Syntactic Processing in Developmental Dyslexia and in Specific Language Impairment

A study on the acquisition of the
past participle construction in Dutch

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A study on the acquisition of the past participle construction in Dutch

Syntactische verwerking in Ontwikkelingsdyslexie
en in Specifieke Taalontwikkelingsstoornis.
Een onderzoek naar de verwerving van de voltooid-verledentijdsvorm in het Nederlands (met een samenvatting in het Nederlands)

PROEFSCHRIFT

Ter verkrijging van de graad van doctor
aan de Universiteit Utrecht
op gezag van de Rector Magnificus, Prof. Dr. W. H. Gispen,
ingevolge het besluit van het College voor Promoties
in het openbaar te verdedigen
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door

Anneke Carien Wilsenach

geboren op 26 juni 1975 te Pretoria, Zuid afrika

Promotores: Prof. Dr. E. J. Reuland
Prof. Dr. F. N. K. Wijnen

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Traveler, there is no path,
Paths are made by walking.

Antonio Machado

General Introduction

In the modern (western) world, written language is one of the key modes of communication. Being illiterate or not being able to read properly can be quite distressing is such a world. While most children acquire reading and spelling skills relatively easily (given that they receive proper instruction), a small proportion (roughly 3-10%) of the population has significant difficulties in learning how to read. For these children the onset of reading instruction marks the beginning of their failure to acquire reading skills. These children suffer from developmental dyslexia. Currently, dyslexic children are screened and diagnosed only after they have tried (and failed) to learn how to read. A more ideal situation would be to identify dyslexic children *before* they attempt to acquire reading skills. Early identification and diagnosis (prior to reading instruction) will lead to early intervention. Early intervention, in turn, can have a positive effect on the outcome of dyslexics' reading ability. In the past two decades, this ideal has inspired researchers to search for early precursors of dyslexia. One of the recurring findings of this period is that dyslexic children often have a history of language problems at an early age. This led scientists to believe that dyslexia might have linguistic precursors. As developmental dyslexia is a genetic disorder (reading skills have been shown to be heritable (De Fries 1991), a viable way to determine if linguistic precursors of dyslexia exist is to study the language development of children with a genetic risk of developing dyslexia. Since not all children in the at risk group are in fact genetically predisposed to develop dyslexia, if nevertheless a group effect is found, this underscores the strength of such linguistic precursors.

As was mentioned above, a small but significant proportion of children fail to acquire reading skills properly. Likewise, a small but significant proportion of children fail to acquire spoken language skills properly. These children are referred to as specifically language impaired. For many years, research on dyslexia and Specific Language Impairment (SLI) followed separate paths: the study of SLI was conducted largely by speech/language pathologists or clinical linguists while research on dyslexia was carried out by educational psychologists. In recent years, researchers have questioned the sharp division between these disorders for two reasons. Firstly, dyslexia has been redefined as a *language* disorder in the 1970's. Before that time, dyslexia was frequently conceptualised as a visual perceptual disorder. Secondly, children with SLI who recover from their language impairment during their preschool years often develop reading difficulties (Leonard 1998). Their recovery seems to be partly 'illusory' (Scarborough & Dobrich 1990). Thus, several hypotheses have been formulated about the relationship between reading impairment and (spoken) language impairment. The main idea behind these hypotheses is that developmental dyslexia and SLI exist on a continuum of language disorders, with dyslexia being a milder form of SLI. In this 'milder' form of the disorder many children only experience noticeable problems when they encounter a complex task such as learning to read.

The finding that dyslexic children exhibited language problems in their kindergarten years has been supported mainly by retrospective information. Prospective studies (Catts et al., 2001; Joanisse et al., 1998) often recruited children who are past 5 years of age; which is not surprising if reading skills are to be assessed as well. However, it does entail that the literature is incomplete: the extent to which the language development of dyslexic children resembles that of children with SLI has not been sufficiently explored in *younger* children at risk for dyslexia. The literature is also not conclusive about the nature of developmental dyslexia. Traditionally, the strongest predictors of reading outcome are thought to be those that require the processing, representation and retrieval of phonological information. Dyslexia is frequently said to be the result of a phonological deficit. In contrast, Scarbourough (1990) found evidence that syntactic skills were a unique predictor of reading disability. Other studies during the eighties (see Share et al., 1984; Butler et al., 1985) also highlighted the fact that dyslexic children (or at least some dyslexic children) have had a broad range of linguistic impairments in their kindergarten years. Despite these findings, the linguistic level most often mentioned as being affected in dyslexic children is still the phonological level. This bias possibly obscures the true nature of dyslexia as morphosyntax and semantics may also be impaired in dyslexic individuals.

The work presented in this dissertation was conducted within a longitudinal research programme entitled *Early language development in SLI and dyslexia: A prospective and comparative study*. The aim of this prospective study is to identify linguistic precursors of dyslexia by investigating a wide range of language proficiencies in children at risk for developing dyslexia. The language development of the at-risk children is compared to that of children with SLI and normally developing children. The primary reason for including children with SLI in this study is that their language development can serve as an index of non-typical language development. A secondary aim of including children with SLI is to contribute to the existing debate of whether developmental dyslexia and SLI are related disorders. Both phonological and morphosyntactic skills of children at-risk for dyslexia are under investigation in the project as a whole. This thesis concentrates mainly on morphosyntax. Specifically, it was investigated whether children at-risk for dyslexia are sensitive to the occurrence of morphosyntactic patterns in the language input that they receive.

This dissertation is structured in the following way:

In chapter 1, developmental dyslexia and Specific Language Impairment (SLI) are introduced. Dyslexia and SLI are defined and described in terms of their symptoms and other general characteristics. Current theories of developmental dyslexia and Specific Language Impairment are reviewed and previous research that has suggested a link between the two disorders is summarized. Finally, the general research questions and method of the project as a whole are presented. The objective of this chapter is to demonstrate that the two disorders share some symptoms, and that some of the theories that have been proposed to explain them are based on similar assumptions.

Chapter 2 is devoted to the specific theoretical background and research questions of this dissertation. One of the symptoms of grammatical SLI is difficulty with the acquisition and use of auxiliary verbs. This has been clearly established for English and German, but it is not clear whether Dutch children with SLI have similar difficulties. Auxiliaries often appear in morphosyntactic co-occurrence patterns. The main goal of this study is to assess whether children at-risk for dyslexia and children with SLI are sensitive to such patterns in their native language. Chapter 2 contains three sections. Firstly, the general typology of auxiliaries is discussed. Following this, previous studies of SLI (specifically regarding auxiliaries) are summarized. Finally, the construction of the past participle in English and in Dutch is highlighted. Most of the experiments presented in the following chapters focus on this construction.

In chapter 3, sensitivity to linguistic form is studied in 18- and 24-month-old children. More specifically, *perceptual sensitivity* to morphosyntactic dependency relations is investigated in these age groups. The reader is first acquainted with the literature on infant studies; such studies clearly indicate that infants are sensitive to the presence of grammatical morphology in their native language from very early on. Furthermore, previous linguistic studies with infants at-risk for dyslexia are summarized. Following this, data from three preferential listening experiments (conducted with normally developing infants and infants at-risk for dyslexia at the ages of 19 and 25 months) are presented. Specifically, Dutch infant's sensitivity to the morphosyntactic relation between the temporal auxiliary *heeft* and its verbal complement (the past participle form of a main verb) is assessed.

In chapter 4, the production of the past participle construction is studied. Production data were gathered by means of a sentence completion task and were collected from the infants that were tested in chapter 3. The aim of this chapter is to test the research outcome of the perception studies conducted in chapter 3. Acquisitionists believe that infants' sensitivity to grammatical morphology functions as an important stepping-stone in the acquisition of morphosyntactic constructions. Thus, if an infant is insensitive to a specific grammatical morpheme in the language input, s/he is hypothesized to be less competent in the production of that morpheme. Based on the results of chapter 3, this hypothesis is investigated in chapter 4.

Chapter 5 focuses on the influence of structural complexity and short-term memory on the use of functional items. Data from two experiments (a sentence imitation task and a digit span task) are presented. Based on Bock & Levelt's (1996) sentence production model, the assumption that functional items are more likely to be omitted from sentences containing a complex (verb) argument structure than from sentences containing a simple (verb) argument structure is tested. This hypothesis forms the basis of the first experiment (a sentence imitation task). In a second experiment, the influence of short-term memory on the outcome of the imitation task is investigated. The goal of this chapter is to establish if the ability to process complex structures is affected in at-risk children and children with SLI and if so, whether this has an influence on their use of functional items such as auxiliaries and determiners.

In chapter 6 sensitivity to morphosyntactic agreement is studied in school-going at-risk children.[1] This chapter is a parallel of chapter 3, i.e. the basic research question is the same. However, in chapter 6 the question is addressed by studying older children and by employing a different experimental technique. Knowledge of the morphosyntactic dependency between the temporal auxiliary *heeft* and the past participle and of the

[1] The term "school-going at-risk children" is used (throughout this dissertation) to refer to children with a genetic risk for dyslexia who are already attending primary school, but who are still at-risk for dyslexia (rather than dyslexic) as they are too young to be diagnosed as dyslexic. In this dissertation, this term refers to at-risk children between the ages of 4:6 and 6:0.

dependency between a modal and the infinitive is assessed by using a discrimination task.

In the final chapter (chapter 7), the findings from the different experimental studies are briefly viewed next to one another to elucidate the scientific contribution of this dissertation. Furthermore, the results from the different studies are interpreted within the framework of a general processing limitation theory and the implications of the results for current theories of developmental dyslexia are discussed. Finally, some clinical implications of this study are mentioned and a general conclusion is drawn on the main research questions of this dissertation.

Chapter 1

Developmental Dyslexia and Specific Language Impairment. The same or different?

Developmental dyslexia is defined as a failure to learn to read properly, despite normal intelligence, normal hearing, adequate classroom exposure and the absence of physical, emotional or socioeconomic problems (Vellutino, 1979). According to the International Dyslexia Association, dyslexia is a specific *language-based* reading disorder. Specific Language Impairment (SLI) is defined as a developmental language disorder in which affected children fail to acquire language properly, despite having normal non-verbal intelligence, normal hearing and no known neurological dysfunctions or behavioural, emotional or social problems (Leonard, 1998) Both disorders are defined by way of exclusion: a child is said to be specifically reading impaired or specifically language impaired when the relevant impairment is not caused by a known handicap. However, for both disorders this entails that it is not clear what is specific about them. To make matters worse, both dyslexia and SLI are heterogeneous disorders. Common profiles of dyslexia and SLI do exist, but they don't fit all individuals suffering from either of these disorders. This makes it even less likely that all children diagnosed as dyslexic or language impaired will exhibit the same symptoms. Furthermore, there seems to be a considerable overlap between these two clinical populations. Children with dyslexia and SLI often suffer from the same symptoms, including poor phonological processing, poor short-term memory skills and difficulties in speech perception. Problems with morphosyntax are mainly associated with SLI, but dyslexic children have also been found to experience problems in this domain. Thus, some children fit the criteria of both disorders and are labelled as dyslexic or language impaired by chance, depending on the type of clinician that the child first encounters. McArthur et al. (2000), for example, found that 50% of the children in their study that were diagnosed as dyslexic also fit the defining criteria of SLI, and vice versa. This seems an unhealthy situation, to say the least. Despite a great amount of research on this topic, the literature remains unclear as to whether dyslexia and SLI are essentially the same or different.

This chapter provides a condensed literature study of dyslexia and of SLI, and of the possible relation between them.

1.1. General characteristics of developmental dyslexia

Individuals with dyslexia find it difficult to read. Apart from this core deficit, dyslexics often exhibit difficulties in related areas such as spelling and writing. Problems with spoken language are also not uncommon: dyslexics may find it difficult to express concepts clearly or to fully comprehend what others mean when they speak. Such language difficulties are usually subtle (and therefore difficult to recognize), but they can lead to significant problems. In addition to problems in the language domain, dyslexics are often said to have a visual impairment as well (Lovegrove, 1994; Stein et al., 2001).[1] Some researchers believe that it is this visual impairment that causes difficulties with the processing of letters and words on a page of text. These difficulties include unstable binocular fixations, poor vergence and increased visual crowding.

It has been known for some time that dyslexia runs in families; dyslexic parents are more likely to have children who are dyslexic than non-dyslexic parents. Whereas dyslexia affects around 3-10% of the population at large, the risk of first-degree relatives of dyslexics to develop the disorder is estimated to be around 40% (Gilger et al., 1991). The impact of dyslexia depends on the severity of the condition and on the amount of remediation that an individual has received. Some dyslexics, for example, do not have much difficulty with early reading and spelling tasks but do experience great problems when more complex language skills are required (such as learning a foreign language, understanding textbook material and writing essays). Other areas that are typically affected in dyslexia are short-term memory, mathematics, attention and sequencing.

1.2. Theories of developmental dyslexia

1.2.1. The phonological deficit theory

Perhaps the best-known theory of developmental dyslexia is the phonological deficit theory. This theory assumes the representation, storage and/or retrieval of speech sounds to be impaired in dyslexic individuals (Ramus, 2003). A pre-requisite of learning how to read is the acquisition of the grapheme-phoneme correspondences of an alphabetic system. In other words, a child has to discover that letters and constituent sounds of speech are connected. Theorists explain dyslexia by claiming that if speech sounds are poorly represented, stored or retrieved this would result in a poor understanding of the grapheme-phoneme correspondences of a particular

[1] The visual theory of dyslexia will not be discussed in any detail in this dissertation. The interested reader is referred to the work of John Stein, e.g. Stein et al., 2001 and to the anatomical studies of Livingstone et al., 1991 and Cornelissen et al., 1995).

language (Snowling, 1981, 2001); Brady and Shankweiler, 1991). Supporters of the phonological deficit theory believe that phonology has a central and causal role in dyslexia, suggesting a straightforward link between a cognitive deficit and the behavioural problem.

The phonological deficit theory is supported by findings that dyslexics perform poorly on tasks involving phonological awareness. Phonological awareness refers to the conscious segmentation and manipulation of speech sounds. The ability to analyze words into consonants and vowel segments is a typical example of a phonological awareness skill. According to Snowling (2001) poor verbal short term memory and slow automatic naming also points to a basic phonological deficit. At the neurological level, functional brain imaging studies (Pugh et al., 2000, Shaywitz et al., 2002) and anatomical work (Galaburda et al., 1985) suggest that a congenital dysfunction of the left perisylvian brain areas forms the basis of the phonological deficit.

In its strongest version, the theory claims that the cognitive deficit in dyslexia is specific to phonology. This claim has caused an ongoing debate. Challengers of the phonological deficit theory believe that dyslexia is much more far-reaching than the theory suggests, with its origin in general sensory, motor and learning processes. The existence of phonological problems in dyslexia is not disputed, but such problems are argued to represent only one facet of a more general disorder. Phonological deficits, for example, could be secondary to a more basic auditory deficit. This view forms the basis of the next theory.

1.2.2. The temporal processing deficit

The temporal processing deficit hypothesis (also known as the rapid auditory processing theory) challenges the specificity of the phonological deficit in dyslexia by claiming that phonological problems arise as a result of a more basic auditory deficit (Tallal, 1980, Tallal et al., 1993). Like the phonological theory, the auditory processing theory assumes that a cognitive deficit lies at the heart of dyslexia. Originally, Tallal introduced the rapid auditory processing theory in the 1970's as an explanation of SLI, but went on to suggest that it could also explain the problems of dyslexics. The main idea of this theory is that dyslexia is the result of a perturbation of auditory language processing in the temporal domain. The consequence of a 'temporal processing deficit' is that children are not fully capable of perceiving and processing short or rapidly varying acoustic events, including those crucial to the recognition of speech sounds (Tallal et al. 1996). According to Tallal et al. (1993, 1996) a failure to correctly represent short sounds and fast transitions would cause further difficulties; in particular when such acoustic events are cues to phonemic contrasts (like in *'ba'* versus *'da'*). This claim is compatible with various indications that dyslexic children have deficient speech sound representations (Liberman, 1973; Lyytinen et al. 1992). The auditory processing deficit is further supported by findings of Tallal and her colleagues that dyslexics perform poorly on auditory tasks like tone discrimination and temporal order judgement as well as on backward masking.[2]

The nature of the temporal processing deficit is controversial. It is not clear whether the processing difficulties concern *temporal* features of speech. As Bishop (1997) puts it, the correct label might be *rapid* processing. Rate could be more important than the sequential ordering of stimuli. Researchers are in disagreement about the nature of the underlying factor that causes brief, rapidly presented sequences to be difficult to process.

1.2.3. The cerebellar theory

The problems faced by dyslexic individuals are not confined to reading and spelling. Dyslexics appear to have a general impairment in their ability to perform skills automatically. This ability is thought to be dependent upon the cerebellum. The cerebellar theory (Fawcett & Nicolson, 2004) has a biological basis in assuming that the cerebellum of dyslexics is mildly dysfunctional. As a result, a number of cognitive difficulties arise. The cerebellum plays an important role in motor control and thus in speech articulation. Fawcett and Nicolson explain the phonological problems of dyslexics by arguing that dysfunctional articulation would lead to deficient phonological representations. Furthermore, the cerebellum plays an important role in the automatization of skills such as typing, driving and reading. Dyslexic individuals have been reported to struggle with the automatization of such skills. According to Fawcett & Nicolson (2004) a weak capacity to automatize would (among other things) affect the learning of phoneme-grapheme correspondences.

The cerebellar theory is supported by the fact that dyslexic individuals perform poorly on a number of motor tasks, in dual tasks (demonstrating impaired automatization of balance) and in time estimation (a non-motor cerebellar task).

1.2.4. The magnocellular theory

The magnocellular theory (Stein et al., 2001) has been proposed as a unifying theory that attempts to integrate all the findings of the above-mentioned theories. In addition, it also accounts for the visual deficits reported in

[2] Recently, several researchers have disputed Tallal's findings. Essentially, there have been numerous failures to replicate the finding of auditory temporal processing deficits in SLI and in dyslexia (see McArhtur & Bishop (2001) for a review).

dyslexia. The magnocellular theory suggests that the impaired development of a system of neurons in the brain (magnocells) may be responsible for the visual- and auditory processing as well as the tactile problems found in dyslexia.

The magnocellular theory explains visual difficulties in dyslexia by suggesting that dyslexic individuals have poor control over eye movement. Stein and his colleagues believe that this poor control is caused by impaired development of the magnocellular system. The magnocellular system connects the retina to the occipital and parietal lobes of the brain and thus it allows information brought in by the eye to be processed by the necessary areas of the brain. Magnocells play a crucial role in several different visual processes, such as detecting visual motion, detecting the direction of movement and control of eye movement. Eye movement control is of particular importance for reading. According to Stein et al. (2001), impaired development of the magnocellular system can cause unsteady eye control when reading, which explains the moving and blurred images reported by many dyslexics. Such moving/blurred images will cause visual confusion of letter order in dyslexics. This, in turn, leads to poor memory of the visual form of words and to an impediment in the acquisition of orthographical skills.

The magnocellular theory explains auditory/phonological problems in dyslexics by suggesting an impairment in the auditory equivalent of the visual magnocellular system. A clearly anatomically distinct set of magnocells does not exist in the auditory system, but some neurons in the auditory pathway are nevertheless specialized for processing acoustic transients. Acoustic transients are typically changes in frequency, amplitude and phase. Successful processing of frequency and amplitude transients is essential for being able to distinguish between different letter sounds. For example, the only difference between the sounds of 'b' and 'd' is a decrease compared with an increase respectively during the first 40 to 50 ms in the frequency of the second and third formants of the speech sounds. According to Stein et al. (2001) detection of such frequency and amplitude transients is essential for meeting the phonological demands of reading. Impaired development of auditory transient processing can lead to auditory confusion of letter sounds and hence to an impediment in the acquisition of phonological skills.

The magnocellular theory explains cerebellar deficits in dyslexics by pointing to the fact that the cerebellum receives massive input from various magnocellular systems in the brain. Therefore, the cerebellum will also be affected by a general magnocellular defect.

The strongest physical data implicating the magnocellular pathway in dyslexia lies in the post-mortem study of five dyslexic brains. These studies showed the magnocells in the relevant thalamic nuclei to be disordered and over 20% smaller than cells in normal brains (Galaburda et al., 1994). Although the evidence points to a defect in the magnocellular pathway, researchers are still left trying to understand what role these defects play in reading and learning disorders. The answers, they believe, lie in the parietal and temporal regions of the cortex, both of which process magnocellular information. In particular, the posterior parietal cortex is involved in visual-spatial attention, peripheral vision, eye movement control, and attention tasks. Being able to have the proper control over eye movement and the attention to concentrate and remain focused are crucial to reading and learning skills.

1.3. Theories of developmental dyslexia: critical comments

Despite intensive research over the past two decades, the debate on the underlying biological and cognitive causes of dyslexia remains fierce. Most of the proposed theories have shortcomings in that they cannot account for all of the symptoms associated with dyslexia.

The major weakness of the phonological theory is that it does not explain the occurrence of sensory and motor impairments in dyslexic individuals. Snowling (2000) dismisses these other problems as "not part of the core features of dyslexia". The cerebellar theory also fails to explain sensory deficits. Fawcett & Nicolson (2001) suggested two subtypes of dyslexia to account for unexplained symptoms; perhaps it is the case that some dyslexics suffer from an impaired cerebellum and other from impaired magnocellular pathways. This is plausible, but another problem with the cerebellar deficit theory is that the causal link postulated between articulation and phonology relies on an outdated version of speech perception, according to which the development of phonological representations relies on speech articulation. This view has long been abandoned in the light of cases of normal phonological development despite severe dysarthria or apraxia of speech. It is also uncertain what proportion of dyslexic individuals are affected by motor problems. It has been suggested that motor problems are found only in dyslexics who also suffer from Attention Deficit and Hyperactivity Disorder (ADHD). On first glance, the magnocellular theory looks the most attractive, but the predictions of this theory with regard to auditory and visual processing have been facing growing criticism. On the auditory side of the deficit, one mayor problem is several researchers have failed to replicate findings of auditory deficits in dyslexia (Heath et al., 1999; Hill et al., 1999; McArthur & Hogben, 2001). At best, when auditory problems have been found, such problems existed only in a subgroup of the population studied. More criticism comes from the fact that the results of many studies are inconsistent with the idea that the auditory deficit (when it is present) lies in "rapid" auditory processing (and therefore within magnocellular function). Another argument, suggested by Bishop et al. (1999) is that auditory deficits *do not* predict phonological deficits, as argued by Tallal. On the visual side of the magnocellular theory, criticism also concentrates on failures to replicate findings of a visual deficit (Johannes et al., 1996; Victor et al., 1993) and on inconsistencies between the predictions of the theory and the empirical results. In particular, visual impairments (when found) seem to be observed across the whole range of spatial frequencies and not only those that are characteristic of the magnocellular system. Perhaps the strongest criticism against the magnocellular theory is that evidence for specific magnocellular deficits are found in only a subgroup of dyslexics (Ramus et al., 2003).

Ultimately, it could be true that the discussed theories and their predicted profiles fit different individuals. The implication then is that overlapping subtypes of dyslexia exist. Alternatively, it could be the case that a single theory can account for all individuals with dyslexia, and that the other manifestations observed act as markers rather than as causative factors. Several questions remain. For example, it is still not clear what proportion of dyslexics has a given deficit and whether there are dissociations or systematic associations between certain deficits. Ramus (2003) set out to answer these questions. He tested 16 dyslexic and 16 control subjects (all university students) on a full battery of psychometric, phonological, auditory, visual and cerebellar tests. His data revealed that all 16 dyslexics suffered from a phonological deficit, 10 from an auditory deficit, 4 from a motor deficit and 2 from a visual magnocellualr deficit. Ramus (2003) concluded that a phonological deficit can occur in the absence of any other motor /sensory disorder and that a phonological deficit is sufficient to cause reading problems. Auditory impairments, when they did occur, aggravated the phonological impairment to a certain extent. Importantly, the auditory problems could not be classified as a rapid auditory processing deficit or as a speech perception deficit. Rather, within each individual dyslexic the pattern of good and poor auditory performance was more or less random. Motor problems were found in four dyslexic students, but the results obtained on time estimation and the balance task did not support the idea of a deficit in the cerebellum. Also, Ramus (2003) found no influence of motor/cerebellar performance on phonology or literacy, questioning the causal role of the cerebellum in dyslexia. Visual deficits of a magnocellular nature occurred in only two students. This low incidence and the fact that visual deficits occurred together with phonological and auditory deficits make it impossible to assess whether visual deficits have an independent contribution to dyslexia. Thus, Ramus (2003) concluded that there is little evidence for a causal role of auditory, visual and motor impairments in dyslexia.

