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Introduction

Quantifiers enable us to talk beyond the realm of single entities; by means of words like many, all and every, we are able to generalize and to refer to a set of entities. Moreover, we are able to attribute characteristics to a set by means of these particular words. Consider the sentence in (1).

(1) All children are playing outside

In (1), the quantifier all relates the set of children to the set of entities playing outside, by stating that the former set is a subset of the latter.

All languages share the property of enabling the speaker to make such generalizations. However, the interpretation of quantified sentences has also been argued to require “some more cognitive capacity above the normal apprehension of entities in the world” (Bloom, 2000:216). Acquiring quantification poses a difficult task for the language learner. How and at which age does a child combine the concept of a set, the possibilities to refer to it and to reason about the relation between sets (i.e. to determine whether the children in (1) are indeed all playing outside or whether there is a subset of children that is not)? This thesis aims to answer this question and connects cognitive development to the acquisition of one’s first language.¹

The complex nature of quantification explains why its acquisition has been addressed in various disciplines in the past decades. Starting with the groundbreaking work of the psychologists Inhelder and Piaget (1958), the acquisition of quantification continued to be an often studied subject in subsequent years. In addition, given the indisputable effect of the linguistic structure of a quantified sentence on its meaning, the acquisition of quantification received much attention in linguistic work on the growth of syntax, semantics and, in recent years, pragmatics in early childhood. Unfortunately, in neither discipline all characteristics of quantified expressions were taken into account simultaneously. This resulted in a deadlock in

¹Cf. the viewpoint of, among many others, Roeper and DeVilliers (1991) on the study of quantification that it “might reveal how cognition connects to grammar and how they are intertwined in the process of quantification” (1991:225).
recent years. On the one hand, children were argued to apply adult like interpretations to quantifiers and, hence, there would not be any need to study children’s understanding of quantifiers. On the other hand, various people continued to find experimental evidence for Inhelder and Piaget’s original observation that children interpret quantified sentences differently than adults. This underlined the need to explore the exact conditions in which children show non-adult-like behavior in more detail than had been done in the past two decades.

In addition, recent theoretical work on the meaning of quantifiers points in a similar way at the need to zoom in on the conditions in which children have been argued to show non-target-like or target-like behavior. Whereas, traditionally, quantifiers have been described in terms of their semantic characteristics and the way syntax provided their quantificational domain and nuclear scope (respectively the noun phrase children and the verb phrase are playing outside in (1)), recent theories analyzed the possible effects of (visual or discourse) context on the meaning of quantified sentences and propose an account for these effects (e.g. Hendriks and De Hoop, 2001). Consider the example in (2) (from Hendriks and De Hoop, 2001:17):

(2) The buildings are all two and three stories running half a block deep with brick and glass fronts. Most were built together, a few have narrow alleys between them. Many are still boarded up, a couple were burned out years ago.

((John Grisham, The Rainmaker, cited in Hendriks and De Hoop, 2001)

This example illustrates that quantifiers take a noun phrase from the discourse (buildings) as their domain. This suggests that quantification is not a matter of just keeping track of the syntactic structure of a sentence and the meaning of a particular word (cf. the difference in meaning between all and many), but rather that quantification is a matter of combining information from various sources (the sentence itself and the context).

Contextually inferred or pragmatic aspects of meaning have often been disregarded in first language acquisition research (see also e.g. Papafragou 2006). In the past, researchers have chosen to focus on semantics in order to demonstrate that child language is constrained by specified universal knowledge (see Crain and Thornton, 1998)). Given recent work that shows that pragmatics enriches the underspecified linguistic meaning of language (cf. also the radical pragmatics school, Cole (1981)) first language acquisition research crucially needs to take into account this interplay between syntax, semantics and pragmatics.²

In this thesis, I study this interplay in addressing the question to what extent children master the meaning of quantifiers. How does the child acquire something like a ‘quantity sense’, i.e. the ability to generalize across entities, to refer to sets of entities by means of a quantified expression and to reason about the relations

²For recent initiatives, cf. for example the work of Van Hout (2008) and Spenader, Smits, and Hendriks (2009).
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between these sets (i.e. to combine syntax, semantics and pragmatics)? Furthermore, since quantifiers are typically related to their meaning by abstract (syntactic, semantic and pragmatic) rules, how does a child know how these rules work and how does she know when to apply each of these different rules?

In sum, in this thesis I explore the hypothesis that acquiring quantification is a matter of establishing a target-like equilibrium between syntax, semantics and pragmatics. This thesis aims to contribute to a better understanding of the interaction between syntax, semantics and pragmatics and its role in first language acquisition. Moreover, the answer to this question will raise challenging predictions for future first language acquisition research. If it is indeed the case that the acquisition of quantification is a matter of fine-tuning the interaction between syntax, semantics and pragmatics, it follows that studying the course of language development is a matter of unraveling which factors are at play at certain stages in development instead of determining whether a child shows target-like behavior or not.

