading. However, it is rather her paraphrase of the Westerståhl reading in terms of switching around the quantifier’s arguments that leads her to this conclusion, than the sentence itself.\footnote{\textit{i.} Many firemen are available
  a. “There are many firemen available”
  b. “Many of the firemen are available”

\textit{ii.} Many firemen are altruistic
  a. “There are many firemen altruistic”
  b. “Many of the firemen are altruistic”

The different possible interpretations of *many*, can be attributed to the different kind of predicates in (i.) and (ii.) (Milsark, 1979); whereas (i.) contains a stage being predicated over, (ii.) contains a property being predicted over. These cases, however, are outside the scope of this chapter.}
5.4. Accounting for the many meanings of *many*

<table>
<thead>
<tr>
<th>Many of(A,B)</th>
<th>INTERSECTIVE</th>
<th>CONTEXT DEP.</th>
<th>SYNTACTIC STRUCTURE</th>
<th>FD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ⟨[Many of the]<em>{strong} [birds]</em>{n'} [fly]_{vp} ;</td>
<td>(A ∩ B)</td>
<td>&gt; c ·</td>
<td>U</td>
<td>⟩</td>
</tr>
<tr>
<td>▼ 2. ⟨[Many of the]<em>{strong} [birds]</em>{n'} [fly]_{vp} ;</td>
<td>(A ∩ B)</td>
<td>&gt; c ·</td>
<td>A</td>
<td>⟩</td>
</tr>
<tr>
<td>3. ⟨[Many of the]<em>{strong} [birds]</em>{n'} [fly]_{vp} ;</td>
<td>(A ∩ B)</td>
<td>&gt; c ·</td>
<td>B</td>
<td>⟩</td>
</tr>
<tr>
<td>4. ⟨[Many of the]<em>{strong} [birds]</em>{n'} [fly]_{vp} ;</td>
<td>(A ∩ B)</td>
<td>&gt; c ·</td>
<td>U</td>
<td>⟩</td>
</tr>
<tr>
<td>▼ 5. ⟨[Many of the]<em>{strong} [birds]</em>{n'} [fly]_{vp} ;</td>
<td>(A ∩ B)</td>
<td>&gt; c ·</td>
<td>A</td>
<td>⟩</td>
</tr>
<tr>
<td>▼ 6. ⟨[Many of the]<em>{strong} [birds]</em>{n'} [fly]_{vp} ;</td>
<td>(A ∩ B)</td>
<td>&gt; c ·</td>
<td>B</td>
<td>⟩</td>
</tr>
</tbody>
</table>
At first sight, Herburger’s paraphrase of the Westerståhl reading in (45-b) seems similar to the alternative, more precise paraphrase of the reading in (45-c).

\[(45)\]
\[\begin{align*}
&\ a. \text{Many Scandinavians have won the Nobel price in literature} \\
&\quad \text{“Many winners of the Nobel price in literature are Scandinavians”} \\
&\ b. \text{“Many of the Scandinavians that are relevant to winning a Nobel price} \\
&\quad \text{in literature, have won a Nobel price in literature”}
\end{align*}\]

However, whereas (46-a) rules out the reading in (46-b), it does not rule out (46-c). In a similar way, (47-a) rules out reading (47-b) but it allows reading (47-c).

\[(46)\]
\[\begin{align*}
&\ a. \text{All Scandinavians have won the Nobel price in literature} \\
&\quad \text{“All winners of the Nobel price in literature are Scandinavians”} \\
&\ b. \text{“All Scandinavians that are relevant to winning a Nobel price} \\
&\quad \text{in literature, have won a Nobel price in literature”}
\end{align*}\]

\[(47)\]
\[\begin{align*}
&\ a. \text{Many of the Scandinavians have won the Nobel price in literature} \\
&\quad \text{“Many of the winners of the Nobel price in literature are Scandinavians”} \\
&\ b. \text{“Many of the Scandinavians that are relevant to winning a Nobel price} \\
&\quad \text{in literature, have won a Nobel price in literature”}
\end{align*}\]

This shows that Westerståhl readings also exist for strong quantifiers like all and many of. Herburger’s observation that sentences containing all and many of do not allow their arguments being ‘switched’, does not prove that these sentences do not allow a Westerståhl reading, but rather that a description of this reading in terms of switching around the arguments does not cover its meaning. My account of many in OT as discussed above shows that one does not have to assume that arguments are syntactically ‘switched’ or even that the Westerståhl reading violates syntactic principles. The more refined properties of the discourse rather allow such a reading to arise or not.

In sum, the framework of (bi-directional) OT accounts for two observations. One, in the case of implicit quantifier domains, syntax, semantics and pragmatics compete for the quantifier’s final meaning. Two, it incorporates the idea that shared knowledge between speaker and hearer is the basis for selecting the right interpretations. Bi-directional OT thus allows us to account for the many readings of many. In addition, by taking an optimization approach to interpretation, it is not necessary anymore to posit the existence of any kind of covert domain variables or syntactic anomalies.