1.4. General characteristics of SLI

The language development of children with SLI is often impaired over the whole spectrum of language domains. Children with SLI experience phonological difficulties (e.g. problems with syllable-final consonants and consonant clusters), lexical problems (delayed acquisition of vocabulary and word-finding problems) and comprehension problems (e.g. problems with understanding metaphors). Despite this wide range of difficulties, SLI is often (in academic research) characterized in terms of problems with morphosyntax, possibly because of the fact that English-speaking children with SLI experience extraordinary limitations in their use of grammatical morphology. Many researchers focus their research primarily on children suffering from grammatical deficits, and some even refer to the relevant type of SLI as G(rammatical)-SLI (e.g. Van der Lely & Battell, 2003).

Leonard (1998) estimates that around 6% of children suffer from some form of specific language impairment, but that only 1.5% have a language age of less than two thirds of their mental age. SLI affects around three times as many males as females. Some children seem to grow out of SLI during childhood, while for others the symptoms persist into adulthood. Bishop & Edmundson (1987) report that of 68 children diagnosed as suffering from SLI at 4 years of age, 56% continued to show poor scores in language tests at ages 5;6 and 8;6; Johnson et al (1999) report that 73% of the preschool children they studied who were language-impaired continued to be language-impaired at age 19.

An important discussion in the literature on SLI revolves around the matter of *delay* versus *deviance.* If SLI is the result of delayed development, children suffering from the disorder will go through the same stages as normally developing children, but more slowly. They might also reach a plateau (a stage beyond which they never progress). If SLI is the result of deviant development, children will show abnormal patterns of development not seen in normally developing children. Another issue is whether the errors of children with SLI are generally *omission* or *commission* errors. In omission errors, children leave out a word or inflection in an obligatory context (e.g. omitting third person singular present tense *-s* inflection). A commission error, on the other hand, would involve using a word or affix in an inappropriate context (e.g. extending the use of *-s* from third person singular subjects to other subjects). The delay versus deviance debate has lead to different theories of SLI. The most important of these are discussed in the next section.

1.4.1.Overview of the grammatical errors in SLI

Grammatical errors in SLI mainly consist of omission errors. Commission errors are also found, but are less common. The most frequent types of omission and commission errors are summarized here. Seeing that symptoms of SLI are co-determined by language typology, it is not possible to give a complete overview of the errors that children with SLI make. Rather, the *categories* involved in errors are introduced. For this reason, this summary is restricted to English and Dutch.

Children with SLI frequently omit affixes.[3] In English, verbal affixes typically omitted by children with SLI include the present-tense *-s* (as in *He drink**s** his beer*) and the past-tense *-ed* (as in *He walk**ed** home*) (Leonard, 1998). Nominal inflections (e.g. plural *–s)* have been shown to be problematic in some SLI studies, but the general consensus is that such affixes are omitted much less often than the verbal affixes mentioned above. Dutch children with SLI often omit or substitute the verbal morpheme marking subject verb agreement. In stead of using the marked form of the verb, these children use the infinitive (for example *Hij drink**t*** becomes *Hij drinken*). Furthermore, Dutch children with SLI often omit the past tense marker or use a present tense form instead (De Jong, 1999). According to De Jong, children with SLI have an 'immature' inventory of past tense forms, i.e. they resemble younger normally developing children in this respect.

Children with SLI also have a tendency to omit auxiliaries. In English, auxiliaries appear in full form and in a (contracted) clitic form. In its clitic form, a contracted auxiliary attaches to the word immediately preceding it, forming for example *he's smiling* and *they've gone home.* In spoken English, clitic forms are usually preferred to full forms. However, children with SLI frequently omit auxiliaries in contexts where adults would use a clitic form of the auxiliary. In contrast to English, Bol & De Jong (1992) found that Dutch children with SLI do not have particular difficulties with auxiliaries (this will be discussed in detail in chapter 2).

Children with SLI frequently omit articles. In English, definite (*the*) and indefinite (*a(n)*) articles are frequently omitted by children with SLI in obligatory contexts. In Dutch, this category is also vulnerable to omission (Leonard, 1998).

Children with SLI occasionally produce commission errors. The most common pattern of this type of error involves producing over-regularised forms of irregular words. Thus, the plural noun *mice* is often produced as the over-regularised form *mouses*. Likewise, irregular past tense forms (as in

[3] Affixes are grammatical morphemes that attach to verbs or nouns and that cannot function as independent words.

sing) are sometimes exchanged for over-regularised forms (as in *singed*). These types of errors are by no means restricted to SLI; they are also found in the language of normally developing children and are generally believed to indicate that children know morphological rules and can apply them to newly learned forms. Errors in the same vein are multiply inflected forms in which the regular past tense ending is attached to an adult irregular past tense form, resulting in forms like *wented* and structures containing two tensed verbs (as is *He didn't worked in the garden* instead of *He didn't work in the garden*).

1.5. Theories of Specific Language Impairment

Theoretical accounts of SLI generally try to explain the disorder by appealing to one of three broad explanations. Some theories explain the impairments in SLI as a developmental delay that is also present in younger normally developing children. Others theorists believe that the problems of children with SLI are the result of a deviant, rather than delayed grammar. These are the so-called modular accounts. Yet other theories explain the limitations of children with SLI as the result of a (general) processing deficit (the non-modular accounts). The main theories within each of these explanations are discussed in the following section.

Importantly, the theories reviewed here were all proposed as an explanation of the *grammatical* impairment in SLI. These theories are not concerned with children suffering exclusively from phonological or pragmatic impairments, even though such children exist. This bias in existing theories of SLI is a result of researchers' belief that delayed/deviant acquisition of grammatical morphology represents the most distinctive feature of the disorder. The separation of grammatical research from phonology, semantics and pragmatics makes it hard to estimate the overlap between subgroups of SLI. Even so, as this dissertation is mainly concerned with morphosyntax all of these theories are potentially relevant.

1.5.1. From the Extended Optional Infinitive Stage towards the Agreement and Tense Omission Model

Rice & Wexler (1995) and Wexler et al. (1998) proposed the Extended Optional Infinitive Stage (EOIS) as an explanation of SLI. This account suggests that the *Optional Infinitive Stage (OI)* (Wexler: 1994), a developmental stage that normally developing children go through between the ages of approximately 1;10 and 3;6, persists in children with SLI. During this developmental stage, children use both bare infinitives and finite verbs in finite contexts[4]. Finiteness is not obligatory yet and as a result, the tense and agreement features of the verb are not always marked.[5] So, for example, in a past tense context a child in the OI stage might say either *I fell on my knee* or *I fall on my knee*, alternating between the finite verb form *fell* and the bare infinitive form *fall*. Wexler also observed that during the OI stage, children tend to omit auxiliaries and copula BE in finite contexts, saying for instance *Mommy eating* instead of *Mommy is eating* or *Daddy gone* rather than *Daddy has gone.* The generalization is that during the OI stage, children alternate between producing finite and non-finite clauses in finite contexts. Wexler and Rice suggest that children with SLI go through an Extended Optional Infinitive stage, which typically lasts until they are 7 or 8 years old.

Initially, Wexler (1994) argued that children with SLI have a Tense Deficit in the sense that they sometimes mark tense but sometimes leave verbs underspecified for tense. The use of bare infinitive forms in contexts that require finite forms represents a tense-omission error under Wexler's assumptions. In later collaborative work between Wexler and Schütze (Schütze & Wexler 1996), it was argued that optional infinitives could arise as a result of either tense or agreement features (or both) being underspecified (i.e. omitted). In their 1998 paper Wexler, Schütze and Rice argue that SLI involves a syntactic feature deficit, which leads affected children to sometimes omit tense and agreement features in obligatory contexts. Wexler et al. refer to this model as ATOM (Agreement & Tense Omission Model). Support for this model comes from erroneous case marking of subject NP's by children with SLI and (younger) normally developing children using root infinitives. In adult English, the subject must be marked with nominative case. However, in SLI and in early (normal) language development, children use root infinitives with accusative subjects as in *him fall down* and *her have a big mouth* (examples from Schütze, 1997). Tense and Agreement both have a relation with the subject. Tense licenses overt subjects, while Agreement assigns the subject's case. With regard to case marking, the Agreement & Tense Omission Model predicts that:

- Structures containing an inflected verb (both tense and agreement are marked) will have nominative subjects.
- Modal/past tense structures in which tense is marked, but agreement may or may not be marked will have either nominative or default subjects (i.e. *He/Him went out*).

[4] A bare infinitive is an infinitival verb-form used without the infinitive particle *to*. The infinitival status of the verb-form is clearer in languages in which infinitives carry an overt inflection, such as German or Dutch. A finite context is a context where an adult would use a (auxiliary or main) verb marked for tense and agreement.

[5] Grammatical features such as 'tense' and 'agreement' are discussed in chapter 2.

- Bare verb/missing auxiliary structures are ambiguous with respect to whether they are (i) specified for agreement but not for tense, (ii) specified for tense but not agreement, or (iii) specified for neither tense nor agreement. Such structures will have nominative subjects (i.e. *He snore, He snoring*) in the case of (i) and accusative subjects (e.g. Him snore, Him snoring) in the case of (ii) / (iii).

Both the EOI and ATOM accounts presume a delay in the language development of children with SLI. Thus, the grammar of a child with SLI is not qualitatively different from the grammar of a normally developing child; it merely develops at a slower pace.

1.5.2. The Missing feature hypothesis / Implicit Rule Deficit Hypothesis

In this account, the grammatical problems of children with SLI are believed to stem from an underspecification of the morphosyntactic rules that mark features such as tense, number and person. Gopnik (1990a, 1990b) originally characterized the problem as *feature blindness* (the features of tense, number and person are missing from the underlying grammars of children with SLI) and based this assumption on a case study of a language-impaired boy. Morphophonological rules and rules that match features in the syntax were absent in the language production of this boy. Feature blindness entails that the grammatical morphemes that encode these features will be produced in a haphazard way. Gopnik presented further evidence for her account with data from a British family (the KE-family).

Gopnik & Crago (1991) reconstructed the missing feature hypothesis by proposing an absence of rules rather than features in the grammars of children with SLI. They proposed the Implicit Rule Deficit account as an explanation of SLI, using as backdrop the dual model of acquisition of morphology (Pinker & Price, 1988). According to the dual model, regular and irregular inflections are acquired differently. Irregular forms are stored in memory, whilst the acquisition of regular morphology necessitates an abstract rule that affixes a morpheme to a verb stem. The suggestion of the implicit rule deficit hypothesis is that such abstract rules are not available to children with SLI and that these children can use only memory. Thus, learning regular forms will be approached in the same way by children with SLI than learning irregular forms (i.e. they will also be rote-learned). However, the implicit rule deficit hypothesis cannot account for the fact that children with SLI sometimes produce overgeneralizations of irregular verb forms. Such productions are an indication that a rule is 'at work' and cannot be rote-learned, as they do not appear in the input. Also, the authors of this account have struggled to deal with the problem of grammatical utterances in an 'ungrammatical child'. Gopnik (1994) assumes that correct manifestations of grammatical morphology in children with SLI are also to be interpreted as the outcome of a deficient system. Thus, examples that do not fit the theory are not seen as counterevidence, but as the chance output of a deficient grammar. As De Jong (1999) points out, falsifying such a theory is hard or even impossible, making the theory itself weak.

1.5.3. The Missing agreement hypothesis

The Missing Agreement hypothesis was proposed by Clahsen (1989). Working with data from German-speaking children with SLI, Clahsen proposes that the children's problem lie in establishing the structural relationships of grammatical agreement. Clahsen claims that children with SLI lack the knowledge of asymmetrical relations between categories, where one category controls the other. Support for this claim came from his observations that children with SLI have trouble with gender and number markings on determiners and articles. Furthermore, the children in this initial study frequently made agreement errors on verbs and produced sentences with the verb in the final position rather than in the appropriate second or first position. According to Clahsen, these children's ungrammatical verb-final productions are not the result of a deficit in 'movement' itself, but are related to their inability to generate the morphology (i.e., finite forms) required for the verb-second position. Grammatical morphemes are missing from the output as children lack the agreement relations that permit their use and not because the children cannot produce the forms themselves.

Following Generalised Phrase Structure Grammar (particularly the Control Agreement Principle (see Gazdar et al., 1985)), Clahsen (1992) anticipates that a deficit in Agreement will cause problems in several domains that depend on agreement relations. The Missing Agreement hypothesis predicts that subject-verb agreement, finite forms of auxiliaries, overt structural case marking and gender marking on determiners and adjectives will all be deficient in SLI. Paradigmatic learning on the other hand should be relatively well preserved in SLI. According to De Jong (1999), there is no reason why children with SLI (under the assumptions of this account) would not be able to learn, for example, the past tense forms of irregular verbs (as verb regularity is not related to subjects features). Furthermore, the Missing Agreement hypothesis does not predict significant difficulties with Tense. Clahsen acknowledges that children with SLI have problems with Tense, but he sees such problems as marginal in comparison to the problems experienced with subject-verb agreement.

1.5.4. Representational deficit for dependency relations

The Representational deficit for dependency relations (RDDR) hypothesis finds the cause of SLI in the computational syntactic system (van der Lely, 1998; Van der Lely & Battell, 2003).[6] The RDDR adopts the Minimalist Program of Chomsky (1995; 1998) to explain SLI.[7] Within the Minimalist Program, long distance dependencies necessitate 'movement', where 'movement' is interpreted as the attraction of non-interpretable features (e.g. tense, gender) for the purposes of feature checking. 'Move' takes place when neither 'Merge' nor 'Agree' are options for the deletion of non-interpretable features. The RDDR states that the core deficit responsible for the grammatical pattern seen in SLI lies in 'movement'. The assumption is that the basic operation/rule 'move' is obligatory in normal grammar (by definition) but optional in the grammar of children with SLI. Thus, the grammar of children with SLI can be characterized by 'Optional Movement' (van der Lely, 1998). 'Optional Movement' entails that it is not the rule per se that is missing from SLI grammar, but that the implementation of the rule is not 'automatic' and compulsory. The RDDR explains problems with tense and agreement marking in SLI as optional head-to-head movement (e.g. V to I) while problems with A- (Argument) movement explains SLI subjects' difficulty in assigning thematic roles to noun phrases.

The RDDR claims that the grammars of children with SLI are deviant, as these children's never reaches a steady state with regard to the implementation of syntactic rules. The prediction is that children with SLI will experience problems in the comprehension and production of all elements that mark syntactic dependency.

1.5.5. The surface hypothesis

The surface hypothesis (see Leonard, 1989, 1998) is perhaps the best known of the non-modular accounts of SLI. The physical properties of grammatical morphemes in English are accentuated in this account, hence the term "surface" hypothesis. Acoustic features such as low phonetic substance and short duration render the acquisition of English grammatical morphology difficult even for normally developing children. The surface hypothesis supposes "a general processing capacity limitation in children with SLI but assumes also that this limitation will have an especially profound effect on the joint operations of perceiving grammatical morphemes and hypothesizing their grammatical function" (Leonard, 1998:247). This limited

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[6] In very recent studies, the RDDR hypothesis has been renamed. It is now called the *Computational Complexity Hypothesis*

[7] The Minimalist Program is discussed in more detail in chapter 2.

processing capacity is maybe best described as a *reduced speed* of processing. The main idea is that children with SLI can perceive word-final consonants and weak syllables, but that these children's processing capacity is severely strained when such taxing forms play a morphological role. When this is the case, children do no not only have to perceive the short duration consonant or weak syllable, they also have to perform additional operations to discover that it functions as a separate grammatical morpheme and fills a specific cell of the morphological paradigm. These additional operations are in effect those discussed in Pinker's (1984) learnability model, in which Pinker offers an explanation for the way in which children build morphological paradigms.[8] According to this model, language acquisition starts off with children forming word-specific paradigms. In the course of language development these paradigms become general and children become aware of the fact that specific affixes represent specific syntactic features. When this happens, children "know" that different affixes represent different dimensions and they can apply them to new words. Thus, on hearing the Italian verb *corre* (he/she runs) a child who has moved from word-specific paradigms to general paradigms can produce *corro* (I run) without having heard it before (examples from Leonard, 1998). Affixes are not all acquired at the same time. Rather, Pinker (1984) argues for a ranking order determined by several characteristics of the affixes themselves. Affixes that are perceptually salient and semantically transparent (e.g. *–ing* and plural *–s* in English) are introduced earlier than affixes that are non-salient or abstract in nature (e.g. 3rd singular *–s* in English).

Ultimately, the surface hypothesis assumes the underlying grammars of children with SLI to be in tact; the morphological paradigms that these children form are essentially the same as those of normally developing children. However, due to their reduced processing speed, the input of children with SLI is distorted. In particular, grammatical morphemes that are perceptually unsalient are at risk of not being perceived or processed. As the processing speed limitation is believed to be general rather than specific, its effect may be different from one language to another. In English, grammatical morphology is affected because of the fact that morphology is quite fragile. In a language with a typology that differs markedly from

[8] Leonard (1998) defines a paradigm as a matrix representation of a set of related morphemes. Paradigms contain cells. Each cell represents a combination of levels of different dimensions. For example, a paradigm may contain the dimensions of number and person; number containing the levels of singular and plural and person containing the levels of 1st, 2nd and 3rd person. Freestanding closed class items such as articles and auxiliaries also enter into paradigms (paradigms are thus not limited to inflections).

English (e.g. Italian), the effects of the same processing limitation can lead to a different kind of linguistic profile in children with SLI

1.5.6. The limited processing account

Another non-modular explanation of SLI is that children with SLI have a limited resource capacity for the processing and storage of information. The notion of a limited capacity system has been incorporated in various models of language processing (Baddeley, 1986, 1996; Bloom, 1993; Bock & Levelt, 1994; Just & Carpenter, 1992). These models all share the same underlying idea that our cognitive resources (which are assigned to different tasks) are limited. In situations where task demands exceed available resources, the processing and/or storage of information are affected negatively. In other words, when processing one aspect of a cognitive task is unusually difficult and demands a lot of the available resources, fewer resources are left for processing other aspects. Thus, breakdowns in performance can occur when processing demands exceed resource capacity. Although task accuracy also is used to measure processing capacity, the speed with which mental operations are carried out is viewed as a fundamental processing resource. Capacity limitations are typically revealed in linguistic interactions and trade-offs across language domains. Individual differences in cognitive capacity are thought to hamper language processing more in some individuals than in others (Just and Carpenter's, 1992).

Several researchers have suggested that children with SLI, even more than normally developing children, have limitations in their capacity to process and store information (Bishop, 1992b; Ellis Weismer & Hesketh, 1996; Gathercole & Baddeley, 1990, 1993; Johnston, 1994; Lahey & Bloom, 1994; Montgomery, 1995a, 1995b). Limitations are proposed to be either specific to a particular resource capacity (e.g. Gathercole & Baddeley (1990) proposed a limitation in phonological working memory) or more general. General resource capacity limitations include limitations in working memory size, computational energy, processing rate, or all three (Kail & Salthouse, 1994).

1.6. Theories of Specific Language Impairment: some critical comments

The study of SLI and the formulation of linguistic theories that explain the disorder remain in continuous motion. Theorists regularly modify their explanations of SLI, as new facts and insights are continuously obtained. Even though the different theories provide researchers with valuable insights, no single theory seems to be able to fully explain the (cross)-linguistic symptoms of SLI. Some are even very much restricted in their applicability. One of the main reasons for this is that theories of SLI are often inspired by observations in a particular language. For example, based on the symptoms of SLI in German, Clahsen formulated the Missing Agreement Hypothesis; in which subject-verb agreement plays a central role. Essentially, Clahsen's theory predicts that SLI will not exist in languages such as Swedish or Afrikaans (that do not have subject-verb agreement). In reality, SLI does exist in these languages; a fact that contradicts the predictions of the Missing Agreement Hypothesis. Furthermore, most existing theories (like the EOI account, the RDDR and the Surface Hypothesis) were formulated based on the symptoms of SLI in English. When investigating SLI in other languages, the symptoms predicted by these theories might not occur at all. To complicate matters even more, the discussed theories are also bound to specific developmental stages. Some theories assume language development in SLI to be delayed (rather than deviant). By definition, these theories only apply to early stages of SLI. The EOI account and the Surface hypothesis, for example, do not explain why some children with SLI have persistent language problems. Other theories, like the RDDR and the Missing Agreement Hypothesis were designed specifically to (also) apply to children with persistent SLI or G-SLI.

As mentioned before, most theories of SLI either describe the disorder as a deficit in representation (modular accounts) or as a processing deficit (non-modular accounts). Modular accounts basically assume that the language acquisition device is not intact (Fletcher, 1999). As a result, grammatical components or relationships are assumed to be 'missing'. The major weakness of modular accounts is that they fail to give an adequate explanation for the finding that children with SLI sometimes correctly produce exactly those forms that, according to the modular theories, should not be available to them. Moreover, the distribution of errors versus correctly produced forms is variable. Theorists supporting the modular position tend to ignore the inconsistency in morphological marking by children with SLI. An exception is Bishop, who confronts the modular position by arguing that the "deficits that are seen in SLI, although undoubtedly severe, are not fully compatible with any hypothesis arguing that these children are unable to use certain kinds of syntactic information. Performance on critical constructions is typically above chance level, even when it is not possible to identify any plausible nonsyntactic strategy that a child use to perform correctly" (Bishop, 1997).

Limited processing capacity accounts have been criticized because of their inadequate theoretical and methodological specificity (Johnston, 1994; Navon, 1984). However, at least part of the appeal of these accounts is in the intuitive way they describe the range of deficits in linguistic and nonlinguistic task performance shown by children with SLI. For instance, a limitation in general resource capacity has been used as one possible explanation for the difficulty children with SLI show in acquiring grammatical morphemes with low-phonetic substance (Leonard, McGregor, & Allen, 1992), the difficulty in learning novel words presented at a fast speaking rate (Ellis Weismer & Hesketh, 1993, 1996), slow word recognition (Edwards & Lahey, 1996), and poor haptic recognition of shapes (Montgomery, 1993).

1.7. Aetiology

1.7.1. Genetics

Both dyslexia and SLI tend to run in families, suggesting a genetic component to both disorders (Orton, 1937, Flax et al., 2003). Evidence for a genetic basis comes from three types of studies: family aggregation studies, twin studies and linkage studies.

Many studies have demonstrated that relatives of probands[9] with dyslexia have an increased risk of developing reading and spelling disorders (see Hallgren, 1950; Pennington et al., 1991; Lubs et al. 1993). Halgren, for example, studied the family histories of approximately 300 children who displayed substantial reading deficits. He found that 88% of the children had an immediate family member with a reading disorder, and proposed that dyslexia was a hereditary trait. Although a well-documented family history of reading disability does suggest a genetic component to dyslexia, by itself it does not sufficiently prove that genes are involved. Members of the same family often share a similar environment and upbringing. This could in principle also explain why two members of the same family have reading problems.

Comparing reading abilities in identical twins (who have an (almost) identical genetic make-up) and non-identical twins (who share approximately 50% of their genes) does enable researchers to distinguish hereditary from shared environmental influences. Strong support for the genetic basis of dyslexia came from such studies. For example, De Fries & Alarcón (1996) found a concordance rate of 68% in identical twins compared to 38% in non-identical twins. In a large twin study in England, Stevenson et al. (1987) found that approximately 50% of reading disability is due to inherited genetic influences and 50% to upbringing and environment.

Several studies have linked the sites on chromosomes 1, 2, 3, 6, 15, and 18 with reading problems (see Grigorenko, 2003 for an overview). So

[9] A proband is the affected individual through whom a family came to the attention of a researcher/clinician.

far, the strongest linkage evidence connects reading problems with a site on the short arm of chromosome 6. The first candidate gene for dyslexia was presented by Finnish researchers in 2003 (Taipale et al, 2003). This gene, now known as DYXCI is situated on chromosome 15. Unfortunately, it is not clear exactly what this gene does and less than 10% of dyslexics unrelated to the original family show mutations on this gene.[10]

The first studies to suggest that SLI is a genetically transmitted disorder were conducted by Gopnik and Crago (1991). Their investigation of a three-generation British family (the KE family) led them to the conclusion that about half of the immediate family members (siblings and parents) of children with SLI have language problems[11]. Rice, Wexler and Hanney (1998) reported that the incidence of language disorders is 22% in families where one child has been diagnosed with SLI, compared to an incidence of only 7% in families with no diagnosed cases.

Twin studies show a concordance rate of 80-86% for identical twins (i.e. that in 80-86% of cases where one twin is diagnosed as having SLI, the other has also been diagnosed as having SLI), and a concordance rate of 38-48% for non-identical twins (Tomblin and Buckwalter, 1998). Bishop (1992a) reported similar findings. In her study of 61 twins, she found a concordance rate of 67% for identical twins and 32% for non-identical twins). The fact that boys are affected three times more than girls also suggests that SLI has a genetic basis.