After presenting a summary of the main findings in the field in the past decades regarding children’s understanding of quantified sentences in chapter 2 and discussing my Equilibrium Hypothesis in detail in chapter 3, I present the data of six experiments addressing children’s understanding of quantified sentences in different contexts. Chapter 4 presents three experiments, addressing the question how children use the syntactic structure of a quantified sentence when the visual context preceding these sentences is manipulated. Following up the work by Roeper, Strauss, and Pearson (2006) that the existence of floating quantifiers in the input to the child might explain why children ignore the syntactic structure, I investigate Dutch children’s understanding of the floating quantifier *allemaal* (‘all’). Floating quantifiers are not followed by the noun phrase they quantify over, rather one needs to find the appropriate noun phrase in the sentence to determine its domain. Consider (3).

(3) De kinderen spelen allemaal buiten
    ‘The children are all playing outside’

In (3), the quantifier binds the variable introduced by *de kinderen* (‘the children’), but unlike (1), the quantifier does not precede the variable it binds. Roeper et al. (2006) argue that it is this characteristic of floating quantifiers that causes the child to let a quantifier bind non-target variables, also for non-floated quantifiers. Children would ignore the syntactic information provided by a quantified sentence and take the entire sentence to supply a variable for the quantifier. In Dutch, the quantifier *allemaal* ‘all’ can be used either as a floating or non-floating quantifier, with different

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3The development of this ‘quantity sense’ contrasts with the well-studied development of number sense in infants. A clue that there exists something like a ‘quantity sense’, as opposed to the well-studied number sense in psychology, follows for example from the work Hurewitz, Papafragou, Gleitman, and Gelman (2006). They found that children of four years of age show different acquisition paths for counting and quantification.
meanings. The two uses are easily distinguishable (cf. the universal *allemaal* in (3) and the existential *allemaal* in (4)), and, hence, an ideal case to test children’s understanding of floating quantifiers versus non-floating quantifiers.

(4) Er spelen *allemaal* kinderen buiten

There play *allemaal* children outside

‘There are playing a lot of/many children outside’

The results of three experiments addressing children’s interpretation of this quantifier show that children do not only include sets denoted by the object and/or the subject in the domain of floating *allemaal*, but additionally include visually represented sets. This suggests that children differ from adults in their mapping of meaning to form and over-rely on visual clues to restrict the quantifier domain.

In chapter 5, I study the many meanings of the quantifier *many* in English children. Recently, it has been suggested that the acquisition of universal quantification can be characterized in terms of domain restriction that is characteristic for existential quantifiers (see Geurts, 2003), in particular in terms of the context dependent domain of *many* (Drozd and Van Loosbroek, 1999). 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, 2003a,b on Dutch *veel*, ‘many / a lot of’). *Many* allows different kinds of cardinal and proportional readings. Context plays an important role in establishing the actual interpretation of *many*. The possible interpretations of *many* point at the necessity to characterize (implicit) domain restriction in terms of the interplay between syntax, semantics and pragmatics (see Hendriks and De Hoop, 2001). This chapter presents experimental data on children’s understanding of *many*. The results suggest that children’s non-adult-like understanding of *many* is due to the different order they apply syntactic, semantic and pragmatic constraints to determine its meaning.

Chapter 6 discusses children’s understanding of quantified expressions in discourse. Various accounts argue that children are able to understand quantified sentences adult-like if the quantified sentence is embedded in a proper discourse (cf. among others Crain, Thornton, Boster, Conway, Lillo-Martin, and Woodams, 1996). Given children’s non-adult like interpretation of quantified sentences when these are not embedded in a discourse, the question arises why and under which conditions children show adult-like behavior if a discourse is provided. What are the characteristics of a discourse that enables a child to understand quantified expressions adult-like? In chapter 6, I test children’s understanding of quantified expressions in several discourse manipulations.

In chapter 7, I summarize the experimental findings presented in this thesis which provide experimental evidence for the hypothesis that pragmatic principles determine, next to linguistic structure, the meaning and acquisition of language. Formulating them in Optimality Theoretic Semantics (Hendriks and De Hoop, 2001), I conclude that the results show that the acquisition of quantification is indeed a matter of establishing a target-like equilibrium between the usage of syn-
tactic, semantic and pragmatic constraints. I argue that this provides the key for understanding the actual nature of the child’s quantificational system. Finding the balance in using syntactic, semantic and pragmatic constraints is the necessary step toward an adult understanding and use of quantification. This raises challenging questions for future first language acquisition research and underlines the need of joined research of psychologists, theoretical syntacticians, semanticists, pragmaticists and first language acquisition researchers.