### 5.5 The relevance of many from an acquisition viewpoint

Recently various authors have argued that the weak quantifier many and the role pragmatics c.q. context plays in determining its domain provides the key for understanding children’s non-adult like interpretation of sentences containing a universal
5.5. The relevance of many from an acquisition viewpoint

I discuss two such approaches; Drozd and Van Loosbroek (1999) and Geurts (2003). Neither paper however presents experimental evidence as to what kind of pragmatic information children exactly use to constrain meaning. I will argue for an account that can explain why the interplay between syntactic, semantic and pragmatic constraints in child language differs from the interaction between these constraints in the target language.

5.5.1 Children’s understanding of weak versus strong quantifiers

As discussed above, for adults, expectations c.q. world knowledge determine the domain of weak quantifiers, in particular for the quantifier many. Drozd and Van Loosbroek (1999) argue that, in a similar way as adults allow contextual expectations to restrict the domain of many, children let their expectations (about the quantifier’s first argument set) take precedence over the syntactic structure to determine the meaning of strong quantifiers. In the next sections, I will discuss the account in which this peculiar interpretation (and the characteristics of weak quantifiers more generally) plays an important role for accounting for children’s non-target-like interpretation of universally quantified sentences (see chapter 2 for an introduction to this subject).

5.5.1.1 Drozd and Van Loosbroek (1999) and Drozd (2001)

Drozd and Van Loosbroek (1999) and Drozd (2001) argue that children also allow a Westerståhl reading for sentences with a universal quantifier and propose the Weak Quantification Hypothesis (WQH). This hypothesis states that children allow context to determine the domain of the quantifier. This, they argue, will especially be the case if the quantifier’s first argument set is not discourse active or salient enough:

“According to the WQH, children interpret universal quantifiers as weak cardinal quantifiers . . . because they find it difficult to distinguish the two sets they need to represent in order to proceed with a presuppositional interpretation of the universal quantifier. Children faced with such contexts will analyze the quantifier as a weak cardinal quantifier, whose interpretation is both supported by such contexts and requires no presuppositional commitments” Drozd (2001:367)

Their experimental results show that children are indeed sensitive to the salience of the first argument set.14 Drozd and Van Loosbroek (1999) and Drozd (2001) conclude that the difference between universal and existential quantifiers plays a central role in acquiring quantification. Universal quantifiers, in contrast to existential quantifiers (‘strong’ and ‘weak’ in Milsark’s (1979) terminology), presuppose the

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14See also chapter 6 and the results of Drozd and Van Loosbroek (2006) that children’s interpretation of quantified sentences improves when the quantifier domain is introduced previously in the discourse.
The many meanings of many

existence of the NP they are quantifying over. For example, (48) implies that the
speaker assumes that there exist certain men in the universe of interpretation. In
order to interpret the sentence, one needs to check whether there is no man that is
not carrying a donkey. Conversely, for (49), with the weak quantifier some which
does not presuppose the existence of one or more men, one rather has to check
whether there are any men that are carrying donkeys (cf. Strawson, 1952).

(48) Every men is carrying a donkey
(49) Some men are carrying a donkey

Whereas a sentence with a weak quantifier is felicitous if the speaker and hearer do
not share the assumption that the quantifier first argument set exists, a sentence with
a strong quantifier is only felicitous if the existence of the quantifier’s first argument
set is background information, i.e. part of the information shared by the speaker
and the hearer.

In sum, Drozd and van Loosbroek argue that children accept an interpretation
for strong quantifiers similar to what adults accept for (6), repeated below as (50)
(i.e. reading (50-a)). Children differ from adults in that they allow their expectations
or ratios of the quantifier’s first argument set to overrule the syntactic structure of
the sentence in cases in which adults do not allow this.

(50) Many Scandinavians have won the Nobel prize in literature
    a. ‘Many winners of the Nobel prize in literature are Scandinavians’

5.5.1.2 Krämer (2000;2005a,b)

Krämer (2005a,b) presents data on children’s understanding of veel, ‘many’ in
Dutch. Krämer shows that children between four and eight years of age mainly have
cardinal interpretations of “many” followed by an noun phrase, regardless of the
syntactic structure (existential sentence or canonical sentence). Compare (51) and
(52) (examples from Krämer, 2005b:355)

15Hence, Drozd and Van Loosbroek (2006) relabel the WQH and call it the ‘Presuppositional
Account’.
16This is confirmed by using classic tests (Strawson, 1952) for presuppositions which show that
sentences with strong quantifiers keep their presupposition in different contexts and, hence, show that
the presupposition arises due to the type of the quantifier and not due some special meaning expressed in
the sentence. For example, (i.) keeps its presupposition of existence of the set of men in a yes-no question
or when embedded in a clause with a verb like wonder. In (ii.) however, no presupposition shows up, no
matter what kind of context the sentence is embedded in, because it may be that the are no such men.