Finally, linkage studies found that individuals suffering from SLI have an anomaly in chromosome 7, as well as other genetic anomalies (Fisher et al. 1998, Tomblin et al 1998)[12].

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[10] In the original family, members from several generations had a mutation where part of the long arm (q) of one chromosome (in this case chromosome 2) had exchanged with chromosome 15q.

[11] Note however, that the conclusions of Gopnik & Crago are now considered to be controversial. Many researchers (see Vargha-Khadem et al, 1995) believe that the problems of this family are not language specific. Vargha-Khadem et al. investigated the phenotype of the disorder and showed clearly that it is not grammar or speech specific. They tested both affected and unaffected members of the KE family and concluded that the disorder had the following characteristics: defects in processing words according to grammatical rules; understanding of more complex sentence structure such as sentences with embedded relative clauses; inability to form intelligible speech; defects in the ability to move the mouth and face *not associated with speaking* (relative immobility of the lower face and mouth, particularly the upper lip) and significantly reduced IQ in both the verbal and the non-verbal domain. Lastly, the KE family is not representative of the larger SLI population, since girls are just as likely to be affected as boys in this family.

[12] The anomalies found on chromosome 7 are also based on studies of the KE family. Thus, gene's specific influences on brain development remain unknown.

1.7.2. Environmental factors

Despite general consensus that dyslexia and SLI are genetically transmitted disorders, some environmental factors are believed to also influence the outcome of reading- and spoken language skills. Even though environmental factors cannot *cause* dyslexia or SLI, it can aggravate the impact of both disorders. The main environmental factors linked to dyslexia are the educational experiences and home environment of the child. Conventional definitions of dyslexia specifically exclude children whose reading problems are caused by "inadequate classroom exposure" (see again the definition of Vellutino, 1979), but it is not always clear what "adequate classroom exposure" entails. Studies of the reading ability of children from different schools (located in the same area) have highlighted that education can have a significant effect on reading outcomes (Rutter & Maughan, 2002). The idea that the home environment influences children's reading achievement is supported by a study from Whitehurst and Lonigan, 1998). However, this evidence is correlational and it remains difficult to establish the true nature of the association between the home environment and dyslexia. It could be the case that the association arises because of the fact that parents who themselves have a genetic predisposition to reading problems tend to have children with similar problems. If this is true, the association does not reflect a *direct* influence of the home environment on the child's learning.

With regard to SLI, several environmental factors have been implicated as possible causes of the disorder, but none has been shown to be necessary or sufficient to cause SLI. Factors that have been investigated include lack of verbal stimulation by parents, neurological impairments and hearing loss due to otitis media (see Bishop, 1997, for a review). However, none of these factors impair language in the way that it is impaired in children with SLI. Note that the conclusion should not be that verbal deprivation, mild-to- moderate hearing loss and focal brain injury have no impact on language development. Rather, the documented effects of these factors have been shown to be relatively mild, not specific to language skills and they do not lead to the clinical picture found in SLI.

1.8. Linguistic precursors of developmental dyslexia

1.8.1. Phonological development

Several prospective and retrospective studies in the eighties consistently found that phonological processing abilities of kindergartners at risk of developing dyslexia (and older children with dyslexia) are deficient. Especially, phoneme awareness (the representation, retrieval, or metalinguistic analysis of phonological information) is said to be less well developed in dyslexics than in non-dyslexics. In agreement with this view, Mann (1984), Mann & Ditunno (1990) and Stuart & Coltheart (1988) found evidence that dyslexic children had impaired phonemic awareness as kindergartners. Lefly & Pennington (1996) found that the at-risk group in their study differed from the control group in letter knowledge, detection of initial consonant differences, rhyme oddity and rapid naming in kindergarten. According to Byrne et al. (1997), the strongest predictors of dyslexia in the sample of at-risk children that they studied were deficiencies in phonological awareness, poor letter knowledge and knowledge of print at age 55 months. In a similar study with Danish at-risk children, Elbro et al. (1998) found that the best predictors of dyslexia were letter naming and phoneme identification skills in preschool, together with a measure of a child's accuracy in articulation.

1.8.2. Syntactic development

Hollis Scarborough (1990) conducted a groundbreaking study with children at-risk of developing dyslexia. She found that 65% of the children in her sample of at-risk children could be classified as dyslexic by the age of 8 years. A retrospective analysis of the early language skills of these children revealed that they experienced more language difficulties as kindergartners than a group of normal controls. These language difficulties had a changing pattern over time. At age 30 months, the dyslexic children had a similar range of vocabulary items as the comparison group, but they demonstrated a more restricted range of syntactic devices and made more speech production errors. However, at the ages of 36 and 42 months, the vocabulary skills of the dyslexic children were less well developed than those of the controls and their syntactic difficulties persisted (Scarborough, 1991). At age 60 months, the dyslexic children displayed deficiencies in phonological awareness and letter knowledge, but their syntactic difficulties were no longer visible. According to Scarborough, the most important finding of her study was that phonological skills did not account for significant variance in outcome, but that syntactic skills was a unique predictor of reading disability. Thus, she argued, the phonological deficit hypothesis cannot fully explain the occurrence of dyslexia.

In an attempt to evaluate the phonological deficit hypothesis and extend the available evidence concerning the precursors of dyslexia, Gallagher et al. (2000) studied 63 at-risk children with an average age of 45,68 months. They found that almost half of the at-risk children were late in taking their first steps into literacy development. Retrospective analysis of their language development suggested that these children were subject to mild delays in all aspects of their spoken language. Consistent with

Scarborough's finding that preschool syntactic ability was a significant predictor of reading at 8 years, the language factor (sentence length as a measure of syntactic proficiency) in Gallagher et al.'s study accounted for unique variance in literacy development. Furthermore, consistent with the other above-mentioned studies, Gallagher et al. found that the at-risk children recognized fewer letters than the control children at age 45 months. Thus, it is still not clear whether a specific aspect of language ability (e.g. phonological processing) or a more general language delay is most directly responsible for reading failure.

More evidence of delayed morphosyntactic development in young at-risk children comes from studies by Lyytinnen et al. (2001) and Rispens (2004). In Lyytinnen et al's study, a group of at-risk children produced significantly shorter sentences (measured in MLU) than their normally developing peers at the age of 2;0. Rispens (2004) found evidence that kindergarten children at-risk for dyslexia were less sensitive to violations of subject verb agreement than normally developing children. Rispens revisited the at-risk children in her sample after they had received one year of reading instruction and found that those children who did not show normal reading progress differed significantly in their sensitivity to subject verb agreement from children who show normal reading progress.

1.9. Dyslexia and SLI: the same or different

As mentioned in the introduction of this dissertation, researchers have recently suggested that dyslexia and SLI exist on a continuum of language disorder (Goulandris et al, 2000; Catts, 1995; Stackhouse and Wells, 2000). Within such a continuum, dyslexia is regarded as a form of language impairment affecting primarily the phonological system. Additionally, dyslexia is seen as the lasting result of the disorder should oral language difficulties disappear. The two syndromes are accordingly treated as different manifestations of the same underlying problem, differing only in severity and in the stage when the disorder manifests itself (i.e. SLI is considered the more severe manifestation of the disorder, appearing in early childhood. Dyslexia is considered to be the less severe manifestation of the disorder, appearing later in childhood). Nowadays, this idea has become so widespread that researchers use new terms such as *language learning impairment* to refer to children with reading and/or oral language impairments. Some researchers, however, have recently pleaded against the tendency to collapse these diagnostic categories or to treat them as points on a continuum of severity rather than as distinct syndromes. In their review of the literature on the relationship between dyslexia and SLI, Bishop & Snowling (2004) point out that a single dimension of severity is not sufficient to capture the range of clinical variation that exist in these disorders. The authors admit that there are commonalities between dyslexia and SLI in the type of phonological deficits experienced, but believe that children with SLI generally have additional syntactic and semantic difficulties affecting their oral language. Furthermore, Bishop & Snowling (2004) believe that the current perception of dyslexia and SLI underestimates the role that such syntactic and semantic difficulties play in attaining fluent reading. Bishop & Snowling (2004) offer several reasons why it might be helpful to retain a distinction between dyslexia and SLI. These reasons are briefly summarized in the following section.

(i) Disorders that appear similar at the behavioural level may have different causal origins. With regard to behaviour, one could ask whether children diagnosed with SLI have problems with reading and spelling and whether children with dyslexia show impairment on oral language tests. Importantly, however, if the behaviour of dyslexic children and SLI children does overlap it does not automatically mean that the disorders are qualitatively the same; different underlying cognitive impairments may cause similar behavioural patterns.

(ii) Nonphonological aspects of language play an important role in the acquisition of literacy skills. Children with SLI usually have the same phonological deficits that are traditionally regarded as a core feature (and a causal factor) of dyslexia. However, children with SLI also experience pronounced deficits in syntax and semantics, which have an additional affect on their literacy development. A detailed analysis of literacy development in SLI often shows that the reading problems experienced by children with SLI are different from those experienced by classic dyslexics. In particular, poor comprehension of written material seems to be a more prominent feature in SLI than in dyslexia. In this, children with SLI resemble poor comprehenders, rather than classic dyslexics.[13]

(iii) Understanding the neurobiological and etiological basis of dyslexia and SLI is not promoted by collapsing the syndromes. From the perspective of neurobiology, any attempt to merge the findings from structural brain imaging studies of dyslexia and SLI is hindered by the fact that (even within each of the syndromes) findings from one study to the next are often inconsistent. For instance, several studies have found that the normal asymmetry of the planum temporale is reduced or reversed in both dyslexia and SLI. Others have failed to replicate this finding; in fact, some have even found an enhancement of the normal leftward asymmetry (see Bishop & Snowling, 2004, for references). The most likely reason for such confusing

[13] The term *Poor comprehenders* refer to children who can read accurately, but with poor understanding of what is read (their IQ being within normal limits). The language profile of poor comprehenders is different from that of dyslexics in that their phonological skills are normal. Their language deficits appear to be in language areas outside of the phonological domain (typical deficits include weak vocabulary and a limitation in semantic knowledge).

result patterns is that different types of language and literacy problem are included under the headings of SLI and dyslexia in imaging studies. In attaining a better understanding of the neurobiology of dyslexia and SLI, neurolinguists would have to include more homogeneous groups of each of the disorders in their studies. Collapsing the syndromes would only create a more heterogeneous group. With regard to genetics, there is evidence from a range of studies that phonological processing deficits are heritable and thus that classic/phonological dyslexia has a genetic basis. In contrast, it is much less clear whether reading disability that is associated with semantic and syntactic difficulties (i.e. the predominant type of reading disability in SLI) is heritable.

Bishop & Snowling (2004) conclude that although dyslexia and SLI present enticing similarities, it might prove essential to rethink the relationship between these disorders. Their proposal is to conceptualize the disorders in terms of a two-dimensional model, as shown in figure 1.

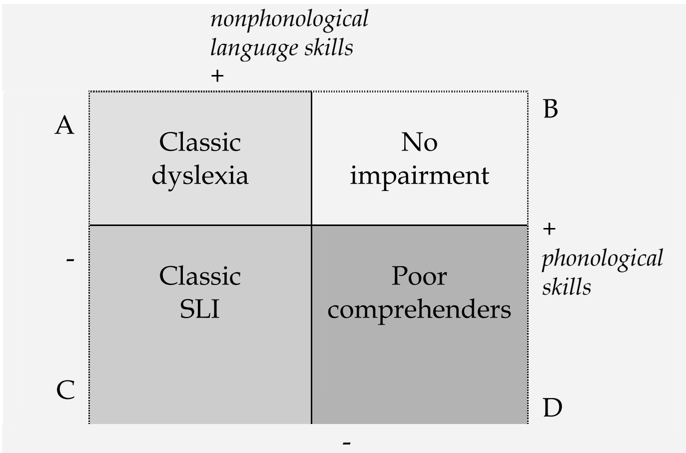

Figure 1. A two-dimensional model of the relationship between dyslexia and SLI.

In this model, classic SLI is treated as a case of double deficit. Both phonological and nonphonological language processes are impaired, and therefore both the phonological and semantic routes are only partly available to these children in establishing mappings to orthography. Poor comprehenders are placed in a different quadrant than SLI as these children have primarily weak semantic processing (and intact phonological skills).

Bishop & Snowling (2004) acknowledge that there may be children whose profile is midway between the categories that they have listed and that additional variables such as visual perception, processing speed and attention may play a role in the acquisition of reading skills. As such, the model is an oversimplification. Even so, the authors believe that it provides a useful framework for thinking about subtypes of reading impairments and their relation to language impairments.

1.10. General Research Questions

The central research questions of the project at large are formulated as follows:

(1) Can pre-school children with a genetic predisposition for dyslexia be distinguished from normally developing children on the basis of their language development?

(2) Do pre-school children with dyslexia resemble children with specific language impairment in their (processing of) spoken language and, if so, what is the relation between the two disorders?

(3) Do the delays/deviancies in the language development of children with a genetic predisposition for dyslexia predict their reading performance?[14]

(4) Can those effects be observed at the level of the group of at-risk children?[15]

1.11. Research Methodology

1.11.1. Subjects

1.11.1.1. Number, age and selection criteria

In total, 250 children participated in the research programme. These children can be divided into three groups (at-risk, control and SLI) and into two age cohorts ('infants' and 'toddlers'). The children in the infant group were between the ages of 18 and 22 months at the beginning of the study. This group consisted of 70 at-risk and 40 control children. The infant group contained no SLI subjects as the disorder is generally not diagnosed before the age of 3;0. The children in the toddler cohort were between the ages of

[14] This question can, at this time, not be answered. The reading performances of the at-risk children are as yet unknown, but it is of course the intention that their reading skills are assessed in the near future.

[15] For brevity's sake, properties established for a group of 'at-risk' children are attributed to the 'at-risk' children in the following chapters. Strictly speaking, on the individual level, they apply only to the subgroup of children that are in fact predisposed. The latter group, however, is often not independently identifiable in the present study..

3;0 and 3;6 at the beginning of the study. This group consisted of 70 at-risk, 40 control and 30 SLI subjects.[16]

All children in the at-risk group were recruited via an advertisement campaign. In order to be included in this group, the child had to have (at least) one dyslexic parent or sibling[17]. All dyslexic parents were tested on a number of standardized measures. This was done to ascertain that these parents were indeed dyslexics. These measures included a single-word reading test (*One-minute-test*, Brus & Voeten 1973), a pseudo-word reading test (*Klepel*, Van den Bos, Spelberg, Scheepstra & de Vries 1994), a non-word repetition task, a pseudo-word dictation and a rapid naming task. In addition, the verbal comprehension test from the Wechsler Adult Intelligence Scale was administered. In order to be classified as dyslexic, a parent had to obtain a score in the bottom 10th percentile on either of the two word reading tests. Alternatively, a score in the lower 25th percentile on both reading tests or a large discrepancy between the score on the pseudo-word reading test and the verbal comprehension test (≥ 60) also resulted in a dyslexic classification.

The control children for the infant group were recruited via the same advertisement campaign that recruited the at-risk children. The control children for the toddler group were recruited via day-care centres in the city of Utrecht. These children were in the same age ranges as the at-risk children at the beginning of the study. All subjects in the control group had to be normally developing children from families with no history of speech-language or reading difficulties.

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[16] In order to determine the extent to which the language of SLI children is impaired, it is important to compare them with normally developing (ND) children. However, the comparison of children with SLI with ND children is not straightforward. There are three main groups of ND children which children with SLI are typically compared with, namely:

- chronological age controls (ND children of the same chronological age)
- mental age controls (ND children who have comparable scores on an intelligence test)
- language age controls (ND children at the same stage of grammatical development)

Most studies of the grammatical development in SLI typically compare children with SLI with ND children at the same stage of grammatical development and with chronological age controls. The conventional way of quantifying a child's grammatical development is in terms of *Mean Length of Utterance* (abbreviated to *MLU*). A child's MLU is calculated by taking a sample of 50 to a 100 utterances produced by the child, and calculating the mean number of *morphemes* per utterance in the child's speech sample (by adding up the total number of morphemes which the child produces and dividing it by the number of utterances the child produces). MLU controls were not included in this project, seeing that the main comparison was between children at-risk for dyslexia and normally developing children. Given the large number of children tested, it was also not viable to include a group of MLU controls.

[17] Only a few children were included on the basis of having a dyslexic sibling. In all of these cases, the sibling had been diagnosed as dyslexic by an educational psychologist and was in possession of a "dyslexie-verklaring" (certified proof of being dyslexic).

Children with SLI in The Netherlands are admissible to special schools from the age of 3;0. They are also diagnosed in audiological centres. As a result, the subjects in the SLI group were recruited via both special schools and audiological centres throughout the country. All subjects in the SLI group had been classified as specifically language impaired after assessment by a speech-language pathologist or a clinical linguist. Typically, exclusion criteria are applied when children with SLI are selected for linguistic research: the children should have normal hearing, an IQ within the normal range and no primary perceptual disorder or other neurological deficits. These exclusion criteria were also adopted in this research programme.

Given the potential overlap between dyslexia and specific language impairment, one possible problem with the selection of at-risk children is that these children might not only be at risk for dyslexia, but also at-risk for language impairments. Unfortunately, establishing whether an adult dyslexic person used to be a language-impaired child is not a simple undertaking. Firstly, there is no Dutch language test that can formally establish whether an adult is language-impaired or not. Secondly, the only measure that has been used by other researchers (see Catts et al., 2001) to distinguish between adults with and without specific language impairment is a non-word repetition task; this task is however also used to distinguish between adults with and without dyslexia. In order to gain insight into the linguistic background of all parents (i.e. also those in the control group) all families participating in the programme were asked to complete a questionnaire. The questionnaire contained (amongst other things) specific questions relating to the parent's language development as a child.

1.11.1.2 Individual and demographical characteristics of the subjects

As mentioned before, environmental factors can play an important role in the developmental path of disorders such as dyslexia and SLI. With this in mind, some individual and demographical characteristics of the subjects (outside of the language domain) were also taken into account in this project. The three groups were compared on non-verbal intelligence (as measured by the *SON-R*, Tellegen et al., 1988), birth rank order and educational level of the mother. Table 1, adapted from Van Alphen et al. (2004), gives an overview of these characteristics.[18]

[18] These data are not yet complete. However, the table provides a reliable characterization of the three groups of subjects.

Table 1. Demographical and individual characteristics of the participants.

Groups	IQ (SON-R) Mean *(s.d.)*	*N*	Birth order Mean *(s.d.)*	*N*	Mother's education Mean *(s.d.)*	*N*
Baby cohort						
Control	110.7 *(17.3)*	31	1.5 *(.70)*	36	3.6 *(.55)*	35
At-risk	108.5 *(15.0)*	63	1.7 *(.83)*	60	3.2 *(.91)*	66
Toddler cohort						
Control	115.2 *(15.6)*	30	1.2 *(.67)*	12	3.7 *(.77)*	18
At-risk	111.3 *(14.4)*	61	1.3 *(.59)*	41	3.1 *(1.2)*	53
SLI	101.9 *(10.1)*	22	2.4 *(1.1)*	9	3.3 *(1.3)*	9

Concerning non-verbal intelligence, table 1 shows that, in both cohorts and in all three of the groups, the children fall within the normal IQ range. The control and at-risk infants are not significantly different with regard to their IQ. In the toddler cohort, a one-way ANOVA showed a significant difference between the average scores ($F_{(2,110)} = 5.93$, $p = 0.004$). Post-hoc testing indicated that the SLI group differs significantly from the other two groups.

With regard to birth rank, an interesting observation is that the average rank of the children with SLI is significantly higher than that of the other two toddler groups $F_{(2, 59)} = 12.53$, $p = 0.004$). This finding is in line with previous studies showing that laterborn children are more likely to experience language problems than firstborn children (Bishop, 1997; Tomblin, 1989).

The mother's education was classified as belonging to one of 4 levels. These levels are in accordance with the number of completed years in secondary school and thus also with school type as these are correlated in The Netherlands. Levels 1 and 2 respectively represent 4 and 5 years in secondary school. Level 3 represents 6 years in secondary school, comprising of advanced vocational training or preparatory training for university. Level 4 represents at least 8 years of secondary education. Mothers falling in this level typically completed a tertiary education at BA or MA level. As can be seen from table 1, all mothers (on average) belong to the higher levels. In the baby cohort, the educational level of the mothers in the control group is slightly higher than those of the mothers in the at-risk group ($F_{(1, 99)} = 4.92$, $p = 0.029$, one-way ANOVA). In the toddler cohort, there is no significance difference in educational level between the three groups of mothers.

1.11.2. General procedure

As mentioned before, the subjects were tested in a longitudinal fashion. The subjects in the infant cohort were first tested around the age of 1;6 and were around 3;0 at the time of the final test session. The subjects in the toddler cohort were around 3;0 at the first session and around 5;0 at the time of the final test session. The two cohorts were tested simultaneously, resulting in roughly 250 test sessions every six months. Usually, all participants were tested in four separate sessions with intervals of 6 months. As is often the case in research projects of this nature, some children dropped out of the programme after the first or the second session. Some other children missed one of the sessions due to familial circumstances. Nevertheless, data obtained from all these children are included in the analysis, as the experimental sessions functioned independently from one another.

The participants were tested in different locations. The tests sessions of the at-risk children took place in the language acquisition laboratory at the Utrecht institute of Linguistics OTS. The control children were initially tested in their day-care centres (sessions 1 and 2) and later on (after they started going to school) in the language acquisition lab (sessions 3 and 4). Children with SLI were tested in the special schools that these children attended or in the language acquisition lab.

Each session consisted of a number of age-appropriate and tailor-made experiments. Thus, the experiments discussed in chapters 3-6 of this dissertation were always conducted as part of a sequence of tasks and never individually. Generally speaking, each of the four researchers taking part in this project designed one experiment for each of the sessions.

1.11.3. General expectations

As mentioned earlier, children of dyslexic parents have a risk of around 40% to develop dyslexia themselves. The implication is clear: not all at-risk children end up as dyslexics. The sample of at at-risk children in this study naturally includes some children who are normal in every aspect of their development. The general expectation is therefore that approximately half of the at-risk children would show no signs of language delay. These at-risk children should perform on the same level as the sample of normally developing children. The language development of the other half of at-risk children is expected to be mildly to moderately delayed and/or impaired in both phonology and morphosyntax. Under the assumption that dyslexia and SLI are related disorders, the language development of those children who will eventually become dyslexic is expected to be comparable to that of children with SLI.

1.12. Summary of General Introduction and Chapter 1

Dyslexia and SLI are specific developmental disorders. These syndromes share several commonalities: both have a genetic basis and both present individuals with problems in attention, short-term memory, following instructions, planning and organization and phonological awareness. Several theories have been formulized to explain these symptoms (usually focussing on only one of the syndromes), but none of these seem to be able to account for all cases of the syndromes. Furthermore, whereas theories of SLI are mostly linguistic, theories of dyslexia often assume a cognitive deficit (not necessarily within the linguistic domain). In a way, this seems counter intuitive, as developmental dyslexia has been redefined as a *language* disorder some thirty years ago.

Originally, developmental dyslexia and SLI were studied only as separate disorders. Recently, theorists have questioned this sharp divide between the two syndromes. The reason for this was at least threefold. First, children diagnosed with either of these syndromes share several symptoms. Secondly, early language deficiencies are often an indication of subsequent reading problems. Finally, existing clinical tests fail to reliably distinguish between these groups; a child with dyslexia often also fit the criteria of a child with SLI, and vice versa. Especially over the past two decades, this led to several studies suggesting that dyslexia and SLI are manifestations of the same underlying problem. However, Bishop & Snowling (2004) suggest that at least two dimensions of impairment are needed to conceptualize the relationship between dyslexia and SLI.

The main purpose of the present study is to identify linguistic precursors of developmental dyslexia. A secondary purpose is to contribute to the current debate on the relationship between dyslexia and SLI. This was undertaken by studying language development in children with a genetic risk for developing dyslexia and comparing it to language development in children with SLI.