i. a. Is every men carrying a donkey?
   b. I wonder whether every men is carrying a donkey?

ii. a. Are some men carrying a donkey?
   b. I wonder whether some men are carrying a donkey?
5.5. The relevance of *many* from an acquisition viewpoint

(51)  
Veel eieren zitten in de mand  
many eggs sit in the basket  
‘A lot of eggs are in the basket’

(52)  
Er zitten veel eieren in de mand  
there sit many eggs in the basket  
‘There are a lot of eggs in the basket’

Children do not make a difference between (51) and (52) as adults do (i.e. a proportional reading for (51) and a cardinal reading for (52)) and allow a cardinal reading in both cases.

Krämer explains her findings by arguing that children do not aim for a mutual understanding of the conveyed information between speaker and hearer. Krämer (2005b), following Clark and Marshall (1981), takes as a null-hypothesis that, in order to interpret a sentence with *many*, a standard of comparison must be derived from information that is available for both the speaker and the hearer (i.e. the hearer will make an effort to retrieve the speaker’s Standard of Comparison and the speaker will provide the hearer with sufficient information in this respect, cf. Clark and Haviland (1977)’s speaker-hearer contract, cited in Krämer, 2005b). Adults, Krämer argues, put different weight to the different kinds of information that indicate what counts as *many*. This can be e.g. visual information (cf. in this respect also the work of Newstead and Coventry (2000) who show that the size of a container effects the interpretation of *many*), encyclopedic knowledge or syntactic information. Crucially, the syntactic information does not ‘force an interpretation’, but rather is one of the hints to the Standard of Comparison. Children, according to Krämer (2005), only employ a context-independent Standard of Comparison, circumventing to take the speaker’s perspective into account. This would explain why children do not pay attention to syntactic clues to determine the different interpretations of *many* and allow a cardinal reading of *many* in both a canonical and an existential sentence; for a proportional reading, there needs to be a mutual understanding between speaker and hearer which set the speaker is talking about. And it is exactly this mutual understanding, Krämer argues, that children do not aim for.

From this perspective, children’s interpretations of *many* are in line with the argument put forward in Krämer (2000) that children’s non-target-like interpretation of universally quantified sentences, does not illustrate syntactic or semantic development but rather pragmatic development. It is children’s difficulty in handling shared knowledge between the speaker and the hearer that is causing their non-adult like behavior.

5.5.1.3 Geurts (2003)

Geurts (2003) also points at the difference between universal and existential quantifiers and the role of context c.q. pragmatics. He explains children’s interpretation of quantified sentences as a mapping problem between syntax and semantics and
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introduces the *Weak Processing Account* (WPA). Due to a “malfunctioning mapping from syntactic structure to semantic representation” (2003:203), the domain of quantification remains undetermined. This allows more room for pragmatics to determine the domain of quantification. Geurts argues that there is no incomplete syntactic, semantic or pragmatic system in child language. The only difference between adults and children is a different mapping from syntax to semantics.

Discussing the pragmatic constraints that play a role in the target language to restrict a quantifier domain, Geurts singles out two that he argues to play a role in children’s interpretations of universal quantifiers. Geurts treats the presuppositionality of strong versus weak quantifiers in a similar way as anaphoric pronouns. Just like one needs to retrieve the identity of a pronoun in the preceding context, one must retrieve in the context preceding a universally quantified sentence “a contextually salient collection of Xs, which are to serve as Q’s domain. Or, to put it the other way, the context constrains the domain of the quantifier by making salient this or that set of individuals” (2003:205).

A second constraint on quantifier domains is focus (cf. Hendriks and De Hoop, 2001). Consider the following set of examples (based on Geurts, 2003:205):

(53) Most people visit Berlin [in the spring]
    a. Most people who visit Berlin (at some point in time), do so in the spring

(54) Most people visit Berlin in the spring
    a. Most of the people visit Berlin in the spring

In (53), part of the VP is focused (i.e. *in the spring*) and, as a result, the remainder of the VP *visit Berlin* is backgrounded. Only the backgrounded material enters in the quantifier’s first argument set (as illustrated in (53-a)). In the default case in (54), in which focus does not play a role at all and the quantifier’s first argument set is the set of people and the quantifier’s second argument set the people that visit Berlin in the spring, the entire VP set is the quantifier’s second argument set. Accordingly, (54) gets interpretation (54-a) which says that most of the (contextually relevant) people visit Berlin in the spring (and not that most of the contextually relevant people that visit Berlin, do so in the spring).