Chapter 2

Some notes on auxiliary verbs

An underlying assumption of this dissertation is that the linguistic difficulties experienced in SLI can serve as an index of possible linguistic problems in dyslexia. It has been found that the production of auxiliary verbs is problematic in children with SLI (Hadley & Rice, 1996; Leonard, 1998). Thus, auxiliaries might also be affected in children with dyslexia (and in children with a genetic predisposition for dyslexia). In SLI, problems with auxiliaries are especially evident in English, a language where auxiliaries have low phonetic substance and are involved in complex syntax. Findings for languages other than English are mixed: some studies show that problems with auxiliaries appear to be of a cross-linguistic nature while others suggest that problems with auxiliaries are language specific. Concerning English and Dutch, previous findings are conflicting. Problems with auxiliaries are widely documented in the former language but apparently non-existing in the latter (see Bol & De Jong, 1992). Studies of SLI in other Germanic languages (such as German and Swedish) have also found problems with auxiliaries. The inconsistent finding for Dutch seems peculiar. Why would auxiliaries not be affected in Dutch children with SLI? This question invites a cross-linguistic comparison of studies concerning auxiliaries in SLI. On a more fundamental level, the question remains whether the Dutch auxiliary system differs from other Germanic systems in such a way that problems with auxiliaries are not to be expected in this language.

This chapter serves multiple purposes. In the first place, the general characteristics of auxiliaries in English and in Dutch are discussed. Secondly, the findings of previous cross-linguistic studies concerning auxiliaries in SLI are summarized. Finally, a specific syntactic construction, namely the past participle is highlighted. The ability of children at-risk for dyslexia and children with SLI to perceive and produce this specific construction constitutes one of the focal points of this dissertation; its construction is therefore discussed in some depth in this chapter.

2.1. Outline of this chapter

This chapter consists of three large parts. In the first part (consisting of sections 2.2. and 2.3.), the typology of auxiliary verbs is discussed, with particular reference to auxiliaries in English and Dutch. In the second part (consisting of sections 2.4. and 2.5.), cross-linguistic findings with regard to the acquisition of auxiliary verbs by children with SLI are summarized and some explanations for these findings are offered. In the final part, (consisting of section 2.6. and 2.7.), the role of auxiliaries in morphosyntactic dependencies is explained and a particular syntactic construction (the past participle) is highlighted. The chapter ends with a description of the general research questions addressed in this dissertation (section 2.8.) and a summary of the most important points of this chapter (section 2.9.).

2.2. Some characteristics of auxiliary verbs

Auxiliary verbs constitute one of two parts of complex verb phrases (the other part being main verbs). There is an abundant linguistic literature on auxiliaries and their status in the grammar. For sake of concreteness, the work of Barbiers & Sybesma (2004), was used as a frame of reference. According to Barbiers & Sybesma (2004), auxiliaries may differ from main verbs in their syntax, their phonology, their morphology and their semantics (or any combination of these).

The syntax of auxiliaries is shaped by their involvement with the functional projections in the Tense-domain. Syntactically, auxiliaries differ from main verbs in that they typically take a Verb Phrase (VP) as their complement, whereas main verbs typically have a range of different complement types. In English, auxiliaries are assumed to occupy a position outside the VP, coinciding with the canonical position of Tense (T, or I, in older literature).[1] In Dutch they are more readily taken to be verbal, but, characteristically, with an impoverished argument structure. Introducing an – acceptable – simplification we can say that auxiliaries do not have an argument structure, whereas main verbs do. Cross-linguistically, with regard to their morphology and phonology, auxiliaries may undergo cliticization, affixation, phonological reduction or deletion, whereas main verbs almost never undergo such processes. Semantically, auxiliary verbs can be characterized as differing from main verbs in that they do not have lexical content in themselves. Auxiliaries are functional items with meanings restricted to the domains of tense, aspect, modality, mood and voice. Other semantic features of auxiliaries include their malleability (their meaning can vary with that of the syntactic environment) and their inability to assign theta roles.

[1]Since the introduction of the Split-INFL hypothesis (Pollock 1989), finite clauses are assumed to contain separate tense and agreement heads, rather that a single INFL head. Each of these heads projects into a separate phrasal projection; tense into Tense Phrase (TP) and agreement into Agreement Phrase (AgrP). Under this hypothesis, auxiliaries are thought to be generated in T (the head of the TP). From this position it can move to AgrS (the head of AgrSP), where its person and number features are checked against the features of the subject NP. In cases where the grammatical features of a lexical item have to be checked against those of the subjects NP, the projection AgrP is usually referred to as AgrS(ubject)P. When grammatical features have to be checked against those of the object NP, AgrP is referred to as AgrO(bject)P.

Auxiliaries are generally divided into two classes: non-modal and modal. Non-modal auxiliaries include perfective *have* (Dutch *hebben/worden*), progressive/imperfective *be* (Dutch *zijn*) and the dummy auxiliary *do*. *Can (*Dutch *kunnen)*, *must (*Dutch *moeten)*, *may (*Dutch *mogen)*, *will (*Dutch *willen)*, *shall* are modal auxiliaries.

Of importance for this dissertation is the role of auxiliaries in marking the grammatical properties (tense, aspect and modality) associated with the verb. The notions of tense, aspect and modality have been described at length in the literature and are well known for their complexity. In the following sub-sections, they are discussed briefly.

2.3. The role of auxiliaries in marking grammatical properties

2.3.1. Tense

Tense is the grammatical expression of temporal relations, typically between speech time, reference time and event time, with present tense as the unmarked tense (Reichenbach, 1947). Within the research tradition of generative grammar, the term tense has generally been used to refer specifically to the tense inflection of the finite verb form. Thus, tense is a grammatical feature that is expressed (morphologically) on finite verbs and finite auxiliaries. (Apart from tense, finite auxiliary verbs also carry the grammatical features of person and number, although often with impoverished paradigms). Person-, number- and tense features (called ø-features) describe the kinds of grammatical properties that a word is associated with). Non-finite auxiliaries carry only head features and are not inflected for ø-features. [2]

[2]Radford (1997) assumes that words carry three sets of grammatical features: head-features (which describe their intrinsic grammatical properties), complement-features (which describe the kind of complements that they take) and specifier-features (which describe the kind of specifier/subject they can have). For instance, the auxiliary *are* in English carries the head-feature [+pres], demonstrating that it is a present tense form. It carries the complement-feature [+ing], which means that it selects a complement whose head is a verb carrying the participial inflection *–ing*. The specifier-features of *are* are [2/PNom], meaning that it requires a second person or plural subject carrying nominative case. A central assumption of many syntactic theories is that the grammatical features carried by any specific word (for example by an auxiliary) in a sentence should be matched with the features of those words in the same sentence with which it forms a syntactic dependency relation. Chomsky (1995) explained this 'matching-process' in his theory of *feature checking*. In Chomsky's theory, feature checking is accomplished by moving the relevant word/phrase from the position in which it has been generated to a position (higher up) in the syntactic structure where its features can be checked. For a comprehensive discussion of feature-checking and movement, see Radford (1997).

Finite auxiliaries demonstrate a three-way tense contrast, conventionally described as past tense, present tense and future tense.[3] Finite auxiliaries carrying grammatical information about tense are also known as temporal auxiliaries (see, for instance, Guéron and Hoekstra (1989; 1995) for discussion).

The syntactic category Tense has two different functions in language. The first function is to carry the semantic features for specifying the temporal properties of the clause, as briefly indicated above The second function of T is to carry the morphological features that syntactically represent its relation to the VP and the subject (see footnote 2). Structurally, Tense (T) is the head of Tense Phrase (TP).

In Dutch, the temporal auxiliaries *hebben* and *zijn* are normally referred to as past tense auxiliaries, while *zullen* and *gaan* marks future tense. Formally, *hebben* and *zijn* refer to the present (perfect) tense, as the event expressed by the verbal predicate is completed at speech time. Both auxiliaries, however, take the past participle as their complement.

2.3.2. Aspect

The term 'aspect' reflects a perspective on the activity described by the verb. The most common aspectual notions are those of 'progressive' (where the activity described by the verb is represented as ongoing) and of 'perfective' (where the activity described by the verb is represented as completed).[4] Perfective and progressive aspect are examples of 'grammatical aspect'.[5] The aspectual properties of a sentence are often (co-) marked by an auxiliary verb.[6] Consider the examples in (1):

(1a) He has eaten the apple
(1b) He is eating the apple

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[3] The correlation is not straightforward, though. In sentences like "If I went there tomorrow, would you come with me?" the verb *went* is in past tense form, but has future rather than past tense reference (example taken from Radford, 1997). Categories such as Present Tense and Past Tense have to be seen as formal, morphological categories that require semantic interpretation rules.

[4] Notions like 'inchoactive', 'prospective', 'telic' and 'punctual' also describe aspectual properties.

[5]Grammatical aspect is distinguished from another type of aspect, namely Aksionsart/lexical aspect. Aksionsart is described as the inherent aspect related to a verb and its arguments. Well-known Aksionsart categories are durative and telic aspect. The verb *to read*, for example, is inherently durative, but will receive a telic interpretation in combination with the object argument *book*. Thus, Aksionsart is determined compositionally on the basis of the properties of the verb and of its arguments (Booij, 2002).

[6] Other interpretations exist, for example those claiming that aspectual features are marked solely by the verb or solely by the auxiliary. I return to this point in section 2.6.

The auxiliary *has* in (1a) marks perfective aspect (in that it marks the 'perfection' / 'completion' of the activity of eating. For similar reasons the verb *eaten* is referred to as the perfective form of the verb (also known as the past participle). In (1b) the auxiliary *is* marks progressive (or imperfect) aspect as it relates to an activity that is presented as not yet perfected (i.e. completed). The verb eating is thus referred to as the progressive form of the verb, also known as the progressive / present participle (see Borik, 2002 for a discussion of Aspect).

The simplex tenses of Dutch (present tense and past tense) can have either a progressive or a perfective aspectual reading (Boogaart, 1999). In other words, they are aspectually neutral.[7] In contrast, the complex tenses have a specific aspectual value. However, as with Tense, there is no straightforward correspondence between the morphological categories expressing Aspect and the specific semantic interpretation of these formal properties of verbal forms.

Aspect resembles tense in many ways, but the two notions are distinct. Syntactically, Tense is located in the T-C-domain and because of its high position in the syntactic structure takes scope over both the subject and the predicate of a sentence. Aspect on the other hand is taken to be located in the VP-domain. Furthermore, while most linguists would agree that tense constitutes a functional category, the view with regard to aspect is divided. Some theorists believe that aspect is an independent syntactic functional category (see Ouhalla, 1991), but most assume aspect to be one of the semantic features of the verb (Osawa, 1999). Another difference between Tense and Aspect is that the former is indexical while the latter is not.[8] The interpretation of temporal expressions (like expressions for person and location) is sensitive to the context of the utterance. Thus, in order to judge whether the proposition represented in the sentence 'I climbed Mount Everest *yesterday*' is true or false, one needs to know *when* (and by whom/where) it is uttered. The truth of a proposition is however not affected by aspect. For example, in the sentences *Nelson Mandela objects to the war in Iraq* and *Nelson Mandela is objecting to the war in Iraq*, the truth of a proposition is not affected by the fact that the sentences are aspectually different from one another.

[7] Dutch differs in this respect from English. In English, simple past tense tends to receive a perfective aspectual reading.

[8] Indexicals are words used to refer to persons or objects that are situated in different locations, times or contexts of the sentence. The designation of an indexical shifts from speaker to speaker, time to time and place to place. Different utterances of the same indexical designate different things, because what is designated depends not only on the meaning associated with the expression, but also on facts about the utterance (http://www.csli.stanford.edu/~john/indanddem/indanddem/indanddem.html).

2.3.3. Modality

Modality is associated with notions such as possibility, futurity and necessity (Radford, 1997). In English and in Dutch, modality is primarily expressed by a subclass of auxiliary verbs, the modal auxiliaries. The modals *can* (denoting possibility) and *must* (denoting necessity) serve as standard examples of modal expressions. There are many different modalities; the distinction between *epistemic* and *deontic* modality is perhaps best known. Epistemic modality is concerned with the logical structure of statements which asserts that propositions are known or believed by the speaker. Deontic modality is concerned with the logic of obligation, requirement and permission. The same modal auxiliary can be used to express both epistemic- and deontic modality, as can be seen in the example in (2):

(2) The car must be ready
Epistemic reading: '*It is surely the case that the car is ready*'
Deontic reading: '*I oblige you to ensure that the car is ready*'

Like temporal auxiliaries, modal auxiliaries are finite and thus inflected for the grammatical properties of tense, person and number (although the paradigms may be impoverished as remarked earlier). Auxiliaries that take an infinitive as their complement mark future tense or modality (note that often, future tense is analyzed as a form of modality). The modals *zullen* and *gaan* both express future tense, but these forms are semantically distinct. Respectively, they convey epistemic modality and the near future. Examples of some other Dutch modals are given in (3):

(3a) moet eten
mod-eat-*inf*
'*have/has to eat*'

(3b) wil eten
mod-eat-*inf*
'want/s to eat'

(3c) kan eten
mod-eat-*inf*
'*am/is able to eat*'

In particular, the modal *kan* features in this dissertation. Like the modal *can* in English, *kan* in Dutch can express different modalities, depending on the context of an utterance. This is illustrated by the example in (4):

(4) Ik kan paardrijden, maar ik kan het nu even niet.
'I can ride a horse, but I am not allowed to ride a horse now.'

In the first clause of (4), the modal *kan* expresses dynamic modality.[9] The subject announces that s/he is able to ride a horse. In the second clause of (4), *kan* expresses deontic modality. Here, the subject tells the audience that s/he is not permitted to ride a horse at the time when (4) is uttered (possible because his horse is sick). Note that the paraphrase in (4) is feasible, but that it is not the only interpretation of this utterance. The speaker could also have meant: 'I am allowed to ride a horse, but I am not in the physical condition to ride a horse' or 'I know how to ride a horse, but I am not in the physical condition to ride a horse'. Modal auxiliaries are in some sense context dependent expressions: their interpretation depends on the situation in which they have been uttered.

2.4. The acquisition of auxiliary verbs by children with SLI

2.4.1. Early studies in English

Initial studies concerning auxiliary use in SLI focused almost exclusively on auxiliary *be* and were rooted within broader examinations of grammatical morphemes (based on Brown's 1973 set of morphemes). During the seventies and eighties, researchers also inherited from Brown an emphasis on studying contractible vs. uncontractible occurrences of copula and auxiliary *be*. Some main findings from this early period are summarized in the following paragraphs.

In a study by Ingram (1972) children with SLI produced auxiliary *be* forms less consistently than MLU–matched controls. The same SLI subjects also showed no advantage in using auxiliary *be* in uncontractible contexts, while the controls did. In another study, Johnston & Schery (1976) showed that contractible and uncontractible auxiliary *be* was used less than 70% correctly by children with SLI in obligatory contexts. In contrast with these studies, Steckol & Leonard (1979) found no significant difference between the auxiliary use of SLI subjects and control subjects. Still, the control group in this study produced auxiliaries in obligatory contexts 66% of the time while children with SLI did so only 41% of the time. Loeb & Leonard (1988) found that none of the children with SLI in their sample produced auxiliary *be* in more than 6% of obligatory contexts, but that two of the subjects produced modal auxiliaries around 50% of the time.

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[9] Palmer (1986) uses the label 'dynamic modality' for wishes/abilities that are somehow internal to the subject. Like deontic modality, dynamic modality is a root /circumstantial modality. However, dynamic and deontic modality are distinguished on the basis that the former is subject-oriented, while the latter is not.

The ability of children with SLI to produce auxiliaries in negative constructions was examined by Buhr & Rice (1988). They established that their SLI group (aged 5;0) performed similarly to a control group matched for MLU when the target forms were negative forms of modal auxiliaries. Neither group omitted modal auxiliaries, but all children on occasion substituted other modals or used do-support. However, in producing the target forms, the SLI group made significantly more tense and agreement errors than the MLU group.

The emergence and mastery of auxiliary *be* have been shown to vary considerably in individuals with SLI. Khan & James (1983) conducted a longitudinal investigation of the acquisition of grammatical morphemes by 3 SLI subjects (between the ages of 8;7 and 9;1). One subject showed 100% correct use of *be* at the start of the study, while the other two produced almost no auxiliaries. At the age of 10, these two subjects still had not acquired auxiliary *be*.

2.4.2. Later studies in English

In a longitudinal study, Hadley (1993) examined the acquisition of the auxiliaries *can*, *will*, *do* and *be* in the spontaneous speech of 12 children with SLI. The subjects were between the ages of 2;11 and 5;5. Hadley assumed that *can*, *will* and *do* are inserted directly into their canonical position outside the Verb Phrase as the head of the Inflectional Phrase (I) with finite tense features attached. In contrast, Hadley assumed aux *be* to be base-generated in a position within the VP. From this position, aux be has to move to the I-position. This type of movement is exceptional in English since main verbs always stay in the V-position. Hadley found that the auxiliaries emerged in the following order in the SLI group: *can*, *will*, *do*, *be*. In general, it appeared that the SLI children didn't have extraordinary difficulty with the entire auxiliary system, but with auxiliary *be* in particular. Hadley suggested that this difficulty is linked to the underlying position of auxiliary *be* in V and its exceptional characteristic of V-to-I movement.

The use of auxiliary *be* and copula *be* has also been studied at later points in development. Cleave and Rice (1996) reported that auxiliary *be* was used less accurately than copula *be* among a group of 5-year-olds with SLI. Rice et al. (1995) also found a higher percentage of correct use of copula *be* relative to auxiliary *be* in the statements of children with SLI, but the reverse was true in questions. In a longitudinal study, Eyer and Leonard (1995) found that children with SLI performed similarly in both forms of *be* between 4 and 5 years. (Omission rates were higher for auxiliary *be* at the time of the first measurement points, but this difference was not reliable over the following 9-month period).

Conti-Ramsden & Jones (1997) examined three children with SLI, aged 3;9, 5;3 and 5;8. Apart from lexical verbs, the children's use of the primary auxiliaries (*be*, *have*, *do*) and the modals (*can*, *will*, *may*) were investigated. At MLU 1.2-2.0, both groups of children showed restricted use of auxiliaries. Children with SLI mostly used *can* and *don't* and the control children mostly used the primary auxiliaries. At MLU 2.2-3.0, the control children used a wider range of auxiliaries, while the SLI children still almost exclusively used *can* and *don't*. By MLU 3.2-3.8 the SLI group showed more variety in their auxiliary use, but they still used less than half as many auxiliaries as the control group. In contrast to auxiliary verb use, copula use by children with SLI was comparable to those of the ND children.

2.4.3. Italian and French

There has been little systematic study of the use of auxiliaries and copulas in Italian children with SLI. Data from a 1987 study by Leonard et al., suggested that children with SLI in Italian omit the 3rd person singular present copula form *è* more frequently than would be expected given their MLU. Leonard & Bortolini (1998) found that Italian children with SLI produced fewer monosyllabic auxiliary forms of *avere (have)* and *essere (be)* than their control group. These morphemes appear in non-final weak syllables and are therefore susceptible to omission.

Methé and Crago (1996) studied verb morphology in French children with SLI. The SLI subjects (aged 6;8 to 8;4) were compared to age-matched controls and to younger normally developing children. Methé & Crago concluded that the children with SLI omitted copula and auxiliary forms more frequently than the children in both the control groups. They also found the SLI subjects were more likely to use indistinct syllables in copula and auxiliary contexts; these indistinct syllables most likely served as fillers and not as attempts at a specific target.

2.4.4. Swedish

Hanson and Nettelbladt (1995), Hansson (1997) and Håkansson and Nettelbladt (1996) studied the morhposyntactic characteristics of Swedish speaking children with SLI. In these studies, spontaneous speech served as the source of data. One of the findings was that children with SLI omitted the auxiliary *har* (have), used in the present perfect, more often by than the MLU controls. Hansson, Nettelbladt and Leonard (2000) examined the use of present copula. They compared 42 SLI subjects (aged 4:3 to 5:7) with age-matched and MLU-matched control groups. They found that the age-matched controls used copulas more frequently than the MLU-matched group, which in turn used more copula forms than the children with SLI.

2.4.5. Dutch and German

Bol and De Jong (1992) studied the acquisition of auxiliaries in Dutch children with SLI. Their study was based on spontaneous speech samples collected from 16 children with SLI and 16 control children matched for MLU. The authors hypothesized that the problems with auxiliaries in English speaking children with SLI are language specific and not applicable to Dutch, “since the Dutch (auxiliary) system is far less complex than the English system”[10] Bol and De Jong’s study revealed no significant differences between the SLI group and the control group. In total, there were 10 omissions of auxiliaries in 42 obligatory contexts (by six of the SLI subjects). Auxiliary *hebben ‘have’* and auxiliary *zijn ‘to be’* were omitted seven and three times respectively, as in:

(5a) Broertje daan
‘brother <has> done <that>’

(5b) ja, dat Zeppelin daan
‘yes, Zeppelin <has> done <that>’

In these utterances, the prefix of the participle *(ge)*, as well as the auxiliary *heeft* (*to have*) has been omitted. The same children who omitted the prefix *ge* in these utterances, produced it (or half of it) in other utterances e.g.

(6a) broer edaan
‘brother <has> done <that>’

(6b) ja, dat Zeppelin gedaan
‘yes, Zeppelin <has> done <that>’

According to Bol and De Jong, the results support their hypothesis. No type of auxiliary was used significantly less often by the children in the SLI group. As mentioned in the introductory note to this chapter, their finding is discrepant with the findings for other Germanic languages. A study by

[10]According to Bol & De Jong (1992), the low phonetic substance of English auxiliaries and their involvement in complex syntax are responsible for the problems that English children with SLI experience with these items. Most of the difficult aspects of the English auxiliary system are not relevant for the Dutch system. However, with regard to the phonetic environment in which Dutch auxiliaries occurs, it might be relevant that auxiliary *zijn* (to be) can be produced in a contracted form in the 3rd person singular, (though only after a pronoun) e.g. *Da’s gevallen* (*That has fallen*) vs. *Dat is gevallen (That has fallen)*. Likewise, auxiliary *hebben (have)*, can be produced in contracted form, (though only in colloquial language) as in *Hij’ft ‘n auto gekocht (He has bought a car)* vs. *Hij heeft ‘n auto gekocht (He has bought a car)* and *Jij’b gejokt (You have lied)* vs. *Jij hebt gejokt (You have lied)*.

Clahsen (1989) especially comes to mind. Clahsen investigated a group of German children with SLI and found that "all the children use simple verbs" but that "auxiliaries and copulas, however, are used in only a few cases". Of the ten subjects in the German study, eight omitted auxiliaries. Clahsen found high deletion rates and no systematic progress as the children got older. If the assumptions of Bol & De Jong are correct, German children with SLI should not experience difficulties with auxiliaries (as German is closer to Dutch than to English with regard to its auxiliary system). Bol and De Jong acknowledged this discrepancy, and tried to explain it by looking at MLU range and sample size. Since Clahsen's subjects had a MLU range from 1.46 to 2.84 and the Dutch children had a MLU range of 2.1 to 4.7, a simple explanation might be that the German children may still outgrow their problems. However, this is not fully supported by the Dutch data, since the children who omitted auxiliaries had MLU's from 2.1 to 4.2. Another explanation offered is that the Dutch sample of utterances was smaller; children may have had less opportunity to use auxiliaries in obligatory contexts.

2.4.6. Conclusion

Auxiliary verbs are often omitted (and sometimes substituted) in the speech of children with SLI. This phenomenon has been documented since the early seventies. A wide range of auxiliaries are affected cross-linguistically. In English, auxiliary *be* seems to be affected more noticeably than, for example, *do* and *have*, but this might be the result of a research bias. In other Germanic languages (like Swedish and German), auxiliary *have* has been shown to be problematic for children with SLI. In Romance languages, both *have* and *be* are omitted more frequently by SLI subjects than by normally developing children.

To date, the only study focusing on auxiliaries in Dutch children with SLI found no obvious difficulties with this category. However, the data set used by Bol & De Jong (1992) was not ideally suited to the purpose of the study (personal communication with the author). Thus, Bol & De Jong's hypothesis that Dutch children with SLI will not experience problems with auxiliaries is perhaps too strong. It might be true that Dutch auxiliaries are syntactically less complex and perceptually more salient than English auxiliaries, but the inconsistent finding for Dutch (in comparison to other related languages) is essentially left unexplained. Moreover, difficulties with auxiliaries are to be expected given the assumptions of several current linguistic theories of SLI. The extended optional infinitive account, the surface hypothesis, the Representational Deficit for Dependency Relations account and the limited processing capacity account all predict the omission auxiliaries in English. Likewise, these accounts also predict difficulties with auxiliaries in Dutch children with SLI.

2.5. Possible explanations for the findings

2.5.1. The extended optional infinitive stage hypothesis

As was mentioned in chapter 1, the Extended Optional Infinitive Stage hypothesis assumes that the period of development in which children do not obligatorily mark tense is extended in children with SLI.