Geurts claims that children use these two pragmatic constraints to restrict a quantifier domain for strong quantifiers instead of restricting it by means of syntactic and semantic constraints. As for why children should resort to these pragmatic constraints to determine the quantifier domain, Geurts claims that children prefer to process quantified statements as easily as possible and, therefore, interpret all quantifiers as if they were weak; weak quantifiers pose a symmetrical, intersective relation between their arguments and are therefore easier to process (see chapter 2).\(^{17}\)

\(^{17}\)Geurts points out that this is supported by processing research by Just (1974) and Meyer (1970).
Geurts’ ‘Weak Processing Account’ (WPA) states that children interpret quantified sentences in a two-step fashion; first, the child analyzes a quantified sentence as if it contained a weak, existential quantifier since these quantifiers are easier to process. This leaves the domain of the quantifier undetermined. Second, because children have adult knowledge of the meaning of universal quantifiers and make a distinction between the first and second argument set, they use pragmatic constraints like focus-background and contextual saliency to restrict the quantifier domain. This would explain why a child answers ‘no, not that one’ when asked *Is every cowboy riding a horse* in an extra object situation. The child represents the sentence as saying that there are cowboys riding a horse and then continues by restricting the quantifier’s first argument set by means of the salience of the horses in the picture (due to the fact that one horse is not being ridden). As a result, for the child, the quantifier domain consists of the set of horses and the set of cowboys instead of only the set of cowboys as in the target language. For a child, the sentence *Every cowboy is riding a horse* is only true if there is no cowboy that is not riding a horse and there are no horses that are not being ridden by a cowboy. The pragmatic constraints the child uses (i.e. the ones discussed above) are universal and play a role in both the child and the target language. As Geurts puts it:

“Pragmatic reasoning can play a larger role in children than in adults whenever an incorrect mapping from surface form to semantic representation leaves the quantifier’s domain undetermined, but the pragmatic mechanisms that take over at this point are the same for all ages” (2003:208/9)

5.5.2 Pragmatic constraints

Crain, Thornton, Boster, Conway, Lillo-Martin, and Woodams (1996) also point out that children allow pragmatics to play a role in determining a quantifier domain in situations in which adults do not. Crain et al. do not take this strategy to be a linguistic one but rather to result from the setup of the experiments used to test children’s understanding of quantified sentences. They take the explanation of children’s non-adult like understanding of quantified sentences to lie outside linguistics (see also chapter 2). They differ from Geurts and Drozd and Van Loosbroek in not relating children’s difficulties with quantified sentences to a difference between weak and strong quantifiers.

In more recent papers, Crain and colleagues argue why the weak-strong distinction is not at issue. First, Meroni, Gualmini, and Crain (2006) claim that Drozd and Van Loosbroek’s WQH poses a learnability problem (and see Meroni et al. (2006) for similar arguments against Geurts (2003)). According to Meroni et al., Drozd’s and Van Loosbroek’s accounts presupposes that the child, at a certain moment in her language development, has to accept the target-like interpretation and disregard the non-target-like interpretation. Becoming an adult means that a child disregards one interpretation and only allows the target one to be the correct interpretation of
a quantified sentence. Meroni et al. doubt whether the child is ever able to do so, given the input the child receives.

Second, Meroni et al. take the WQH to imply that children assign a meaning to the VP set that the syntax does not allow. They take the WQH to imply that the quantifier’s first argument set is reversed with the quantifier’s second argument set. This implies according to Meroni et al. that the child restructures the VP as e.g. *is being ridden by a cowboy*. Only then can the child’s answer “no, not that one” be explained in the case of *Is every cowboy riding a horse* and the extra-object situation. This would also raise a learnability issue; how will the child unlearn this option given that, as Meroni and colleagues take to be the null-hypothesis, an adult does not add material to the VP set to restrict a quantifier domain or uses other than syntactic information to determine the quantifier’s first or second argument? 18

Third, Meroni et al. take the WQH to predict that extra agents pose a problem for children; adding an extra cowboy instead of an extra horse, the WQH also predicts non-adult-like behavior. Meroni et al. present experimental data that this prediction is, however, not born out. Children give adult-like answers when they are asked whether (55) is true in a situation in which there are three balloons and four tigers and only three tigers are holding a balloon (in 90% of the cases, they correctly answer “no” to (55)). Given Meroni et al.’s interpretation of the WQH, this situation is however predicted to give rise to a yes-answer, according to the analysis that (55) gets a similar interpretation as (54), cf. (55-a). 19

18 Note however that this is not the case in adult language at all; focus and background and context can affect the quantifier domain (cf. the examples from Geurts discussed above, and among many other Hendriks and De Hoop, 2001).

19 In addition, Meroni, Gualmini, and Crain (2007) present evidence against the prediction of both the WQH and the WPA that children treat universal quantifiers as existential ones by looking at children’s understanding of *have*. *Have* is ambiguous between a possession reading and a custodial reading only if it is not followed by a universally quantified sentence as exemplified in respectively (55) and (56). They set up an experiment in which children were to judge similar sentences as (54). The reasoning behind this experiment is that, if a child knows that *every* is a strong quantifier, the child should only assign a custodial interpretation to the verb *have*. Their experimental results show that this is indeed the case; children only assign a possession reading to the verb *to have* in 12% of the cases when both of the readings are made equally plausible in a discourse preceding the test item.

(i.) Tiger has some roosters that the farmer fed
   a. Tiger owns the roosters that were fed by the farmer
   b. Tiger has custody of the roosters that were fed by the farmer

(ii.) Tiger has every rooster that the farmer fed
   a. Tiger owns the roosters that were fed by the farmer
   b. *Tiger has custody of the roosters that were fed by the farmer

Despite these experimental results against any account that argues that the difference between weak and strong quantifiers is the key to children’s understanding of quantifiers, note that this experiment only presents indirect evidence against such an hypothesis. For example, if children are able to access a custodial reading of *to have* solely on the basis of the (experimental) context, bypassing the information
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(55) Every tiger is holding a balloon

a. \((\text{balloon} \cap \lambda x \ [x\ \text{is held by a tiger}] \in \text{EVERY(balloon)}\)\)

5.5.3 Intermediate conclusions

Summing up, in the literature on the acquisition of quantification, the difference between weak and strong quantifiers and the pragmatic factors that constrain quantifier domains have played a central role. In the adult language, *many* and *most* allow pragmatics (discourse context) to constrain their meaning and, as such, illustrate the kind of pragmatic constraints that are argued to be used by children above syntactic and semantic constraints to constrain meaning (Drozd and Van Loosbroek, 1999; Geurts, 2003). Crain et al. (1996) and Meroni et al. (2006, 2007) come to a related, yet different conclusion about the role children allow pragmatics to play. They crucially maintain the view that children resort to a non-adult-like interpretation because the experimental setup forces them to. This differs from Drozd and Van Loosbroek and Geurts who argue that children restrict a quantifier domain by means of the pragmatics in the first place. Crain et al. argue that this cannot be right since it raises a learnability issue: both Drozd and Van Loosbroek’s WQA account and Geurt’s WPA presuppose that children have to unlearn their interpretation of a quantified sentence, and crucially have to learn to restrict a quantifier domain solely on the basis of the syntactic structure of the sentence. According to Crain et al. and Meroni et al., this is impossible given the input the child receives.

However, the null-hypothesis of Crain and colleagues that quantifiers typically restrict their domain in the target language on the basis of their syntactic structure is unsubstantiated. As a result, their learnability argument against both Drozd and Van Loosbroek (1999) and Geurts (2003) turns out be irrelevant. Rather, the question needs to be answered how children use pragmatic reasoning to restrict a quantifier domain. The work of Brooks and Braine (1996) points into the same direction. Presenting an experiment on children’s ability to restrict *all* to the subject noun phrase (e.g., *All of the men are carrying a box*) or the object noun phrase (e.g., *There is a man carrying all of the boxes*), Brooks and Braine argue that children have no difficulty with restricting the domain of *all*. Note however that the test sentences contain the overt partitive *all of the*. This construction is known for the presupposition of existence the noun phrase it modifies conveys. For example, *All of the men are carrying a box* presupposes that there exists a set of men. The presupposition might provide an additional clue to the child how to restrict a

the strength of the quantifier provides about this matter does not result in any different readings than the experimental results show. To put it differently, experimental data is needed about children’s understanding of the different constraints that play a role in quantifier domain restriction before we can jump to any conclusions about how they use these constraints to solve other ambiguity issues as with the verb *have*. See Partee (1999) for the different readings of *have*.

Moreover, as Jack Hoeksema (p.c.) pointed out to me, note that the WQH implies that the lexical semantics of determiners changes in the course of acquisition, not just the role of pragmatics. This raises another learnability question: what can trigger this lexical shift?
quantifier domain. If this is indeed the case, the results of Brooks and Braine with *all* do not necessarily mean that children use the syntax to restrict a quantifier domain. Rather, it is possible that children apply a similar strategy as they found for *each* and ignore the syntactic information available to them. It is the presuppositional nature of *all of the* that enables them to localize the target-like domain. In this respect, the work of Brooks and Braine (1996) underlines yet again that the question needs to be answered which clues children use to restrict a quantifier domain.

The quantifier *many* provides a tool to address this question in detail (cf. Drozd and Van Loosbroek (1999) who already pointed at *many*). In order to use this quantifier to examine children’s usage of the discourse context to restrict a quantifier domain, its many meanings should first be taken into account. Before turning to an experiment addressing children’s understanding of *many*, and taking its many readings into account, I will distill an hypothesis on the basis of the accounts of *many* presented in this chapter and the findings reported in this section.

### 5.6 Hypothesis and predictions

Do children use the same principles to restrict a quantifier domain as adults? In section 5.4, I showed that interpreting *many* crucially concerns taking into account constraints that appeal to the discourse context and the type of quantifier (weak or strong). The possible readings of *many* were explained in terms of a bi-directional OT framework, a framework that takes successful communication as a starting point and, moreover, allows to account for the different readings of *many* in various discourse contexts.