In the extended optional infinitive stage hypothesis, Rice et al. (1995) argue that the set of morphemes known to be problematic for children with SLI includes primarily the ones that carry tense marking. Verbal morphemes like *–ed* (past tense), *–s* (3rd person singular, present tense) and the copula and auxiliary forms of *be* are often omitted by English children with SLI. Rice et al. (1995) argue that these morphemes share the common linguistic feature of finiteness. The crux of the extended optional infinitive account is that the child's grammar allows either a finite or a nonfinite verbal form (where adults would exclusively use the finite form). The finite form of a verb carries tense and agreement features in a language. Finite verbs appear in main clauses where tense and agreement marking is obligatory. For example in the sentences *they walk* and *they walked*, the verbs carry tense features. In *they walk*, the bare stem of the verb carries an invisible feature for present tense that is checked at the syntactic level of the grammar. In *they walked*, the presence of the *–ed* affix on the verb walk marks past tense. In contrast, when a verb appears in its infinitive form, it does not carry features of tense and agreement.

Reasoning along these lines, the Optional Infinitive account predicts that because auxiliaries' function is primarily to mark tense, these forms will be omitted just like the bound morphemes for tense marking. As a result, the non-finite form of the verb will be preferred for selection by the child.

2.5.2. The limited processing capacity hypothesis

The limited processing capacity account has also been used to explain the omission of closed class forms in the speech of children with SLI. In this account, Ellis Weismer (1996) and Johnston (1994) assume a limitation in the processing capacity of children with SLI. The idea behind this account is that within a specific domain, the specific nature of the material is less important than how this material is mentally manipulated. Proposals of a limited processing capacity carry the assumption that the processing system can deal with a limited amount of information at any one point in time. When a difficult task is encountered, processing limitations have the effect of processing trade-offs. For example, a child might have the knowledge required to use a grammatical form, but because of the processing load omit this form in favor of other (e.g. semantically more important) material. The suggestion is that the learning of morphosyntactic forms as well as the production of morphosyntactic forms already learnt could be negatively influenced by limitations in the processing capacity. With regard to the production of grammatical morphology, Bock & Levelt's (1994) sentence production model can serve as a useful framework. According to the Bock and Levelt model, a speaker starts the production of a sentence by selecting the lexical items that match the intended message at the conceptual level. Grammatical functions (like "subject" and "object") are then assigned to the lexical items on the basis of the argument structure required by the verb. It is assumed that the more complex a lexical item (the greater the number of grammatical functions or arguments required), the longer this process takes to be completed. In the Bock & Levelt model, once the grammatical functions have been assigned, a syntactic frame is retrieved that is compatible with the lexical items and argument structure. Only thereafter are the closed morphemes, required by the syntactic frame, retrieved from a separate store and inserted into the syntactic frame. The final step in the production of a sentence occurs when the different elements of the sentence are integrated into a prosodic structure. Following this model, Leonard (1998) suggested that slow and/or inefficient processing in children with SLI could lead to a struggle between completing the final steps in the sentence production model and continuing with the actual production of the sentence. The result of this "competition" might be the production of a sentence with missing closed-class morphemes, such as auxiliary verbs.

2.5.3. The surface hypothesis

Leonard (1989, 1998) claims that the surface forms of morphological markers on English verbs are "weak" and that this makes them prone to distorted processing. He gives the following definition of weak: "Low phonetic substance morphemes are nonsyllabic consonant segments and unstressed syllables, characterized by shorter duration than adjacent morphemes, and, often, lower fundamental frequency and amplitude". In speech perception, these morphemes are non-salient, and in language production, they are the victims of phonological processes such as final consonant deletion or cluster reduction. The prototypical example of such a morpheme is the 3rd person singular *-s*. But there are more grammatical morphemes that share these features; the omission of auxiliaries in by children with SLI has also been explained by the surface hypothesis. In English, auxiliary *be* forms and copulas can (and often do) occur in a contracted form, i.e. *he is sick* becomes *he's sick* and *she is swimming* becomes *she's swimming*. The argument is that the contracted form of auxiliaries and copulas are phonetically less salient and are therefore more vulnerable to omission. The surface hypothesis can thus explain the omission of auxiliary *be* forms by English speaking children with SLI.

2.5.4. The Missing Agreement hypothesis & The Representational Deficit for Dependency Relations (RDDR)

Both the Missing Agreement hypothesis (Clahsen, 1989) and the RDDR (Van der Lely, 1998) assume a difficulty in establishing structural relationships. Clahsen explains SLI as a selective impairment in establishing the structural relationships of agreement. The main claim of the Missing Agreement account is that children with SLI do not have the linguistic competence required in order to manipulate the asymmetrical relations between categories, where one category controls the other. As a result, most functional categories (including auxiliaries) are affected in SLI subjects.

The RDDR also assumes problems with grammatical agreement, but Van der Lely essentially explains SLI as a representational deficit for dependent relationships. As a result of this deficit, children with SLI experience a wide range of problems, including problems with tense, agreement and case marking. As auxiliaries are functional categories that are marked for tense and that have to agree with the subject, this category is predicted to be troublesome for children with SLI.

2.5.5. An evaluation of the different theories based on the cross-linguistic data

With the exception of the Missing Agreement Hypothesis, all of the above - mentioned accounts have originally been developed as an explanation of SLI in English speaking children. In order to evaluate them, their predictions should be tested for a wider range of languages.

The predictions of the Extended Optional Infinitive Stage hypothesis with regard to auxiliaries should be true for any language in which children go through an Optional Infinitive Stage. Just like English-speaking children, German, Dutch, Swedish and French children all go through a stage where Tense is underspecified and thus considered to be optional (Blom, 2003). The cross-linguistic data show that in most of these languages, children with SLI do encounter problems with auxiliaries (the exception being the Dutch data). [11] Root infinitives (seen as a 'marker' of the Optional Infinitive Stage) hardly ever appear in Italian, suggesting that Italian-speaking children do not go through an Optional Infinitive Stage (Blom, 2003). Yet, the cross-linguistic

[11] This discrepancy does not necessarily point to a weakness in the Extended Optional Infinitive Stage hypothesis, as the available Dutch data are limited and might not reveal the whole truth about auxiliaries in Dutch children with SLI (see paragraph 2.4.6.).

data show that Italian-speaking children do have problems with the auxiliaries *avere (have)* and *essere (be)*. Thus, even though the Italian data fit the predictions of the Extended Optional Infinitive Stage hypothesis, their explanation may involve some further factors.

A limitation in processing resources, as assumed in the Limited Processing Capacity hypothesis, potentially affects grammatical morphemes in any of the discussed languages. However, different classes of grammatical morphemes are affected cross-linguistically. For example, in English, Dutch and German verbal inflections are particularly vulnerable to omission, while function words like articles and clitics are prone to omission in Italian (and in Spanish, a language not discussed here). With regard to its cross-linguistic relevance, a weakness of this theory is that it is not clear as to which grammatical morphemes will be affected when processing trade-offs occur. Even so, assuming that grammatical morphemes will be omitted in favor of other material when processing resources are limited, the omission of auxiliaries can be accounted for in all of the discussed languages by means of the Limited Processing Capacity hypothesis.

The surface hypothesis has been used to explain the omission of auxiliaries in English-speaking children with SLI. As auxiliaries are contractible forms in English, they have low phonetic salience and are therefore susceptible to omission.

The Missing Agreement Hypothesis and the RDDR focus on properties of language that are highly susceptible to cross-linguistic variation. For this reason, these hypotheses make particularly strong predictions that mainly hold for German and English respectively. The Missing Agreement Hypothesis can account for some of the findings for English. Auxiliary *be* and copula forms do involve agreement in English and are difficult for children with SLI. The data from other Germanic languages do not conform to the predictions of the Missing Agreement Hypothesis. Dutch auxiliaries are inflected for person and number features and thus have to agree with the subject. Yet, auxiliaries in this language do not seem particularly challenging. Swedish auxiliaries are not inflected for person and number features and do not involve agreement relations with the subject, yet auxiliaries are omitted from the speech of Swedish children with SLI. Italian auxiliaries are inflected for person, number and tense features and should be problematic according to the Missing Agreement Hypothesis (which they seem to be). Note that clitics and articles, which must agree with the noun in number in gender, are also omitted by Italian children with SLI (as predicted by the Missing Agreement Hypothesis). Yet, when they are produced, these forms almost always show the correct marking, a finding that is extremely hard to interpret in the Missing Agreement Hypothesis.

The same problems arise with the predictions of the RDDR. This hypothesis also assumes that grammatical agreement is deficient in SLI.

Auxiliaries, which are inflected for person and number features in several of the discussed languages, have to agree with a noun. Indeed, auxiliaries are affected in many of these languages. However, when they are produced, they are usually correct. This finding is problematic for the assumptions of the RDDR.

2.6. Auxiliaries in morphosyntactic dependency relations

Clearly, the productive use of auxiliaries by children with SLI has been studied quite extensively. It seems clear that, in various languages, auxiliaries are prone to omission in the speech of children suffering from SLI. It is less clear how these omissions affect the production of the verbal complement that is associated with a specific auxiliary. The verbal complement is unlikely to be omitted completely from the structure as this would result in an utterance with no main predicate. Even so, one might argue that the omission of a temporal auxiliary (for example) can affect the realization of verbal morphology. In other words, the omission of an auxiliary could lead to a disruption of the morphosyntactic dependency between the auxiliary and its verbal complement.

The morphosyntactic dependency between an auxiliary and participle has received considerable attention in the linguistic theories of many European languages. Prima facie, it would seem that in a construction such as *They have*$_{aux}$ *eaten*$_{perfective}$, only the auxiliary (and not the participle) conveys Tense. However, if so, it is less clear how *have eaten* conveys the idea of Present Perfect Tense. One view, stemming from American structuralism, has been that both the auxiliary and participle morphology are types of Saussurean sign, bearing some set of morphosyntactic features as part of their lexical representation. This view gave rise to two descriptive traditions. The meaning of Present Perfect Tense is either associated with the auxiliary or with the participle form. In the first instance, the auxiliary has to select the correct participle form (i.e. the 'perfect auxiliary' approach). In the second instance, the participle form has to select the correct auxiliary (i.e. the 'perfect participle' approach). Put in simple terms, perfective aspect is conveyed by the auxiliary verb in the 'perfect auxiliary' analysis and by the participle form of the verb in the 'perfect participle' analysis.

A third (alternative) analysis was proposed by Ackerman and Webelhuth (1998).[12] They argue that it is a mistake to derive the interpretation of the Present Perfect Tense exclusively from the auxiliary or exclusively from the participle. Instead, they propose that it is the construction as a whole that conveys the meaning of Present Perfect. The notion 'Perfect' is signaled twice, by the auxiliary and the participial form in

[12] Similar ideas were developed in the seventies by Frank Heny.

tandem. According to Ackerman and Webelhuth (1998), there is no need to regard either of these as the main exponent of Tense. Such an analysis seems reasonable if one considers the auxiliary and the participle to be verbal clusters that *together* behave as a verbal unit.[13] The properties of the verbal unit (including aspect) are then determined compositionally be unifying the properties of the individual verbal elements.[14]

2.7. Some notes on (the construction of) the past participle

In both English and Dutch, the past participle entails use of an auxiliary and of verbal morphology, making its construction in child language susceptible to errors (especially in SLI). Yet, information on the development of the past participle in children with SLI is significantly sparser than for example information on the acquisition of past tense in these children. This is somewhat surprising, given that the formation of the past participle (in English at least) is just as complex in terms of phonology, morphology, semantics and syntax as the formation of past tense.

2.7.1. The past participle in English

With regard to phonology, the *–ed* affix as it appears in simple past tense and in past participle represents an unstressed, brief duration, low salience morpheme. As far as morphology goes, children acquiring the English past participle have to learn that the inflection of this verbal form involves five different types of alternations. Syntactically speaking, the production of the English past participle requires command of four advanced grammatical contexts: the passive (*the tree was watered*), the present perfect (*he has watered the tree*), the past perfect (*he had watered the tree*) and the past modal (*he would have watered the tree*). Each of these constructions could be considered more complex than a simple active sentence seeing that they require children to coordinate multiple relations between tense, voice, aspect and mood within the verb phrase (Redmond, 2003). Another interesting observation is that the structures in which the English past participle occurs do not appear frequently in child directed speech (see Brown, 1973 & Gathercole, 1986).

The complex nature of the past participle (structurally) in combination with the fact that children are seldom addressed with sentences containing it should render the acquisition of this particular verbal form

[13] The assumption that the temporal auxiliary and the participle behave as a verbal unit is based on work by Reuland (1990) and Ackema (1999). According to them, the ungrammaticality of a sentence such as **dat Jan gewerkt gedurende een week heeft* indicates that the main verb and the auxiliary cannot be split by PP over V and that these elements therefore form a unit of the type $[VV]_V$.

[14] The operation of unification is discussed by Börjars, Vincent and Chapman, 1997).

challenging for children, especially for children with SLI. But do theoretical accounts of SLI predict the past participle to be one of the problem areas in the grammar of children with SLI? Each of the characteristics mentioned in the above paragraph (i.e. phonological salience, morphologic and syntactic complexity and input frequency) has been implicated as possible explanations for the difficulties encountered by children with SLI. Morphophonological accounts of SLI like the Surface hypothesis predict that the past participle should be at least as challenging as simple past tense. Some of the morphosyntactic accounts of SLI predict a different outcome. Recall that the EOI account assumes that children understand the morphophonological processes involved in marking tense and other grammatical features and that their deficit in marking tense results from an indifference to the fact that tense is obligatory. Within the EOI framework, non-finite forms like the past participle should not present language impaired children with many difficulties, seeing that morphophonological knowledge is sufficiently available for the inflection of this particular form.

2.7.2. The past participle in Dutch

Past participle constructions in Dutch minimally consist of the temporal auxiliary *hebben* (have) or *zijn* (to be) and the past participle form of a lexical verb.[15] Examples of these simple constructions are given in (7).

(7a) De man heeft gelachen
'The man has laughed'

(7b) Het meisje is gevallen
'The girl has fallen'

Hebben and *zijn* occur with two different classes of intransitive verbs. The former is selected by unergative verbs, while the latter is selected by unaccusative verbs. Unergatives and unaccusatives differ with respect to their argument structure. According to the unaccusative hypothesis (Perlmutter 1978) the single argument of an unergative verb is mapped onto the subject position of a sentence, while the single argument of an unaccusative verb is mapped onto the object position of a sentence and then promoted to the subject position. Perlmutter's hypothesis explains why the subject of an unaccusative (*het meisje* in (1b)) has similar properties to an object of a transitive verb. In short, one could say that in terms of argument

[15] More complex structures, in which the auxiliary verb is combined with the past participle form of a lexical verb as well as a modal, also exist. This type of construction will not be discussed any further, as it typically does not occur in the language production of young children.

structure, an unergative has a single external argument and an unaccusative has a single internal argument. Past participle constructions can also contain transitive verbs. However, transitive verbs are only used with auxiliary *hebben,* and not with auxiliary *zijn*.

Morphologically speaking, Dutch lexical verbs are regular (weak) or irregular (strong). This distinction is based on the pattern of the verb's inflectional morphology. As far as the formation of the past participle is concerned, different morphological rules apply for regular and irregular verbs. For regular verbs, the past participle is formed by adding the prefix *ge-* and the suffix *-t/-d* to the verb stem. For irregular verbs, the formation of the past participle is more complex. The prefix *ge-* is used with most irregulars, but different suffixes can occur. Three paradigms are possible: 1.) the verb stem undergoes a vowel change (umlaut) and the suffix *–en* is added (*rijd* becomes *gereden*), 2.) the verb stem undergoes a vowel and a consonant change and the suffix *–t* is added (*denk* becomes *gedacht)* and 3.) the suffix *–en* is added to the verb stem (*vaar* becomes *gevaren*). Furthermore, the auxiliary *have* (*hebben*) also has different morphological forms. *Hebben* is used with plural subjects, *heeft* is used with third person singular subjects while *heb* is used with a first person singular subject.[16] Syntactically, both the auxiliary (*heeft)* and the past participle form of the verb are marked for specific grammatical features (like those discussed in paragraph 2.2.1 of this chapter). These features have to be checked during the derivation of a sentence. Consider how the grammatical features in a sentence such as *de man heeft gelachen (the man has laughed)* are checked. The grammatical features carried by each of the phrases in the sentence can be described as follows: the head-features of *de man (the man)* indicate that it is a third person singular in the nominative case, the head features of *heeft (has)* specifies that it carries present tense, while the head-features of *gelachen (laughed)* indicate that it is a past participle. Furthermore, the specifier-features of *heeft* indicate that it requires a third person singular nominative subject, while its complement-features indicate that it requires a complement headed by a verb in the past participle form. In this particular sentence, d*e man* and *gelachen* have neither specifier nor complement. From the perspective of current syntactic theories, the past participle construction *de man heeft gelachen (the man has laughed)* can be structurally represented as in (8):

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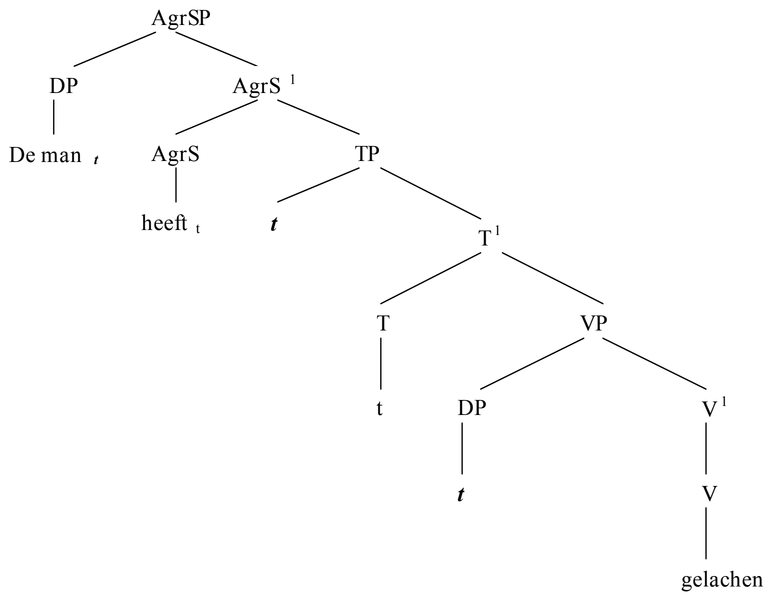
[16] For two reasons, it was not investigated whether children obeyed these subject-verb agreement rules. Firstly, these rules are most likely influenced by the different dialects of Dutch. Secondly, the interest of this dissertation lies not in subject-verb agreement, but in auxiliary verb-complement agreement.

(8)



Using an approach based on feature checking, it can be derived as follows: The DP *de man* is base generated in the specifier position of the VP. From this position, it moves via [spec;TP] to the specifier position of AgrSP, where eventually its head features [3rd person sing.;NOM] will be checked against the complement features of the auxiliary. The lexical verb *gelachen (laughed)* is non-finite, which means that it carries no person, number or tense features. As it has no features that need to be checked, it does not move from its base position. The auxiliary *heeft* (has) is base generated under T in the Tense Phrase. Its head feature [+tense] and complement feature [+participle] is checked in this position. From this position, the auxiliary moves to AgrS, where its specifier features [3rd person sing.; NOM] are checked against the features of the DP in specifier position.

2.7.3. Previous studies in English speaking children with SLI

As mentioned before, the production of the English past participle has received very little attention. Nevertheless, there have been a few studies investigating this particular form in children with SLI. Smith-Lock (1993) used an elicitation task to investigate the production of participles by seventeen children with SLI (aged 64 - 87 months). These children were compared to a group of normally developing children matched for age and a group of normally developing children matched for their language skills. Smith-Lock found very few differences between the children with SLI and the normally developing children in their production of participles. Similar levels of correct past participle use were observed across all three groups of children. Furthermore, all children produced highly similar error types. Typically, the affix *–ed* was used inappropriately with irregular verbs (as in *he got bitted*). Another common error was the use of the active sentence version of the passive target. Smith-Lock's results suggest that neither omissions nor bare stems were prominent features of impaired or unimpaired children's production of the past participle in elicited productions.

Leonard et al. (2003a) examined the use of homophonous past tense and participle forms in twelve children with SLI (aged 4;5 - 6;10). The SLI group was matched to a group of normally developing age peers and to a group of younger normally developing children matched on the basis of their MLU. A sentence closure task was used to compare the children's productions of the past tense *–ed* and the participle *–ed*. Leonard et al. found that the children with SLI were less successful in their productions of both -*ed* affixes, but that the production of the past tense *–ed* was even less accurate than the past participle *–ed*.

Redmond (2003) studied the production of the affix *–ed* in past and in past participle contexts in three groups of children (children with SLI, age-matched normally developing children and MLU-matched normally developing children). Data were collected from spontaneous speech samples and from elicited productions. Redmond's findings were comparable to those reported in Smith-Locke. Although the children in the SLI group produced fewer obligatory contexts for both past tense and the past participle, they did not exhibit extreme difficulty with the mechanisms of marking participle forms. In contrast, they showed high omission rates of the past *–ed*. The outcome of Redmond's study overlapped with the study of Leonard et al. to some extent. Both studies found that past tense targets were significantly more challenging for children with SLI than past participles. Important though, that according to Leonard et al. (2003a), the SLI group in his study produced significantly fewer correct past participles than the MLU matched normally developing children. This finding was not replicated in Redmond's study.

On the basis of the theoretical and empirical work described in the previous sections, one could conclude that the past participle is a complex syntactic structure in both English and in Dutch. However, English children with SLI seem to have fewer problems with this construction than, for example, the simple past tense. Essentially, current linguistic theories of SLI fail to fully explain why the construction of the simple past tense seems to be more challenging for children with SLI than the construction of the past participle.

2.8. Main Research Questions of this thesis

The main research questions of this dissertation are:

> (i) Can children at-risk for dyslexia discriminate well-formed and ill-formed morphosyntactic agreement relations, particularly those containing auxiliaries?
>
> (ii) Can children with SLI discriminate well-formed and ill-formed morphosyntactic agreement relations, particularly those containing auxiliaries?
>
> (iii) Does an increased processing load affect children's ability to discriminate well-formed and ill-formed morphosyntactic agreement relations?

The temporal auxiliary *heeft* and the modal *kan* feature in the morphosyntactic agreement relations to be described in this dissertation. The research questions were addressed in a longitudinal manner (see chapter 1). At the ages of 19, 25 and 60 months, children at-risk for developing dyslexia and (at 60 months) children with SLI were tested on their ability to discriminate between sentences containing well-formed and ill-formed morphosyntactic dependencies. At the ages of 36 and 42 months, the influence of an increased processing load on children's ability to perceive and produce a particular morphosyntactic dependency was assessed.

2.9. Summary

Problems with auxiliary verbs have been documented for more than twenty years in children suffering from SLI. These problems seem to be crosslinguistic; difficulties are reported not only in English but also in German, Swedish, French and Italian. So far, the only study that investigated the use of auxiliaries by Dutch children with SLI reported no problems in this area. However, the possibility that auxiliary verbs do constitute a problematic class in Dutch SLI (and at-risk) children cannot be ruled out. Auxiliaries form part of morphosyntactic dependencies, i.e. they bear morphosyntactic relations to their verbal complements. The ability of children with SLI and children at-risk for developing dyslexia to control such dependencies has not been studied up to date. The construction of the past participle is an example of such a morphosyntactic dependency. Learning to construct the past participle in English and in Dutch requires of children to coordinate multiple relations between tense, voice, aspect and mood within the verb phrase (Redmond, 2003). Given its complex nature, it is not unreasonable to assume that children with SLI will experience problems with the construction of the past participle. Yet, it has not been studied extensively in English and not at all in Dutch. Available evidence suggests that this specific construction does not present SLI children with great difficulty, a finding that is essentially left unexplained.

Chapter 3

Perceptual sensitivity to morphosyntactic agreement in infants

Language acquisition crucially depends on a child's ability to segment the speech that he or she hears. Sentences have to be segmented into phrases; phrases have to be segmented into words and words into morphemes. Words have to be differentiated into diverse classes. This is a complex undertaking, but the incoming speech stream does provide children with a number of cues that may help them in accomplishing these tasks. Some of these cues are inherent to the language; some other cues are typically provided by the child's caregiver(s).