De Hoop and Krämer (2005/2006) argue that children acquire the ability to reason bi-directionally relatively late; until the age of 6-7, children are unable to take into account the speaker’s alternatives to formulate his message. This hypothesis has been applied to children’s interpretation of pronouns, indefinite objects and imperfectives (cf. Hendriks and Spenader (2006) for pronouns, De Hoop and Krämer (2005/2006) for indefinites and Van Hout (2008) for imperfectives).

For a child, interpreting *many* would therefore not be a matter of considering all the form-meaning pairs identified in the previous section, but simply of checking which meaning is the optimal meaning for one particular form. The ultimate task the child is faced with, according to De Hoop and Krämer (2005/2006), is to learn to apply bi-directional reasoning and to recognize when each reading is allowed. This means that a child is only predicted to check which of the first three form-meaning pairs violates the least number of constraints in the tableau in (43). As illustrated in the uni-directional tableau in (56), the child is predicted to randomly interpret *many* as a cardinal or proportional quantifier if the set of birds is mentioned in the discourse. Alternatively, the child is predicted to randomly interpret *many* as a cardinal or a Westerståhl quantifier if the set of flying entities is mentioned in the discourse (see the uni-directional tableau in (57)).
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Taking De Hoop and Krämer’s (2005/2006) viewpoint that children do not reason bi-directionally until the age of 6-7, children are thus predicted to randomly accept a cardinal or proportional reading for many. Both readings are the most-optimal readings for a discourse context containing the quantifier’s first argument set as a discourse topic (given that these first two form-meaning pairs in the tableau violate no constraints). I label this discourse context the ‘Discourse A context’. If the discourse introduces the quantifier’s second argument set as discourse topic (the ‘Discourse B context’), children are predicted to also interpret many as an ambiguous quantifier, but now between a cardinal and a Westerståhl reading.

In a similar way, children are predicted to assign a proportional reading to many of in a Discourse A context (given that the first and third form-meaning pairs violate constraints), and a Westerståhl reading to the Discourse B context (given that this
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<table>
<thead>
<tr>
<th>Discourse A context</th>
<th>Discourse B context</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>many</em></td>
<td>cardinal/proportional</td>
</tr>
<tr>
<td><em>many of</em></td>
<td>proportional</td>
</tr>
</tbody>
</table>

Table 5.1: Children’s predicted interpretations for *many* and *many of* in a Discourse A context and a Discourse B context

form-meaning pair only violates *Forward Directionality* which is ranked lower than the constraints form-meaning pair 4 and 5 violate. The predictions are summarized in table 5.1.

Assuming that children are not yet able to reason bi-directionally between four and six years of age, children are thus predicted to differ in their interpretation of *many* and *many of* in that they do not take *many of* to be ambiguous between various readings, whereas they do for *many*. Moreover, children are predicted to distinguish a Discourse A from a Discourse B context and to know how these different discourses affect the interpretations of *many*.

The Equilibrium Hypothesis identified in chapter 3 is the alternative hypothesis. According to the Equilibrium Hypothesis (which does not say anything about bi-directional reasoning), children have a non-target-like equilibrium between syntax, semantics and pragmatics. In this line of thinking, if the present experiment shows that children use the discourse information to restrict a quantifier domain regardless of the type of the quantifier (weak or strong), this shows that children use the discourse and neglect to take the syntax into account (supporting the Equilibrium Hypothesis and not the bi-directional hypothesis as formulated above\(^\text{21}\)).

5.7 **Experiment: the acquisition of *many* and *many of***

How do children interpret *many* in different discourse contexts and is this different from adults? The present experiment uses a setup in which the discourse context gives a clue which interpretation of *many* the speaker intended.

5.7.1 **Method**

5.7.1.1 **Subjects**

Twenty-eight children were tested. Seven children were excluded from further analysis because they did not answer the control items correctly, suggesting that they did not pay attention or did not understand the task. The remaining twenty-one

\(^{21}\) As Petra Hendriks (p.c.) pointed out to me, this would not show that the Equilibrium Hypothesis is not compatible with a bidirectional OT account *an sich*, but only that the data does not support the hypothesis I formulated above. Moreover, Hendriks (2008) shows how an explanation of language acquisition in terms of constraint reranking (cf. the Equilibrium Hypothesis) is compatible with a bi-directional OT explanation (cf. also Fikkert and De Hoop, 2009).
children varied in age from 4;1 and 7;3 (mean age 5;10). All children were recruited at preschools in the area of Amherst, Massachusetts (USA).