One well-known potential cue available to a child is the prosodic structure of spoken language (Jusczyk et al. 1992; Jusczyk et al. 1999). Pausing, syllable lengthening and pitch resetting (all prosodic changes), tend to occur at the boundaries of words and sentences and therefore may provide cues to their locations. However, relying on prosody only will sometimes result in an incorrect analysis of the language input. Words, for example, cannot be identified solely on the basis of stress pattern, seeing that all the words of a given language do not necessarily carry the same stress pattern. Furthermore, sentence boundaries are not always marked in the prosodic structure. Additional cues are therefore needed to analyze the language input effectively. These additional cues are provided by closed class items like function words and grammatical morphemes (e.g. determiners and inflectional items). Closed class items are thought to be potential cues for three reasons. Firstly, they usually occur at the periphery of major phrases. Secondly, they appear in co-occurrence patterns with content words. Thirdly, the information needed for the determination of parametric values is often encoded in closed class items. Before children can use the cues that are potentially available to them, they have to be able to process them. However, children's initial language production gives no indication that function words and grammatical morphemes are processed early on, as these items are typically missing from a child's first utterances. The question that comes to mind is whether children are perceptually aware of the cues provided by exactly those items that seem to be missing in their early language system. Over the past twenty years, researchers have studied this question extensively.

Although many studies have concentrated on early sensitivity to linguistic form in normally developing infants, very little is known about the way in which atypical infants perceive language. A reasonable assumption is that atypical language development (as indicated by production) is the result of a child's inability to process the language input adequately during infancy. Consequently, the aim of this chapter is to study language perception (more specifically the processing of a cue provided by grammatical morphology) in infants at risk of developing dyslexia.

3.1. Outline of this chapter

In this chapter, results from three preferential listening experiments are presented. Section 3.2. provides an overview of current research in infant language perception studies. In section 3.3 previous infant studies with at-risk infants are discussed. The research questions that will be addressed in this chapter are listed in section 3.4. Each of the three experiments is described separately (sections 3.5., 3.6. and 3.7.). This is followed by a general discussion of the results in section 3.8. Section 3.9. summarizes the findings.

3.2. Perceptual sensitivity to syntactic categories and combinatorial principles in infants

According to Gerken (2002:26), "perhaps the most controversial area of research on early language abilities concerns syntax". Until recently, acquisitionists believed that language learners link word forms with meanings before they discover syntactic relations among words. The idea that one can study infants' sensitivity to the structure of a complete sentence, without judging their understanding of the sentence is relatively new. Over the past twenty years, innovative experimental techniques have made this possible. The first "syntax studies" (mostly conducted in English) examined infants' reaction to their mother tongue when it was slightly modified. Gerken et al. (1990) and Gerken & McIntosch (1993) and Shady et al., (1995) explored children's sensitivity to the distributional properties of grammatical morphemes. In the first two of these studies, the children (aged 25 months) were tested with a picture selection task, using stimuli like those in (1):

(1a) Find *the* dog for me
(1b) Find *was* dog for me
(1c) Find *gub* dog for me
(1d) Find * dog for me

The researchers hypothesized that if children detect the violations in (1b)-(1d), they should disrupt sentence comprehension. Gerken & McIntosch (1993) found that children were most successful in selecting the correct picture when the expected morpheme was included, as in (1a). When *was* occupied the position of the determiner, children's comprehension was disrupted (only 56% correct selections vs. 86% correct selections in the control condition). The children's response pattern was disrupted even more when a nonsense word (as in in (1c)) was used in place of the determiner, suggesting that toddlers know which items are permissible as grammatical morphemes.

In a preferential listening study by Shady, Gerken and Jusczyk (1995), 10-month-old infants listened to normal English sentences as well as sentences in which determiners and nouns were reversed, producing utterances like "kitten the". Shady and colleagues found that the infants listened longer to the normal English sentences, suggesting that they were able to discriminate between the two types of stimuli.

In comparable studies (see Shady, 1996 and Shafer et al., 1998) researchers presented infants with sentences in which a subset of grammatical morphemes were replaced by nonsense syllables. Remarkably, in these studies infants only discriminated the stimuli in which nonsense morphemes replaced grammatical morphemes, and not those stimuli in which nonsense words replaced content words. This suggests that the information carried by grammatical morphemes about linguistic form is more salient to infants than that of content words.

Golinkoff, Hirsh-Pasek & Schweisguth (1998) examined 18 to 21-month-old infants' sensitivity to the bound morpheme *–ing.* They found that infants watched a visual stimulus significantly longer when it was matched with a verb containing the bound (grammatical) verbal morpheme *-ing* than when it was matched with a verb containing the (ungrammatical) adverbial morpheme *–ly.* Furthermore, the infants watched a visual stimulus matched with the ungrammatical *–ly* condition significantly more than a visual stimulus that was matched with a verb containing the nonsense syllable /lu/. From this they concluded that infants are sensitive to the appearance of the bound morpheme *–ing* and that they can recognize that a nonsense syllable is not a grammatical morpheme.

Of particular interest to the experiments performed in this chapter is a study by Santelmann & Jusczyk (1998). In a series of preferential listening experiments, they explored infants' reactions to discontinuous morphosyntactic dependencies in English. They tested 15- and 18-months olds' sensitivity to the basic dependency between the auxiliary verb *is* and the verbal ending *–ing.* For each experiment, 'natural' (i.e. grammatical) and 'unnatural' (i.e. ungrammatical) passages were created. The relation between the auxiliary verb *is* and the morpheme *-ing* as in *the dog is barking* was maintained in the 'natural' passages, whilst the 'unnatural' passages were constructed with the modal verb *can* and the suffix *-ing* as in **the dog can barking*. *Can* and *–ing* cannot form a morphosyntactic relationship in English. Santelmann & Jusczyk hypothesized that if infants were sensitive to the natural relationship in the grammatical passages, they would show a difference in listening time between the two types of passages. The reason for selecting this particular morphosyntactic dependency (aux *be* + *-ing*) was that, in addition to testing infants' sensitivity to morphosyntactic relations, Santelmann & Jusczyk wanted to explore the nature of infants' processing window. This was done by systematically increasing the distance between the dependent morphemes. The researchers found that 18-month-olds showed a significant listening preference to the passages where the morphosyntactic dependency was maintained, while 15-month olds did not. Thus, the researchers suggested that sensitivity to the morphosyntactic dependency between auxiliary *is* and the verbal ending *–ing* develops between 15 and 18 months in American English infants. However, 18-month-olds' sensitivity to the dependency between *is* and *–ing* is restricted to a short domain. Over distances of one- to three-syllables the 18-months olds showed a significant listening preference to the natural passages. However, over distances of four- or five-syllables, the 18-months olds showed no significant listening preference to the passages with the natural dependency.

It is important to note that the findings of these studies do not indicate that infants have syntactic knowledge about a specific aspect of syntax. They only provide evidence that infants *are sensitive* to aspects of their input that might serve as cues to a property of adult syntax. Cue sensitivity indicates that infants are capable of encoding and recognizing frequently occurring patterns in their native language.

3.3. Early language abilities in infants at risk for dyslexia

Presently, longitudinal research projects with children at risk for dyslexia are carried out in Finland *(Jyväskylä Longitudinal Study of Dyslexia)* and in The Netherlands (*Identifying the Core Features of Developmental Dyslexia)*. Most of the infant studies (within the linguistic domain) conducted in these projects have concentrated on speech perception and lexical abilities. Both the Finnish and the Dutch projects primarily use brain imaging techniques to study speech perception abilities. This section gives an overview of current findings in these longitudinal projects.

3.3.1. The Finnish study

An Event Related Potentials (ERP-) study by Guttorm et al. (2001) found that newborn infants at risk for dyslexia and newborn control infants showed different brain responses to synthetic consonant-vowel syllables (/ba/, /da/, /ga/). The stimuli were presented in equal proportions and with long inter stimulus intervals of 3010 to 7285 ms. The groups differed on a number of latency windows: between 50 and 170 ms the responses of the at-risk group to /ga/ were more positive at the right hemisphere than those of the control group; between 540 and 630 ms the responses to /ga/ were positive in the at-risk group and negative in the control group and between 740 and 940 ms the responses of the at-risk group to /da/ at the posterior electrode sites were more negative than those of the control group. According to Guttorm et al., these results show that cortical activation generated by speech elements differs in infants with and without a genetic risk for dyslexia directly after birth. Specifically, this response pattern was related to poorer receptive language and verbal memory skills at the age of 5.

In another ERP study, Guttorm (2004) presented newborn at-risk and control infants with syllables varying in vowel duration (standard /kaa/, duration 250 ms, probability 88 %; deviant /ka/, duration 110 ms, probability 12 %). Around 350 ms, the groups showed significant hemispheric differences in their responses to vowel duration change. The change detection response was largest in the right hemisphere in the at-risk group and largest in the left hemisphere in the control group. The larger response at the right hemisphere was associated with poorer performance on verbal memory tasks at 5 years, whereas larger left-hemispheric response was related to better language skills at 2.5 years.

Leppänen et al. (2002) measured event-related brain responses to consonant duration changes embedded in the pseudoword /ata/. The pseudoword tokens (with varying /t/ duration) were presented as frequent standard or as rare deviant stimuli. The at-risk infants were different from control infants in both their initial responsiveness to sounds per se and in their change-detection responses dependent on the stimulus context.

One study that used behavioural data is that of Richardson (2003). Using the head-turn preference procedure, she studied Finnish infants' ability to categorize speech sounds according to duration. Infants around the age of 6 months were presented with a set of eight stimuli constructed from the pseudoword /ata/. The eight stimuli were created by adding 20 millisecond increments of silence to the middle of the t-sound. Richardson hypothesized that at some point in the continuum, normally developing listeners will perceive a shift from /ata/ (short) to /atta/ (long). Richardson found evidence that the speech perception of at-risk infants is significantly different from that of control infants. The at-risk infants were able to categorize stimuli as long, but needed a significantly longer duration of the t-sound than the control infants in order to do so.

The lexical abilities of children taking part in the *Jyväskylä Longitudinal Study of Dyslexia* were assessed by means of the MacArthur Communicative Development Inventories (CDI). The Finnish CDI was administered at the ages of 12, 14, 18, 24 and 30 months (Lyytinen, 1997; Lyytinen, Ahonen, et al., 2001; Lyytinen, Poikkeus, et al., 2001). The researchers found no significant differences between the at-risk and control groups for total vocabulary comprehension at 14 months or for total vocabulary production at 24 months. However, individual 14 month and 24 month scores did predict language development at the age of 3;5. The earliest group difference on the basis of the CDI was found at the age of two. At this age, the maximum-length sentences of the at-risk children were on average shorter than those of the control children. The onset of talking was also a consistent early predictor of differences in language development. At-risk children who were considered to be late talkers at the age of two showed delayed language development at 3;5, while the control children who were considered to be late talkers at the same age generally caught up with their peers by the age of 3;5.

3.3.2. The Dutch study

The development of auditory functioning in Dutch infants at-risk for dyslexia was studied by Van Leeuwen et al. (in press). From the age of 2 months, infants were presented with a pre-attentive auditory discrimination task. The stimuli consisted of four different contrasts taken from a /bAk/-/dAk/ continuum, with frequently occurring standards and infrequently occurring deviants. Van Leeuwen et al. report that the normally developing infants have a mismatch response to the deviant stimuli at the age of two months, while the at-risk infants showed no such a response.

Lexical abilities of the children taking part in the *Core features* project were, as in the Finnish project, assessed with the CDI. Koster et al. (2005) report on their findings with infants aged 17 months. At this age, the at-risk group produced fewer words overall than the control group. In order to compare their results with cross-linguistic studies of normally developing children, Koster et al. selected three major grammatical groups of word categories from the CDI. Based on these categories (*Common Nouns, Predicates* and *Closed-Class Words)* more differences between the at-risk and control groups were found. The at-risk group produced significantly fewer *Closed-Class Words* and when the major category *Predicates* was split into *verbs* and *adjectives*, a significant group effect for *verbs* was also found. According to Koster et al., lexical elements like verbs and closed-class items play a crucial role in syntactic and semantic development.

Clearly, one area that has not been studied extensively in infants at risk for dyslexia is that of language perception/syntactic processing. This area is the focus of this chapter. Language perception, specifically perceptual sensitivity to the morphosyntactic dependency between the temporal auxiliary *heeft* and its verbal complement (the past participle) was assessed. This specific morphosyntactic dependency was chosen for two reasons. Firstly, it is highly frequent in the input that Dutch children receive and appears in the language production of children around the age of 2:6. It is safe to assume that all the subjects in this study have been exposed to this particular morphosyntactic dependency in the language around them prior to participating in the experiments. Secondly, available evidence from studies with Swedish and German children with SLI, suggests that these children use the temporal auxiliary *have* less often than normal controls. Assuming that dyslexia and SLI are related disorders, it is not unreasonable to expect deviant sensitivity to this particular auxiliary and to its verbal complement.

3.4. Research questions

The following research questions will be addressed in this chapter:

(i) Are normally developing Dutch infants sensitive to discontinuous morphosyntactic relations?

(ii) Are Dutch infants at-risk of developing dyslexia sensitive to discontinuous morphosyntactic relations?

(iii) What is the nature of Dutch infants' processing window?

The preferential listening procedure was used to investigate these questions. The main objective when using this procedure is to establish whether infants prefer one kind of stimulus to another. If such a preference is found, this is believed to indicate that the infants can discriminate between the different stimuli. There are a number of reasons why this procedure is well suited for studying language in infants. The procedure doesn't require children to point, answer questions or act out commands. Infants only need to employ visual fixation (a response already in their repertoire) in order to fulfill the requirements of the task. Three experiments were conducted in order to answer the above questions. Both the control group and the at-risk group took part in experiment 1. The aim of this experiment was to compare the perceptual behaviour of the two groups at the age of 19 months. Experiment 2 was essentially a replication of experiment 1; the main differences being that only the at-risk infants took part and that they had an average age of 25 months. The idea behind this experiment was to establish whether the perceptual behaviour of the at-risk infants changed between the ages of 19 and 25 months. Experiment 3 was conducted with the control group at the age of 25 months. The aim of the experiment was to determine the effect of an increased processing load on the ability of normally developing children to recognise a discontinuous morphosyntactic dependency.

3.5. Experiment 1

3.5.1. Method

3.5.1.1. Subjects

The subjects were 84 Dutch infants. 53 of these infants are at risk of developing dyslexia. The control group consisted of 31 children. The infants in the at-risk group had an age-range of 18 to 22 months, with an average age of 19.7 months. The infants in the control group had an age-range of 18 to 23 months, with an average age of 19.7 months. The data of an additional 31 infants (22 at-risk and 9 control) were excluded for the following reasons: 18 for crying, 5 for refusing to sit still, 4 for technical failure/experimenter error and 4 for not responding to the lights.

3.5.1.2. Stimuli

The stimulus material consisted of 16 passages. 8 of these passages were grammatical and 8 passages were ungrammatical. All passages were 8 sentences and 77 to 78 syllables long. In the grammatical passages, every sentence contained the temporal auxiliary *heeft (have)* and the past participle prefix *ge-* on the main verb. These morphemes form a grammatical morphosyntactic dependency in Dutch. The two dependent morphemes were separated by a two-syllable adverb. The ungrammatical passages exactly matched the grammatical passages except for the substitution of the auxiliary verb *heeft* by the modal verb *kan (can)*. *Kan* and the past participle prefix *-ge* formed an ungrammatical dependency in the ungrammatical passages.[1] The stimuli used in experiment 1 are given in appendix A. The passages were recorded by a native female speaker of Dutch onto digital tape, using a DAT recorder. The speaker was instructed to read the sentences in a monotonous voice. This was done to ensure that the prosodic structures of the grammatical and ungrammatical passages were similar. The prosodic structures of all the sentences in the grammatical passages were checked against their counterparts in the ungrammatical passages for overall similarity. The sound files were digitized onto a …computer at a sampling rate of 16kHz and were edited in GIPOS. During editing, the natural silent pauses between sentences were cut from all passages and a silent pause of 0.5 seconds was inserted between every sentence. After editing, the duration of all passages was 20.9 seconds.

[1] The modal *kan* and the past participle morpheme *ge-* can form a grammatical word string in Dutch, as in *kan gelopen hebben*. However, in the stimuli used in this study, they always formed an ungrammatical word string.

3.5.1.3. Design and apparatus

The Preferential Listening Procedure (a variation on the head turn preference procedure) was used (Kemler Nelson et al. 1995). The experiment consisted of four training trials and twelve test trials. The training trails preceded the test trials and acquainted the children with the stimuli. At the same time, the training trials taught the infants that there is a relation between their head-turns and the onset of the auditory stimulus. During the training phase, all infants heard the same stimuli, i.e. one occurrence of each type of stimulus at each of the two loudspeakers. The order and position of the training trials were the same for all the infants. During the test phase, each infant heard both kinds of stimuli from both sides of the test booth. The test trials were presented randomly. Computer software determined the randomization: the maximum number of successive same type trials and the maximum number of successive same side trials were both set at two. The order of the trials and the location (i.e. whether they were presented from the left or from the right hand side of the booth) of the trials were independent of the infant's behaviour. During the test phase, listening preferences were measured by exposing an infant to one type of stimulus on half of the test trails, and to the other type of stimulus on the remainder. An infant only completed the experiment successfully if it listened to all twelve test trials. All infants were seen for a single experimental session.

A computer controlled the presentation of the stimuli and recorded the experimenter's scoring of the infant's responses. The procedure was conducted in a three-sided test booth. The test booth is depicted in figure 1. The panels of test booth were constructed from wooden frames that are 200cm × 200cm × 200cm. The panels were covered with light linen fabric. The room containing the test booth was soundproof and dimly illuminated. This soundproof room was located within a bigger room. The centre panel of the test booth, which the infant faces, had a green light mounted at the infant's eye-level. To the left of the centre light was a 5cm hole to accommodate the lens of a Panasonic F15 video camera. On each of the side panels a loudspeaker was mounted at the level of the infant's head, but out of the infant's sight. Small red lights were mounted on each of the side panels in the vicinity of the loudspeaker. The infant's reactions were video-recorded during the experiment and the recording was directly projected to a Sony colour television that was located outside the soundproof room.

All other technical equipment necessary for controlling the experiment (the computer, amplifier, CD-player and a two-button response box) was also located in this room. The response box, which was connected to the Intel Celeron computer, was equipped with two buttons that started and stopped the centre and sidelights in the test booth. The direction and duration of an infant's head turns were recorded by means of the response box and this information was stored in a data file on the computer. Computer software was responsible for the selection and randomization of the stimuli and for terminating a trial when the infants looked away for more than two consecutive seconds.[2]

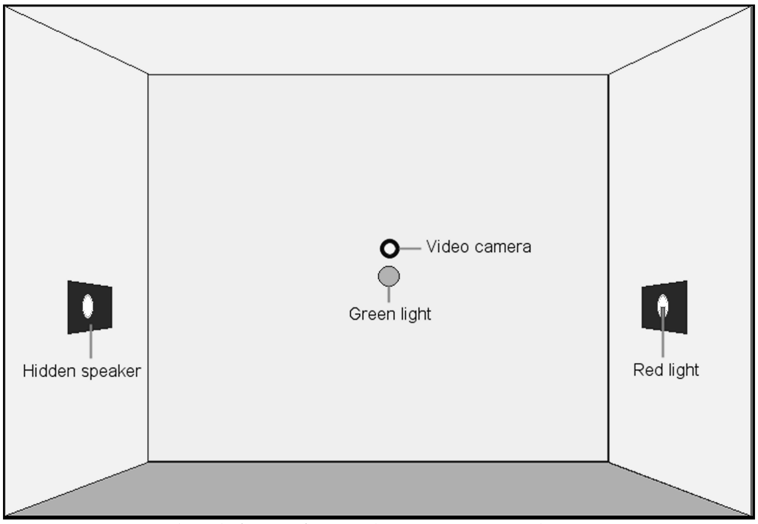


Figure 1. Test booth for Preferential Listening Procedure

3.5.1.4. Procedure

During the experiment, the infant's caregiver sat on a chair, facing the centre panel and holding the infant on his/her lap. At the beginning of each trial, the infant's attention was drawn to the centre by flashing the green light. When the infant's attention was centred, the green light stopped flashing and the red light on one of the two side panels started flashing, indicating the availability of an auditory stimulus on that side. Once the infant made a head turn to that side, the stimulus began to play. The stimulus continued, and the red light kept flashing, until the infant turned away for a continuous period of two seconds or until the entire stimulus for that trial had been played. The infant's listening time was calculated by adding up the total time the infant was orientated to the speech sample.

The experimenter scored the head movements of the infants with a response box that was linked to a computer. The response box had two buttons, one black and one red. The experimenter started every experiment

[2] The computer software controlling the experiment was custom made by Theo Veenker. See http: //www.let.uu.nl/`Theo.Veenker/personal/projects/

by pressing the black button. This resulted in the green centre light flashing. Once the child's attention was centred, a trial could begin. The experimenter pressed the black button a second time. This action initiated a flashing red light on one of the sidewalls of the test booth. When the child made a head-turn in the direction of the stimulus location, the observer pressed the black button for a third time. This

started the auditory stimulus and marked the beginning of the infant's listening time. The red button was pressed whenever the child deviated from the auditory stimulus (by turning its head away). This response stopped the computer program's timer which calculated the total amount of listening time for every trial, but the auditory stimulus continued to play. If the infant orientated back towards the auditory stimulus, the experimenter again pressed the black button. With this response the stopwatch continued counting from where it last stopped. However, if the infant failed to look back at the source of the auditory stimulus within two seconds, the computer program automatically terminated the sound and light. The experimenter, as well as the infant's caregiver, wore tight fitting earphones through which a mask was played during the test session. The mask consisted of instrumental music with very few silent pauses. This was to guard against experimenter bias and caregiver "instruction". The video recordings were used to do reliability checks on the response measures of the experimenter.

3.5.1.5. Data analysis

Computer software created a data file for each of the participants. This data file contained information on the progress of the experiment (i.e. the amount of time an infant was orientated to the sound source while a stimulus played, the direction from which the stimulus was played and the order in which the stimuli was presented). Using this data file, the listening times of every infant to each of the test trials were calculated. This was done by means of a computer script. Thereafter, the average listening time to the grammatical and to the ungrammatical passages were calculated for each of the 30 infants in the control group. From these mean listening times, the mean listening times across all control subjects were calculated for both the grammatical and the ungrammatical passages. The same procedure was followed to obtain mean listening times in the at-risk group. The mean listening times in both the control and the at-risk groups were compared with a paired samples t-test (confidence level set at 95%). The paired variables were the mean listening time to the grammatical passages and the mean listening time to ungrammatical passages.

3.5.2. Results

3.5.2.1. Control group

Across all infants, the mean listening time to the grammatical passages was 9.61 seconds (SE = 0.70) and the mean listening time to the ungrammatical passages was 8.21 (SE = 0.73). The paired difference between the mean listening times was 1.39 seconds. This difference is significant: t (29) = 2.21, P = 0.035. 67% of the infants in the control group (i.e. 20 of the 30 subjects) had a preference for the grammatical passages.

3.5.2.2 At-risk group

The mean listening times across all infants were 8.0 seconds (SE = 0.46) for the grammatical passages and 8.69 seconds (SE = 0.49) for the ungrammatical passages. The paired difference was –0.69 seconds. This difference in listening times is not significant: t (56) = -1.8, P = 0.077. Only 46% of the at-risk infants (i.e. 26 of the 57 subjects) listened longer to the grammatical passages. The results of the control group and the at-risk group are presented in figure 2.

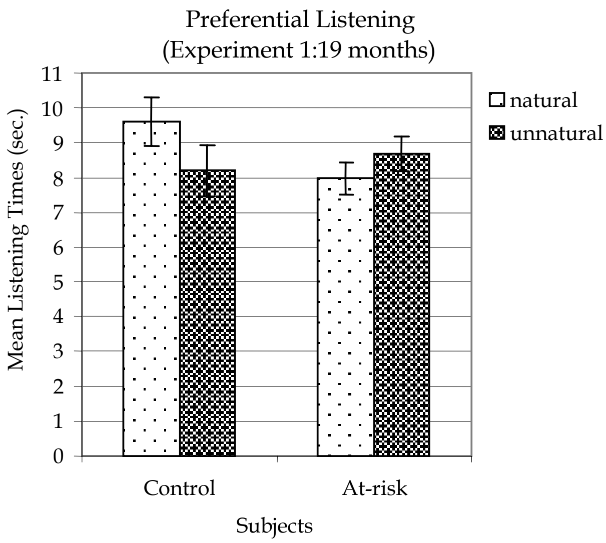


Figure 2. Control children's and at-risk children's average listening times (and standard error of the mean) for grammatical and ungrammatical passages.

3.6. Experiment 2

3.6.1. Method

3.6.1.1. Subjects

The subjects in experiment 2 consisted of 54 children at risk for dyslexia. These subjects were a subset of the children that participated in experiment 1. The children were between 24 and 31 months old, and had an average age of 25.6 months. The data of an additional 13 children was excluded for the following reasons: 4 for crying, 2 for refusing to sit still, 1 for technical failure/experimenter error, 2 for not responding to the lights and 4 for showing a ceiling effect. In order to be excluded on the basis of the last criterion, a child had to listen to the entire trial (i.e. approximately 20 seconds) at least half of the time. Subjects who had listening times of around 20 seconds on at least 6 trials were thus excluded.