5.7.1.2 Materials

The pictures used in the experiment differed from the pictures used in other experiments on quantification. Next to the set of individuals denoted by the noun phrase and the verb phrase, an alternative set of the first argument set and an alternative set of the second argument set was depicted. These alternative sets were depicted to enable the child to select a standard of comparison, either in terms of the denotation of the quantifier’s first or second argument set. For *Many parrots are wearing hats*, this meant that, next to the set of parrots, also other animals (the alternative set of the quantifier’s first argument) were depicted and, next to the set of hat-wearing parrots, also other hat-wearers (the alternative set of the quantifier’s second argument set). The scenarios were used to test children’s comprehension of sentences containing the different types of quantifiers: *many* (6 items) versus *many of* (6 items).

(58) Many/Many of the parrots are wearing hats

![Figure 5.2: Many/Many of the parrots are wearing hats](image)

As a control condition, children were asked to interpret sentences containing *all* with respect to a picture like in figure 5.3 (6 items). The picture for the control condition contained alternative sets of hat-wearers (similar to the Extra Agent condition used in classic tests on children’s understanding of quantifiers, see chapter 2).

In addition to the effect of Quantifier Type, the effect of Discourse Type was tested by varying the introduction to each picture. The description either introduced the quantifier’s first or second second argument set (i.e. the discourse was either a Discourse A context or a Discourse B context). Additionally, the experimenter
pointed at the set of individuals denoted by the noun or verb phrase. This is respectively illustrated in figure 5.4 and figure 5.5.\footnote{Gesture was used to achieve joint attention, cf. psychological work that shows that “pointing gestures circumscribe a referential domain by directing gaze to an approximate spatial region”; see Bangerter (2004:415) and references therein. Children by the age of four are known to understand the mechanism of pointing to establish joint attention of speaker and hearer.}

In a Discourse A context, adults are hypothesized to answer ‘no’. Both a proportional reading and a cardinal reading results in a ‘no’ answer; with a cardinal
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The acquisition of *many* and *many of* is examined in a Discourse B context. In Figure 5.5, *Many/Many of the parrots are wearing hats* are presented, and an experiment was conducted to determine if adults would answer ‘yes’. A proportional reading leads to a ‘no’ response in this context, as only five out of twenty-five parrots wearing hats, or five out of the total of twenty-five parrots, do not count as many.

Conversely, in a Discourse B context, adults are hypothesized to answer ‘yes’ (due to a Westerståhl reading). For Figure 5.3 and the quantifier *all*, the experimenter pointed in a similar way at the quantifier’s first or second argument set. In both cases, adults are hypothesized to answer ‘yes’.

Finally, two control items using *many* and two with *all* were tested. The control items were used in combination with a picture in which respectively only e.g. one parrot was wearing a hat (triggering a ‘no’ answer for *many* and *all*), or e.g. four parrots were all wearing a hat (triggering a ‘yes’ answer). The total number of items was 22.

### 5.7.1.3 Procedure

The children were tested using a Truth Value Judgment Task. Instead of introducing a blindfolded puppet to the child, the experimenter told the child the following story:

> At the university, I built this computer and as you will see, there are a lot of pictures on it and it is also able to play sentences via those speakers! But the problem is, I don’t know whether I built this computer entirely the right way. So, I need your help to check whether the computer has been built the right way or the wrong way. Do you want to help me?

OK, well, I show you the pictures I have on this computer and when I

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23 Of course, a cardinal reading might also lead to a ‘yes’ answer if an adult considers e.g. five parrots wearing a hat to be *many* given the fact that parrots normally do not wear a hat.
will show you a picture, you will also hear something. Now, if you just want to tell me if this matches the picture or not. All right?

A laptop was used to present the pictures and two separate speakers were used to play prerecorded test items. The experimenter said “Let’s hear what the computer says” and subsequently asked the child to press a button on the keyboard to play the prerecorded test sentence. As illustrated in the introduction story above, the child was instructed to check whether the pictures matched the sentences or not. This instruction was given to prevent children from answering in terms of world-knowledge (e.g. “parrots do not wear hats in the real world, so the picture is not right”). In addition to this question, I asked the child to explain her answer, both for ‘yes’ and ‘no’ answers.

5.7.1.4 Coding

The number of yes- and no-answers were scored. Moreover, the qualifications of the answers revealed which interpretation participants assigned to the quantifier. The child’s answer was labeled a ‘proportional answer’ in a case like (59) about balloons instead of parrots:

(59) Child A (age: 5;8.15)
  Computer: Many girls are holding balloons
  Child: No! Many girls are NOT holding balloons

In (59), the child refers to the first argument set (i.e. the set of girls) to explain her answer. Moreover, the child points out that many girls are not holding balloons; she quantifies over the first argument set of the quantifier and checks whether this counts as many. She concludes that this is not the case; many girls are not holding balloons (i.e. 20 girls) which is more than the girls that are holding balloons (i.e. 5 girls).

The child’s answer was called a cardinal reading if the child explained her answer by referring to a certain number (e.g. more than one of the dogs have red tails) or as the answer in (60):

(60) Child B. (age: 7;2.20)
  Computer: Many of the dogs have red tails
  Child: Yes
  Experimenter: That’s true? OK. Why is that?
  Child: Because there is more than one.