3.6.1.2. Stimuli, Design, Apparatus, Procedure

The stimulus material was the same as in Experiment 1. Likewise, the design, apparatus and procedure in experiment 2 were identical to those in experiment 1.

3.6.1.3. Data analysis

The data was analyzed in exactly the same way as described for experiment 1 (see section 3.4.1.5.).

3.6.2. Results

The mean listening time to the grammatical passages was 8.56 seconds (SE = 0.46). The mean listening time to the ungrammatical passages was 8.83 seconds (SE = 0.49). Thus, the at-risk subjects listened 0.27 seconds longer to the ungrammatical passages. This difference is not significant: t (52) = -0.423, P = 0.47. Further inspection of the data revealed that 46% of the subjects listened longer to the grammatical passages and 54% listened longer to the ungrammatical passages. This result is virtually identical to the result of the at-risk group at the age of 19 months. The performance of the at-risk group is depicted in figure 3.

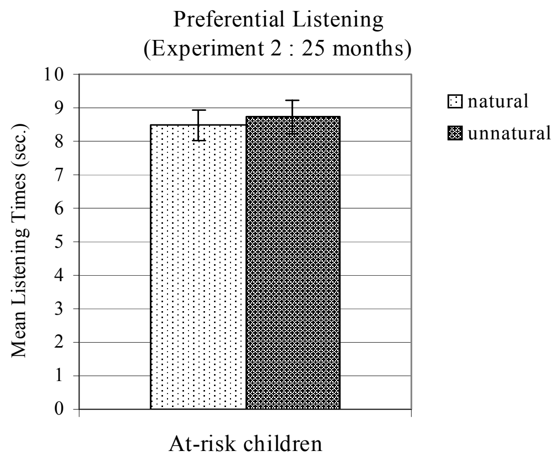


Figure 3. At-risk children's average listening times (and standard error of the mean) for grammatical and ungrammatical passages at age 25 months.

3.7. Experiment 3

3.7.1. Method

3.7.1.1. Subjects

The subjects were 29 normally developing infants. These children were a subset of the normally developing infants that took part in experiment 1. The infants were between the ages of 24 months and 30 months and had an average age of 25.7 months.

3.7.1.2. Stimuli

The stimuli used in this experiment were similar to the stimuli used in the previous two experiments. The only difference in this set of stimuli was that the distance between the dependent morphemes was increased to four syllables. The auxiliary *heeft* and the past participle were separated by two adverbs. Both adverbs were two syllables long. This was done with the intention of making it more difficult for the infants to recognize the dependent morphosyntactic relation. The passages were recorded by the same native female speaker who recorded the stimuli for experiments 1 and 2. The prosodic structures of the grammatical and ungrammatical passages were checked against each other for overall similarity. The sound files were digitized onto a personal computer at a sampling rate of 16 kHz and were edited in GIPOS. The natural silent pauses between sentences were cut from all passages and a silent pause of 0.5 seconds was inserted between every sentence. After editing, the duration of all passages was 22 seconds. The stimuli used in experiment 3 are given in appendix B.

3.7.1.3. Design, Apparatus, Procedure

The design, apparatus and procedure in experiment 3 were identical to those in experiments 1 and 2.

3.7.1.4. Data analysis

The data was analyzed in the same way as for experiment 1 (section 3.4.1.5.).

3.7.2. Results

The mean listening time to the grammatical passages was 9.84 seconds (SE = 0.65). The mean listening time to the ungrammatical passages was 10.44 seconds (SE = 0.62). Thus, the normally developing children listened 0.6 seconds longer to the ungrammatical passages. This difference is not significant: t (29) = -0.751, P = 0.46. This result suggests that the normally developing children are no longer able to discriminate between the different stimuli when the distance between the dependent morphemes is four syllables long. Thus, when the task is made more difficult by increasing the processing load, the behaviour of the normally developing children becomes more like the behaviour of the at-risk children. The performance of the normally developing children (age 25 months) is displayed in figure 4.

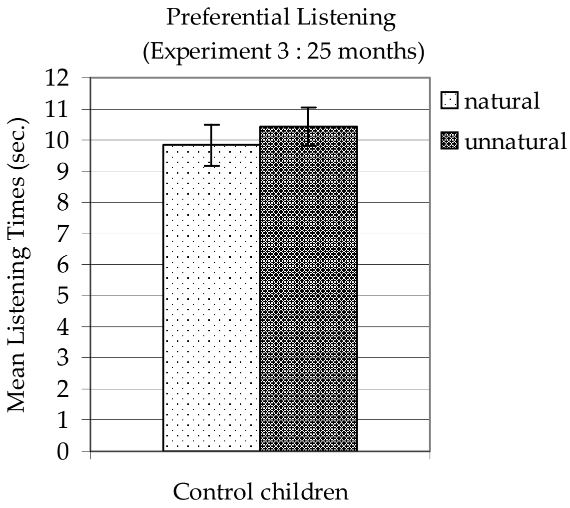


Figure 4. Control children's average listening times (and standard error of the mean) for grammatical and ungrammatical passages at age 25 months.

3.8. Discussion

This study was conducted to explore Dutch infants' sensitivity to discontinuous morphosyntactic dependencies. Three research questions were put forward in this chapter. The first research question was:

> (i) Are normally developing Dutch infants sensitive to discontinuous morphosyntactic relations?

The normally developing infants in this study showed a significant listening preference to the grammatical passages in experiment 1. This result suggests that by the age of 19 months, Dutch infants are sensitive to the morphosyntactic dependency between the auxiliary *heeft* and the past participle morpheme *ge-*. The findings of experiment 1 indicate that Dutch infants have acquired some (passive) knowledge about the types of dependencies that occur between morphemes in their mother tongue. Such awareness provides them with the foundation that is needed for processing longer and more complex sentences. The findings of Santelmann & Jusczyk (1998) are replicated in this study; suggesting that the perceptual language development of infants are highly similar across English and Dutch. A possible concern with regard to the findings of experiment 1 is that they do not reflect infants' sensitivity to the morphosyntactic dependency itself, but to some other frequent aspect of their native language. If, for example, the auxiliary *heeft* generally occurs more frequently than the modal *kan* in the input that Dutch infants receive it could be argued that infants preferred the grammatical passages for this reason. A corpus study of the CHILDES database (see Van der Ven, 2004) indicates that this alternative explanation of the data is unlikely. Using the Groningen corpus, Van der Ven counted the frequencies of *heeft* and *kan* in a total of 88 931 utterances. Only the child's input, i.e. utterances that were directed to the child or to another adult were included in the analysis. Van de Ven found that *kan* appeared significantly more frequent than *heeft*. Thus, if infants' preferences were dependent on frequency, one would have expected a preference for the sentences containing *kan* in experiment 1. Recall also that the modal *kan* and the past participle do not form an impossible string in Dutch. Adding the infinitive *hebben* to this string results in grammatical constructions like *hij kan dat gedaan hebben* (he can have done that).

Even though the ungrammatical passages did not contain such strings, another possible concern is that, even in its ungrammatical form, the *kan* + *ge-* combination might also have presented infants with a potential cue as to the position and word class of the past participle. Since the past participle form and the modal *kan* constitute a valid combinatorial pattern (given that the infinitive *hebben* follows it), one could argue that children should also be sensitive to this pattern in the input. If this turned out to be true and if children heard this pattern frequently, both *kan* and *heeft* could have provided children with a cue as to the position of the past participle in a sentence. Essentially, if children were equally sensitive to the *kan* + *ge-* combination and the *heeft* + *ge-* combination, one would expect no significant differences in listening time. The results of experiment 1 show that this is not the case. So why would they then be more sensitive to the *heeft* + *ge-* combination? The answer again lies in frequency. Apart from counting the mere occurrences of *heeft* and *kan*, Van der Ven also counted how often these items were used in combination with a past participle. From a total of 1105 instances, *heeft* was used 301 times with a participle. The modal *kan* appeared only 5 times with a participle (out of 1904 instances of *kan*). The auxiliary *heeft* is thus significantly more likely to be followed by the past participle than that the modal *kan* is. Grammatical morphemes (in this case a co-occurrence pattern between morphemes) are assumed to act as cues because of their frequency in the input. It seems only logical that the morphosyntactic string *heeft* + ge- is more likely to provide language learners with cues than a string that rarely occurs in their input. It is useful to refer here to the type of cues provided by a string such as *heeft* + *ge-*. Since the auxiliary *heeft* is very frequently preceded by a NP, the child learns to associate words that precede *heeft* as belonging to the same class, i.e. nouns. And since *ge-* is always followed by a verb, the child learns to associate words that follow *ge-* with the category verb. These findings further strengthen the conclusion that the listening preference found in the control group is indeed a preference for the *heeft* + past participle combination.

> (ii) Are Dutch infants at-risk of developing dyslexia sensitive to discontinuous morphosyntactic relations?

The at-risk infants showed no significant preference to either the grammatical or the ungrammatical passages. This was true of both experiment 1 and experiment 2 and suggests that the at-risk children in this sample were not able to discriminate between the grammatical and the ungrammatical passages. This suggests that the at-risk infants were not able to detect the morphosyntactic dependency discussed here. In other words, they are less sensitive to the patterns in which the grammatical morphemes *heeft* and *ge-* can occur in Dutch than their age-matched controls. Taken together, the results of experiment 1 and 2 also imply that the development of the at-risk children's perceptual language skills is delayed by at least 6 months. In other words, by the age of 25 months, the at-risk children have not caught up with the control children; their language perception skills and particularly their ability to recognize a frequently occurring pattern in the input were apparently still lagging behind. Lacking the ability to track relationships between morphemes might have a negative effect on the development of language production in the at-risk children.

It is possible to speculate that the perceptual delay of the at-risk children renders these children less well equipped for the construction and decoding of longer (more complex) sentences. It is therefore likely that the at-risk children will start producing utterances containing this particular morphosyntactic relationship at a later age than the control children. However, an alternative interpretation is possible. Although the dependent morphemes in this study were separated by two syllables, they can occur adjacent to one another in Dutch. One could argue that the at-risk children will be able to detect this morphosyntactic dependency under different circumstances, namely when the morphemes in question occur next to each other in the speech stream. Assuming this to be true, the behaviour of the at-risk children in this study needs to be explained in another way. The fact that they were not able to detect the grammatical passages when the dependent morphemes were separated by two syllables, would then suggest that their processing window is smaller than that of the control children. The term processing window refers to the amount of linguistic information that a child can process at a given moment in time. If, for instance, a child has a processing window of three words, s/he would be able to (in time) detect the dependency between the determiner and the noun in the sentence *The dogs run*. However, this child would find it difficult to detect the dependency between the pronoun and the reflexive in the sentence *He looks in the mirror and sees himself*. It seems as if there are two possible explanations for the at-risk infants' behaviour. They either are not sensitive to the morphosyntactic dependency itself, i.e. they are not sensitive to co-occurrence pattern that exist between the temporal auxiliary *heeft* and the past participle morpheme *ge-* form a morphosyntactic dependency in Dutch, or they suffer from a processing deficit, (i.e. a smaller processing window) that hindered them in deteccting the grammatical passages. In order to determine which of the explanations are accurate, one would need to conduct a preferential listening experiment with 19-month olds' in which the auxiliary *heeft* and the morpheme *ge-* are adjacent to one another in the grammatical passages.

(iii) What is the nature of Dutch infants' processing window?

In the original study by Santelmann & Jusczyk (1998), 18-month-olds' sensitivity to the dependency between *is* and *–ing* was restricted to a short domain. Over distances of one- to three-syllables the 18-months olds showed a significant listening preference to the grammatical passages. However, over distances of four- or five-syllables, the 18-months olds showed no significant listening preference to the passages with the grammatical dependency. The findings of the present study are comparable. The infants in the control group detected the morphosyntactic dependency between the auxiliary *heeft* and the past participle over a distance of two syllables, but not over a distance of four syllables. This suggests that even with regard to their processing window, Dutch and American infants develop in a highly similar way. It has to be said though, that the infants in this study were 25 months old when their processing abilities were assessed, while the American infants were 18 months old. Comparing these data sets might be irrelevant, as it is impossible to speculate how the American infants would have performed at a later age.

An issue that needs to be discussed in relation to the processing window is why the insertion of a two-syllable adverb (in experiment 1 and 2) and two two-syllable adverbs (in experiment 3) would affect the recognition of a co-occurrence pattern. The insertion of a two-syllable adverb does create a "real-time" obstruction between the auxiliary and the past participle in so far as the participle does not immediately follow the auxiliary. But syntactically speaking, the insertion of an adverb between the auxiliary and the past participle does not cause the sentence to be more complex (and thus harder to process). The insertion of (for example) an object NP between the auxiliary and the participle results in a more complex sentence. Hence, the question remains whether the insertion of one or more adverbs increases the processing load to such an extent that it could potentially disturb the recognition of a morphosyntactic pattern. In the stimuli used, the adverbs were of variable duration, but generally they were around 0.35 seconds long. In the field of speech perception, this is quite a lengthy period of time. It is therefore not unthinkable that the time-factor could have created a disturbance big enough to cause a failure in the detection of a morphosyntactic pattern. The influence of structural complexity versus time-span on syntactic processing will be discussed further in chapters 4 and 5.

3.9. Summary

In this chapter, the perceptual sensitivity of Dutch infants at risk for dyslexia to morphosyntactic agreement relations was studied. Three preferential listening experiments were conducted. The outcome of the experiment 1 suggests that at the age of 19 months, at-risk infants are less sensitive to discontinuous morphosyntactic dependencies than their normally developing peers. The normally developing children preferred to listen to sentences containing a grammatical morphosyntactic dependency; the at-risk children showed no such preference. Experiment 2 established that the perceptual language development of the at-risk children is delayed by at least six months. In experiment 3 it was found that normally developing children’s ability to detect a discontinuous dependency is limited. Under strenuous conditions, their perceptual behaviour is similar to that of the at-risk children. The results obtained in this study adds to existing evidence that normally developing children are sensitive to grammatical morphemes, as well as to the relations in which they can occur, even before they start producing them. More importantly, the Preferential Listening Procedure has been used successfully in this study to compare morphosyntactic processing in two populations. Previously, the Head-Turn Preference Procedure has been used by Richardson (2003) to compare the speech perception of Finnish children at-risk of developing dyslexia with Finnish controls, but as far as this study represent a first attempt to compare the syntactic processing abilities of children at-risk of developing dyslexia with a control group.

Chapter 4

The production of the past participle

Chapter 3 established that the group of children with a genetic risk for dyslexia are, or at least seem to be, less sensitive to the morphosyntactic dependency between the temporal auxiliary *heeft* and its verbal complement (the past participle form of the verb). As mentioned in the discussion of the previous chapter, it is not (yet) clear why the at-risk children lag behind in this particular area of their perceptual language development. To recapitulate: one possibility is that the children with a predisposition for dyslexia are not sensitive to the morphosyntactic dependency itself; a second possibility is that they suffer from a general processing limitation that hampers their detection of morphosyntactic dependencies. In principle, the problem could be addressed by performing a series of preferential listening experiments, but limitations in the set-up of the project made it impossible to resolve the matter in this way. However, on the basis of the above mentioned possibilities three hypotheses regarding the productive use of auxiliary *heeft* and its verbal complement by children at risk for dyslexia can be formulated. If the predisposed children are insensitive to the morphosyntactic relation between *heeft* and the past participle form of the verb, one expects their productive use of the past participle construction to be impaired compared to that of normally developing children (hypothesis a). If they suffer from a processing limitation, it is conceivable that they will be delayed in discovering any kind of morphosyntactic dependency. This in itself could cause delayed production (hypothesis b). However, it is also conceivable that these children are sensitive to the morphosyntactic dependency in spite of suffering from a processing limitation. If this is indeed the case, one might expect delayed production of the past participle only in situations that are particularly challenging to them (hypothesis c).

4.1. Outline of this chapter

This chapter reports on an experiment designed to test the above-mentioned hypotheses. In section 4.2., the reader is provided with some background information on the acquisition of the past participle construction by normally developing children. Section 4.3. describes one scenario in which the production of grammatical morphemes (and hence the verbal morphology used to form the past participle) could be jeopardized. The research questions for this chapter are presented in section 4.4. The experimental method and results follow in sections 4.5. and 4.6. respectively. The results are discussed in section 4.7. and the findings are summarized in section 4.8.

4.2. The acquisition of the past participle in Dutch

4.2.1. What children need to learn

As mentioned in chapter 2, past participle constructions in Dutch minimally consist of the temporal auxiliary *hebben* (have) or *zijn* (to be) and the past participle form of a lexical verb. In order to successfully construct past participle constructions, Dutch children have to learn that some intransitive verbs select only *hebben*, while others select only *zijn* and still others select either *hebben* or *zijn*. *Hebben* is selected by unergative verbs, while *zijn* is selected by unaccusative verbs (unergative and unaccusative verbs represent two classes of intransitive verbs). Transitive verbs, on the other hand, always select *hebben* in past participle constructions. Existing evidence (Van Hout, 1996) suggests that normally developing children initially overgeneralize *hebben* for *zijn.* This results in ungrammatical utterances such as "ik heb gisteren in de kamer gevallen" instead of "ik ben gisteren in de kamer gevallen". However, by the age of 4;0, children distinguish two classes of intransitive verbs resembling adult classification. The selection of the correct auxiliary follows rapidly and easily.

Even though it is potentially interesting to study children at-risk for dyslexia with regard to auxiliary selection, constructions with auxiliary zijn were not included in the present study. The main reason for this is that the available experimental time (approximately 15 minutes per child) allowed limited data gathering. Keeping the theme of the thesis in mind, it was decided to study constructions containing the temporal auxiliary *heeft* and to investigate the effect of an increased processing load on the production of this type of past participle construction. Another reason for not including both types of constructions was that the children in this study were around three years old, at which age auxiliary selection is not fully acquired. Production errors like "*ik heb gisteren in de kamer gevallen*" would have been hard to interpret: are they a sign of language delay or simply of normal language acquisition? The focus of chapter 3 will therefore be on the production of past participle constructions like (1a). Before children can construct such sentences, they have to learn at least two things. They have to acquire the morphological rules needed for inflecting a lexical verb in the past participle and they have to acquire the syntactic rule that requires this particular form of the verb to appear as the complement of the auxiliary verb *hebben* (have).

4.2.2. Corpus data on past participle production

Generally speaking, the use of auxiliaries is a fairly early phenomenon in Dutch child language (Gillis & De Houwer, 1998). That being said, the acquisition of the past participle (and its associated temporal auxiliary) has not been studied extensively in Dutch. Children's earliest utterances typically contain only one single verbal element per utterance. These verbs are normally limited to lexical verbs in the infinitive form (Jordens 1990, Bol 1995, Wijnen 1995 a, b). During the multi-word phase, verb use diversifies. The finite form of the lexical verb starts to appear (alongside the infinitive) and children start producing modals and copula's. Furthermore, children start producing *bare participles* during this phase. Bare participles are past participle forms that appear without an auxiliary. This bare participle form is typically used to refer to an action that happened in the recent past.[1] It can be difficult to distinguish the past participle from the third person singular form of the verb in Dutch child language, the reason being that children often omit the prefix *ge-* from early participle forms. This prefix is the only unique marker of this verb form; when it is omitted one is left with a verb form that phonetically resembles the third person singular for many verbs, in particular weak (regular) ones. When the temporal auxiliary is also omitted (as is the case with bare participles), it becomes difficult to distinguish the participle form *_rend (ran)* from the third person singular form *rent (runs)*.

Around the age of 2;6 most Dutch children start producing complex VP's. Once they do so, the use of bare participles declines quickly. When the past participle form of the verb is used during this stage, it is mostly accompanied by an auxiliary (Wijnen, 1995a). The sparse evidence from corpus data suggest that by the age of three (which is the age of the children in this study), most normally developing children should have acquired the morphological and syntactic knowledge needed for the construction of the past participle.

4.3. The production of grammatical morphemes in complex structures

As mentioned in chapter 1, one of the theories that aims to explain the omission of grammatical morphemes (and closed class items) in the speech of children with SLI is the limited processing capacity hypothesis (Ellis-Weismer, 1996). Recall that in this account, children with SLI are assumed to have a limitation in their ability to process information. The processing system can deal with a limited amount of information at any one moment in time. When a taxing task is encountered, limitations in the processing system have the effect of processing trade-offs. For example, a child might have the knowledge required to use a grammatical form, but because of the processing load, this form is omitted in favor of other (typically semantically

[1] Productive use of the simple past tense is not an early phenomenon in Dutch child language. Instead of using the simple past tense form of the verb, Dutch children typically use the past participle to refer to something that happened in the recent past (Van Kampen & Wijnen, 2000)

more important) material. The suggestion is that the acquisition of grammatical morphemes as well as the production of morphemes already learnt could be negatively influenced by a limitation in the processing capacity. Similarly, a limitation in processing capacity could negatively influence the accurate employment of the morphemes that a morphosyntactic dependency is composed of.

It is possible to imagine many different scenarios in language production where an increased processing load can lead to the omission of grammatical morphemes. One scenario occurs in sentences containing a verb with a complex argument structure. Intransitive verbs are simple in the sense that they require only one argument; transitive and ditransitive verbs are more complex as they require two or more arguments. As far as the production of grammatical morphemes in such complex structures is concerned, Bock & Levelt's (1994) sentence production model (see also chapter 5) can serve as a constructive framework. According to this model, the production of a sentence starts at the conceptual level, where the speaker decides what s/he wants to say. Once the intended message exists in 'preverbal' form, the speaker selects the lexical items that match it. The arguments are then inserted in structural positions, such as specifier ("subject"), or complement ("object"), in order to satisfy the requirements of the verb's argument structure. It is assumed that the more complex the lexical item (the greater the number of arguments required), the longer this process takes to complete. After the grammatical functions have been assigned, a (pre-stored) syntactic frame that is compatible with the lexical items and their argument structures is retrieved. Following this, the closed class items (i.e. function words and grammatical morphemes) needed for the syntactic frame are retrieved from a separate lexical store and inserted. These steps occur incrementally, in other words one process is assumed to begin while the previous process is still in operation. The final step in the production of a sentence occurs when the different elements of the sentence are integrated into a prosodic structure. Following this model Leonard (1998) suggested that slow and/or inefficient processing in children with SLI could lead to a struggle between completing the final steps of the sentence production model and continuing with the actual production of the sentence. The result of this "competition" might be the production of a sentence with missing closed-class morphemes. It is thus not unlikely that children will be able to produce specific grammatical morphemes in relative simple structures, but that they would fail to produce the same morphemes in more complex structures. For this reason, this study will not only focus on the production of the past participle, it will also investigate the production of this construction in complex structures.

4.4. Research questions

On the basis of the above discussion, the following research question will be addressed in this chapter:

(i) Can preschool children at risk for dyslexia be distinguished from control children on the basis of their productive use of the auxiliary *heeft* (*has)* and its complement (i.e. the past participle)?

(ii) Are preschool children at risk of dyslexia competent in their production of the past participle construction i.e. do they obey the morphosyntactic rules underlying this construction?

(iii) Does an increased processing load affect the productive use of grammatical morphemes in normally developing children and in children at risk for dyslexia?

In order to investigate these issues, production data were collected by means of a sentence closure task. This type of task requires children to complete a sentence using a specific construction. The reason for collecting the production data by means of a controlled experiment (rather than using spontaneous speech samples) was two-fold. Firstly, a sentence completion task suits the aim of this study i.e. investigating a specific language structure. Secondly, the analysis of data gathered with a sentence completion task is reasonably concise; making it an effective tool for studying language production in a large sample of children.

4.5. Method

4.5.1. Subjects

33 normally developing children (control group) and 60 children at risk for dyslexia (at-risk group) participated in this study. In total, ten children (two control and 8 at-risk) failed to respond to the task. Experimenter error rendered the data of an additional two control children unusable. Subsequently, data from 29 control children and 52 at-risk children were analysed. The mean age of the children in the control group was 3;1, while the mean age of the children in the at-risk group was 3;3.

4.5.2. Stimuli and Procedure

The data were obtained by means of a sentence completion task (closure task). The stimulus material was presented to the children in the form of twelve short movies. Each movie started with the appearance of two characters, for example a frog and a rabbit. The experimenter named the characters in an introductory sentence (e.g. ''look, there is the frog and there is the rabbit"). After this introduction, each movie showed two successive events.[2] For instance, the child saw a movie in which first, a frog jumped and thereafter, a rabbit ran. The experimenter described these events to the child in the simple present tense while they were happening. Upon completion of the events, the two characters again appeared on the screen and the experimenter paused the movie. The experimenter recalled the first of the two events, using a past participle construction. The child was then prompted to recall the second event. Typically, the experimenter would say "What happened? I remember; the frog has jumped and the rabbit…". The child's task was to complete the sentence using the auxiliary *heeft (has)* and the past participle form of the verb. The children's responses were not scored on-line, but recorded with a DAT-recorder. Transcriptions of these recordings served as the main data source.