Example (61) illustrates a case of a Westerståhl reading of a child:

(61) Child C. (age: 6;4.23)
  Computer: All parrots have yellow wings
  Child: No.
5.8. Discussion and conclusions

Experimenter: Why not?
Child: That’s why: all of the characters have yellow wings

In (61), the child explains her answer in terms of the second argument set of the quantifier (all entities that have yellow wings). Put differently, the child quantifies over the intersection of the set of characters with yellow wings and the set of parrots and then checks whether there are no characters that have yellow wings outside this intersection. However, this is not the case; the picture also contains other characters that have yellow wings (cf. the child’s description of the picture in the last line of (61). This ‘no’-answer was taken to reveal a Westerståhl reading.

Finally, children’s answer were labeled ‘other’ if it was unclear what the child meant or could not explain her answer.

5.7.2 Results

For both many and many of, children gave more cardinal interpretations than proportional, Westerståhl and ‘other’ interpretations (t-tests with Bonferroni adjustment of alpha divided by 4, for all comparisons $p < 0.001$); 41% (SD = 1.08) of all answers were cardinal interpretations, 35% were non-intersective readings (SD = 1.82) and Westerståhl readings 10% (SD = 1.16). 15% (SD = 2.40) of the answers were irrelevant (‘other’). Each child gave all four readings (per child, no preferences were found for one particular reading).

Figure 5.6 shows how these different types of readings were distributed over the two quantifiers many and many of. The two bars represent the different quantifier types many and many of and the mean given answer types (in percentages) are mapped on the y-axis.

Children do not make a difference between many and many of. Chi-square analysis revealed no statistically significant associations between the answer the child gave (cardinal, proportional, Westerståhl or other) and the type of the quantifier (many or many of) ($\chi^2(3) = 0.739, p = 0.864$).

Do children differentiate their responses on the kind of discourse information? A chi-square analysis revealed no statistically significant difference between the distribution of answers in the discourse A context ($\chi^2(3) = 0.868, p = 0.833$) nor in the discourse B context ($\chi^2(3) = 2.152, p = 0.542$).

5.8 Discussion and conclusions

Despite suggestions in the literature that context-dependent domain restriction of weak quantifiers is the key for understanding children’s non-adult-like interpretations of quantified sentences, there are few studies on the semantics and acquisition of context-dependent domains of such quantifiers (e.g. many). In this chapter, I defined the various interpretations of many and accounted for these readings in a bi-directional OT framework. I showed that constraints of various nature restrict the
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Figure 5.6: Children’s cardinal (in white), proportional (in grey), Westerståhl (dashed) and other (in black) interpretations of *many* and *many of*. Possible interpretations of this quantifier and, depending on the discourse the quantified sentences occur in, adults accept cardinal, proportional or Westerståhl readings of *many*. The ability of the hearer to consider the alternative forms the speaker could have used to formulate his message, play a central role in this bi-directional framework and, hence, in the account of *many* presented in this chapter.

Following De Hoop and Krämer (2005/2006), I formulated the null-hypothesis that children are unable to reason bi-directionally before the age of six/seven. Given the account of *many* presented above, this predicts that children interpret *many* and *many of* differently, depending on the discourse the quantifiers are used in.

The results show that children allow cardinal readings, proportional readings and Westerståhl readings for *many* across the board. Children’s answers are not affected by quantifier type (*many* vs. *many of*) or discourse context (a discourse A or Discourse B context). The children thus interpreted *many* differently as predicted and the hypothesis that children’s interpretation of *many* and *many of* can be accounted for in terms of bi-directionally reasoning is not supported.

The Equilibrium Hypothesis identified in chapter 3 provides an explanation for the findings. According to the Equilibrium Hypothesis (which does not say anything about bi-directional reasoning), children have a non-target-like equilibrium.
Discussion and conclusions

between syntax, semantics and pragmatics. Since the results show that children use the discourse information to restrict a quantifier domain regardless of the type of the quantifier (weak or strong), this indicates that children, in line with the Equilibrium Hypothesis, use the discourse differently than adults to restrict a quantifier domain. Whereas adults take the difference between weak and strong quantifiers into account (regardless of the discourse), children do not and start out with the information provided by the discourse to restrict a quantifier domain.

In conclusion, the hypothesis formulated in this chapter that children are unable to reason bi-directionally is unable to explain children’s interpretations of many and many of; the data do not confirm the predictions that follow from the hypothesis that children lack bidirectional reasoning as a result of which they interpret many differently than adults. This means that this hypothesis as formulated in this chapter is not supported. In line with the Equilibrium Hypothesis, I therefore conclude that it is the more refined property of projecting the (syntactic and pragmatic) characteristics of quantified sentences onto their semantic representations that are the locus of the problem.