The experiment was divided into a training phase and a test phase. During the training phase, all subjects had to complete two sentences. If necessary, the experimenter corrected the child's utterances during this phase, and encouraged the child to imitate the correct response. During the test phase, all subjects had to complete ten sentences. Five of these sentences contained an intransitive verb while the other five sentences contained a transitive verb. An overview of the stimulus material is provided in appendix C.

4.5.3. Data Analysis

For initial data analysis, the children's responses were divided into two separate data sets. One data set included the sentences containing an intransitive verb (type A sentences), while the other set included the sentences containing a transitive verb (type B sentences). Both data sets consisted of five test items. The reason for this separate analysis was two-fold. Firstly, different within-subjects variables were associated with the analysis of the different sentence types. Secondly, research question (iii) is best answered by analysing the two sentence types separately.

For type A sentences, it was calculated how often responses contained the auxiliary verb *heeft* (*has)*, how frequently responses contained

[2]The events were filmed in a single session with a …digital video recorder. All events were filmed on a white table against a neutral background. The non-human subjects (e.g. the horse, the rabbit and the chicken) were depicted with toys and were manipulated via iron wires, ensuring that human hands were not visible in any of the movies. The human subjects (e.g. the boy, Jan Klaassen, Katrien) were depicted with hand puppets. Care was taken during filming to rid the movies of extra information (i.e. information not related to the event).

a main verb and whether the correct verb was used (a verb was considered to be "correct" when it was the same verb as the one provided by the experimenter during the movie). "Wrong verbs" were scored as either "wrong, semantically acceptable" or as "wrong, semantically unacceptable". These measures were all considered to be dependent variables. Additionally, based on its inflection, the main verb was classified as belonging to one of nine categories. These categories were based on the type of verbs found in the subjects' actual responses and are listed in table 1.

Table 1. Nine categories used to describe the form of the verb

Category	Form of the Verb	Example
1.	Fully inflected past participle	*geverfd*
2.	Past participle, prefix *ge-* omitted	*verfd*
3.	Verb stem	*Verf*
4.	Infinitive	*Verven*
5.	Past tense dummy auxiliary + infinitive	*ging verven/zat te verven*
6.	Present tense dummy auxiliary + infinitive	*Gaat verven*
7.	Present tense	*Verft*
8.	Ambiguous	*verfd(t)* *(tense not inferred from word-order)*
9.	Past tense	*Verfde*

Subjects using a verb from categories (1) and (2) produced a grammatical past participle construction, given that the auxiliary *heeft* accompanied the verb. The use of a verb from categories (3) and (4) resulted in an ungrammatical structure, regardless of the presence of the auxiliary. The use of verbs from categories (5), (6), (7) and (9) all resulted in grammatical utterances. Verbs belonging to category (8) were labelled ambiguous as it was not possible to decide whether these verbs belonged to category (2) or (7).

The same dependent variables used to analyse type A sentences were used to analyse type B sentences. For type B sentences, it was also calculated how frequently responses contained an object NP, how frequently the object NP contained a determiner and whether the correct object was used. Main verbs were again assigned to one of the nine categories in table 1. In order to address research question (ii), three additional dependent variables were identified. Specifically, it was calculated how often a past participle appeared as *bare participle* in the children's responses and how frequently a verb from category 3 or 4 appeared as complement of the auxiliary *heeft*.

For all dependent variables, with the exception of the categorial variable *form of the verb*, mean percentages of occurrence were calculated. For each variable, two different means were calculated. The first was based on the individual subject totals (i.e. the response of subject x to test items A1, A2, A3, A4, and A5) while the second was based on item totals (i.e. the responses of all control subjects to test item A1, of all control subjects to test item A2 ect). To compare the performance of the control group and the at-risk group, T-tests (with 'group' as between-subjects variable) were used. The T-tests were two-tailed with the significance level set at 0.05. The responses of the control and at-risk children to the categorical variable *form of the verb* were compared with a contingency table analysis, based on a chi-squared statistic. By performing this procedure, the null hypothesis that the observed verb category proportions are the same for the two populations was tested.

4.6. Results

4.6.1. Sentence Type A (Intransitives)

The mean percentages of occurrence and standard deviations for the measures *auxiliary verb*, *main verb*, *wrong verb (semantically acceptable)* and *wrong verb (semantically not acceptable)* are presented in table 2. These means were calculated from the individual subject responses to each of the test items. At first glance, the control group seems to use the auxiliary *heeft* more frequently than the at-risk group, while the at-risk group seems to use more (semantically acceptable) wrong verbs that the control group. However, none of these differences are statistically significant. As far as pure occurrence is concerned, the selected measures fail to reliably distinguish the groups from one another.

Table 2. Percentages of realized auxiliaries, main verbs and wrong verbs for type A sentences (intransitives). Between group differences are indicated with the t- and P-values in the last two columns.

Measures	**Control**		**At-Risk**			
	Mean	**(SD)**	**Mean**	**(SD)**	**t-value**	**P-value**
Auxiliary Verb	69.02	(36.75)	65.87	(33.79)	.391	.697
Main Verb	93.79	(19.35)	98.85	(4.66)	-1.798	.076
Wrong V, sem. acceptable	6.21	(16.40)	11.57	(16.53)	-1.593	.115
Wrong V, sem. not acceptable	3.10	(10.39)	0.38	(2.77)	1.416	.073

When the item means (see table 3) across the two groups are compared, the same picture emerges (recall that an item mean was calculated using all the subject responses to a specific test item). The occurrence of the auxiliary verb is again slightly higher in the control group than in the at-risk group, but this difference is not significant. As was the case with the subject means, none of the measures reliably distinguishes the at-risk group from the control group.

Table 3. Item means and standard deviations for type A sentences. Between group differences are indicated with the t- and P-values in the last two columns.

Measures	Control		At-Risk			
	Mean	(SD)	Mean	(SD)	t-value	P-value
Auxiliary Verb	71.15	(6.81)	67.64	(6.37)	.840	.425
Main Verb	97.14	(1.60)	98.62	(2.11)	-1.244	.249
Wrong V, sem. acceptable	7.44	(5.92)	11.44	(8.64)	-.878	.406
Wrong V, sem. not acceptable	3.04	(5.01)	0.5	(1.19)	1.110	.299

4.6.2. Sentence Type B (Transitives)

The mean percentages of occurrence and standard deviations for the measures *auxiliary verb*, *main verb*, *wrong verb (semantically acceptable)* and *wrong verb (semantically not acceptable), object NP, wrong object and determiner* are displayed in table 4. The general pattern for sentences containing a transitive verb is similar to that of sentences containing an intransitive verb. The control group once again seems to use the auxiliary *heeft* more frequently than the at-risk group, but this difference is not significant. There are no group differences in the frequency of occurrence of the main verb, in the occurrence of the object NP or in the occurrence of the determiner. The at-risk children did use significantly more (semantically acceptable) wrong verbs than the control group.

Table 4. Percentages of realized auxiliaries, main verbs, wrong verbs, object NP's, wrong object NP'S and determiners for type B sentences (transitives). Between group differences are indicated with the t- and P-values in the last two columns.

Measures	Control		At-Risk			
	Mean	(SD)	Mean	(SD)	t-value	P-value
Auxiliary Verb	69.45	(38.89)	67.10	(35.11)	.275	.784
Main Verb	96.61	(8.87)	95.63	(10.67)	-.416	.679
Wrong V, sem. acceptable	13.39	(14.56)	21.97	(19.71)	-2.04	.045*
Wrong V, sem. not acceptable	19.94	(23.26)	19.67	(18.56)	.056	.956
Object NP	76.32	(27.73)	78.23	(22.45)	-.334	.739
Wrong Object	7.41	(13.54)	7.87	(14.19)	-.139	.890
Determiner	54.23	(33.3)	56	(33.09)	-.229	.820

The results obtained from the item means (table 5) are no different. Again, there are no group differences in the frequency with which the different sentence parts occur. None of the measures reliably distinguishes the at-risk group from the control group.

Table 5. Item means and standard deviations for type B sentences. Between group differences are indicated with the t- and P-values in the last two columns.

Measures	Control		At-Risk		t-value	P-value
	Mean	(SD)	Mean	(SD)		
Auxiliary Verb	68.83	(5.63)	68.57	(10.09)	.050	.962
Main Verb	96.32	(3.71)	96.01	(3.55)	.136	.895
Wrong V, sem. acceptable	14.29	(16.99)	23.29	(21.74)	-.729	.487
Wrong V, sem. not acceptable	19.22	(11.03)	21.51	(21.60)	-.211	.838
Object NP	76.10	(17.02)	75.90	(17.19)	.019	.985
Wrong Object	6.92	(4.81)	7.59	(10.12)	-.134	.896
Determiner	52.56	(10.13)	53.59	(15.37)	-.126	.903

4.6.3. Form of the Verb

The categorical variable *form of the verb* was analyzed by means of a chi-square test. The observed and expected cell counts for the different categories of the verb (specified in table 1) were first calculated for each of the nine verb categories, as can be seen in table 6. In this initial count, all responses (i.e. responses to both type A and B sentences) were collapsed into a single data set. This was done primarily with the aim of analysing the nine categories separately, for which as big a data set as possible is required.

Table 6. Observed and expected cell counts for the nine verb categories (type A & type B sentences combined). Expected cell counts are given in brackets and printed in italics.

	Response									
	Category of the Verb									
Group	1	2	3	4	5	6	7	8	9	**Row Marg.Total**
Control	200 *(185)*	14 *(24)*	5 *(11)*	11 *(18)*	16 *(8)*	3 *(1)*	6 *(3)*	6 *(8)*	1 *(1.1)*	262
At-Risk	304 *(319)*	52 *(42)*	26 *(20)*	39 *(32)*	7 *(15)*	1 *(3)*	3 *(6)*	16 *(14)*	2 *(2)*	450
Column Marg.Total	504	66	31	50	23	4	9	22	3	712

However, in order to perform a chi-square analysis, all expected counts have to be at least 5. As this is not the case (the expected counts for categories 6, 7 and 9 are 1, 3 and 1.1 respectively) the verb categories had to be collapsed into three larger categories. The first of these three categories included fully inflected past participles and past participles from which the prefix *ge-* has been omitted. The second of the combined categories included verb stems and infinitives, while the third category consisted of all the remaining categories. The reasoning behind these particular combinations was rather straightforward: responses containing verbs from categories 1 and 2 were considered to be grammatical responses within the context of the experiment, responses containing verb categories 3 and 4 were considered to be ungrammatical and responses containing any of the other verb categories were considered to be grammatical, but distinct from the (expected) past participle construction. The observed and expected cell counts for the combined verb categories are presented in table 7.

Table 7. Observed and expected cell counts for combined verb categories (type A & type B sentences combined). Expected cell counts are given in brackets and printed in italics.

	Response			
Group	Categories 1 & 2	Categories 3 & 4	Other categories	**Row Total**
Control	214 *(210)*	16 *(30)*	32 *(22)*	262
At-Risk	356 *(360)*	65 *(51)*	29 *(39)*	450
Column Total	570	81	61	712

Inspection of table 7 leads to the following conclusions. In both the control and the at-risk group, the observed and expected frequencies for category 1 and 2 verbs are highly similar. Neither of the two groups seems to under- or over use these forms of verbs. However, for category 3 & 4 verbs, the observed count is lower than expected in the control group and higher than expected in the at-risk group. A reverse pattern is seen for the combined category *other verb forms*. In this category, the observed count is higher than expected in the control group and lower than expected in the at-risk group. A chi-squared test demonstrates that the differences between the observed and expected counts in table 7 are statistically significant: $\chi^2 = 16.69$, P (df=2) < 0.001. Thus, the data provide evidence that the category proportions are not the same for the control group and the at-risk group. Stated more clearly: the distribution of responses across the 3 (9) categories are significantly different for the two samples of children.

Table 7 provides the observed and expected response frequencies for the three combined verb categories when all responses for type A and type B sentences are counted together. This approach to the data creates a data set large enough to obtain a reliable χ^2 statistic. Unfortunately, this approach makes it impossible to investigate the possible influence that the argument structure of the main verb has on the actual realisation of the verb. In order to investigate this possible influence, observed and expected response frequencies were also calculated for type A and type B sentences separately. The outcomes of these calculations are given in tables 8 and 9.

Table 8. Observed and expected cell counts for combined verb categories (type A sentences). Expected cell counts are given in brackets and printed in italics.

	Response (Type A)			
Group	Categories 1 & 2	Categories 3 & 4	Other categories	**Row Total**
Control	113 *(108)*	8 *(14)*	14 *(12)*	135
At-Risk	183 *(188)*	31 *(25)*	20 *(22)*	234
Column Total	296	39	34	369

Table 9. Observed and expected cell counts for combined verb categories (type B sentences). Expected cell counts are given in brackets and printed in italics.

	Response (Type B)			
Group	Categories 1 & 2	Categories 3 & 4	Other categories	**Row Total**
Control	101 *(101)*	8 *(16)*	18 *(10)*	127
At-Risk	173 *(173)*	34 *(26)*	9 *(17)*	216
Column Total	274	42	27	343

First, consider the observed and expected cell counts for the different verb categories when only responses to type A sentences (i.e. sentences containing an intransitive verb) were included (see table 8). The response pattern is similar to the one described for the combined data in table 7. Category 1 & 2 verbs are used as expected by both groups, category 3 & 4 verbs are used less often by the control group and more often by the at-risk group than expected and the other verb categories are used more often than expected by the control group and less often than expected by the at-risk group. However, the differences between the observed and expected counts are smaller than is the combined data. A chi-squared test shows that the apparent differences in the responses of the control and the at-risk group with regard to the form of the verb are not significant when type A sentences are analysed separately: $\chi^2 = 4.97$, $P(df=2) = 0.08$. Now, consider the observed and expected cell counts for the different verb categories when only responses to type B sentences (i.e. sentences containing a transitive verb) were included (see table 9). The response pattern in the two groups of subjects is again similar to the one mentioned above; the only difference being that the observed and expected frequencies seem to diverge more from one another in type B sentences than in type A sentences. In this case, a chi-squared test shows that the differences between the observed and expected frequencies are statistically significant: $\chi^2 = 16$, $P\ (df=2) < 0.001$. The data therefore provides evidence that the null hypothesis (stating that the observed verb category proportions are the same for the two populations) should be rejected in the case of type B sentences, but not for type A sentences.

Another question relating to the form of the verb is whether the argument structure of the verb influences the realisation of verbal morphology. More specifically, are children more likely to omit the verbal morphology required to mark the past participle when the argument structure of the main verb in the sentence is complex rather than simple? In figure 1., the distribution of the form of the verb is given for sentences containing an intransitive verb. It is clear that both the control and the at-risk subjects predominantly use the fully inflected form of the past participle. 78.48% of all realised verbs in the utterances of the control subjects are fully inflected past participle forms, while 72.74% of the verbs used by the at-risk subjects are fully inflected past participle forms. An independent samples t-test demonstrates that this difference is not significant: t = 1.44, P = .188. Also, there is no difference between the groups with regard to the use of verb category 2 (i.e. past participle forms from which the prefix *ge-* has been omitted). 5.27% of all realised verbs in the control group belong to this category, while 6.34% of all realised verbs in the at-risk group belong to this category (t = -.312, P = .763).

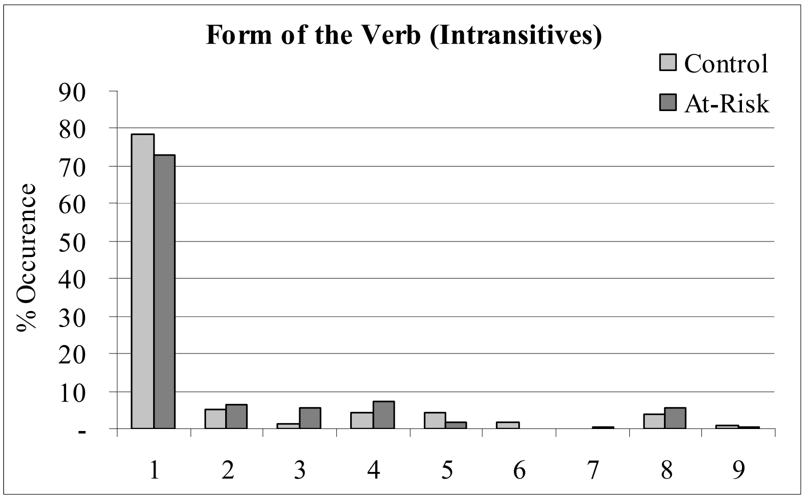


Figure 1. Form of the verb in sentences containing intransitive verbs

For sentences containing a transitive verb (see figure 2.), the results change to some extent. The more complex argument structure of the main verb in these sentences does not seem to dramatically affect the realisation of fully inflected past participle forms in the control group. 74.99% of all verbs are fully inflected past participle forms. However, in the at-risk group, only 62.33% of all realised verbs are fully inflected past participle forms. An independent samples t-test indicated that this difference is significant at the 0.05 level: $t = 3.626$, $P = .007$). Furthermore, there is a striking difference between the two groups of children in the use of category 2 verbs: (17.41% compared to 6.34% in type A sentences). This type of increase is not evident in the control group, as 5.58% of all verbs (compared to 5.27% in type A sentences) used by the control children belonged to category 2. A t-test demonstrated that this difference is significant at the 0.05 level: $t = -5.483$, $P = 0.001$. Thus, it seems as if the at-risk children are more likely to omit verbal morphology when the argument structure of the verb increases in complexity than the control children.

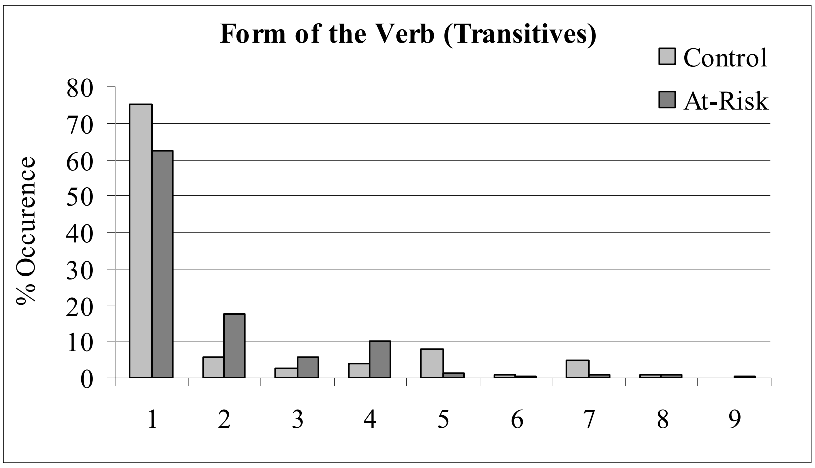


Figure 2. Form of the verb in sentences containing transitive verbs

4.6.4. Violation of morphosyntactic agreement

In section 4.6.3., the performance of the control and the at-risk group with regard to verb use was evaluated. The data provide evidence that the at-risk children use past participle forms just as frequently as the control children, but that they use verb stems and infinitives more often than the control children. However, these results cannot be used to draw conclusions about the children's mastery of the morphosyntactic dependency between the auxiliary and the past participle. As was mentioned in one of the introductory paragraphs, the past participle has to appear with the auxiliary *heeft* in order to satisfy the [+participle] complement features of the auxiliary. The auxiliary *heeft* has to appear with the past participle form of the verb to ensure that a sentence is not tenseless. In order to gain insight into children's understanding of these requirements, it was first calculated how frequently the subjects in both groups used the fully inflected participle form with the auxiliary (producing a grammatical dependency). Secondly, it was calculated how often the past participle was used without the auxiliary *heeft* and how frequently the auxiliary verb was combined with a verb stem or an infinitive (producing ungrammatical dependencies). In the context of this study, the occurrence of bare participles will provide evidence that children (sometimes) consider tense to be optional, while the occurrence of the two other combinations (*heeft + verb stem* and *heeft + infinitive*) will provide evidence that children are not sensitive to the fact that the auxiliary *heeft* selects a past participle form as its verbal complement. In table 10, mean percentages of occurrence are given for the measures *auxiliary + participle*, *bare participle*, *auxiliary + verb stem* and *auxiliary + infinitive*. These means are based on the total amount of responses (i.e. responses to both type A and type B sentences). The occurrence of each of these measures was first calculated separately for each of the ten test items, whereafter a mean occurrence was calculated from these ten totals.

Table 10. Mean percentages of occurrence for grammatical and ungrammatical agreement relations. Between group differences are indicated with the t- and P-values in the last two columns.

Form of the VP	**Control**		**At-Risk**			
	Mean	**(SD)**	**Mean**	**(SD)**	**t-value**	**P-value**
Auxiliary + Participle	58.61	(8.49)	50.02	(10.41)	2.02	.058
Bare Participle	15.48	(4.91)	15.49	(7.12)	-.004	.997
Auxiliary + Verb stem	1.19	(1.93)	2.26	(2.58)	-1.054	.306
Auxiliary+ Infinitive	1.54	(2.74)	3.83	(1.90)	-2.169	.044*

In total, the control group produced 261 utterances of which 154 (59%) were grammatically correct. The at-risk group produced 451 utterances of which 228 (50%) were correct. This difference between the two groups is significant at the .05 level: $\chi^2 = 4.75$, df = 1, p = .0293). Of the total number of verbs used by the control children, 15.48% can be classified as bare participles (i.e. they appeared without the auxiliary *heeft*). The at-risk group used almost exactly as many bare participle forms as the control group, suggesting that the groups are no different from one another with regard to this measure. The combination *heeft + verb stem* appeared slightly more often in the responses of the at-risk children than the control children, but an independent samples t-test indicates this difference is not significant. The occurrence of the combination *heeft* + infinitive was also higher in the at-risk group than in the control group. An independent samples t-test indicates that this difference is significant at the 0.05 level.

4.7. Discussion

The aim of this study was to shed light on three questions. These questions (and their possible answers) will be examined one by one in this discussion. The first research question was:

> (i) Can preschool children at risk for dyslexia be distinguished from control children on the basis of their productive use of the auxiliary *heeft* (*has)* and its complement (i.e the past participle)?

As far as production frequency is concerned, the data provide no evidence that children at risk for dyslexia are any different from normally developing children regarding their use of the auxiliary *heeft* or the past participle form of the verb. Within the experimental set-up used for this study, these forms occur just as often in the utterances of the at-risk children as in the utterances of the control children. This is true for both type A sentences (containing an intransitive verb) and type B sentences (containing a transitive verb). It is possible that the design of the experiment influenced this outcome. Since the experimenter recalled the first event of every movie throughout the entire experiment, the children in effect received ongoing input about the form that they were expected to use. It might be that some children relied strongly on this pattern-like aspect of the experiment to guide them through their responses.[3] The results might have been different if the children were required to recall both the events in any particular movie or if the children were asked to recall the events one by one. These alternative experimental procedures would, however, have caused other difficulties. The first approach was not considered possible because of limitations in the children's working memory: most children found it quite demanding to recall even one event in the sequence. It was therefore not viable to expect children to recall both events; in fact, in the few cases where this happened due to experimenter error the children did not respond at all. The second approach was also not pursued, seeing that it would have been almost impossible to prompt children to use the auxiliary *heeft* and the past participle in such a design. If the children were to recall the events one by one, they had to be prompted with only a question (e.g. *what happened?* or *what did you see?*). The problem with these prompts is that the utterance that follows them does not have to be in the past participle form; in fact, most speakers of Dutch would agree that it is more natural to respond to these questions with an utterance in the simple past tense.[4] The main function of

[3] Spontaneous speech data of the at-risk children would have been helpful in order to investigate this possibility. Unfortunately, such data are not available.

[4] As mentioned before, productive use of the simple past tense starts relatively late (around the age of 4:0) in Dutch children. This makes the fact that the suggested prompts would have

the continuous "input" given by the experimenter was therefore to ensure that the children actually used the forms under investigation, but it cannot be denied that the productive use found in this study may not be representative of the children's true productive abilities. However, a close inspection of the data suggests that the experimental design cannot fully account for the outcome. If children relied exclusively on the input provided by the experimenter, one would not expect to find any utterances containing bare participles. In other words, if the children's utterances were mere imitations of the pattern provided by the experimenter, these imitations should have always included the auxiliary *heeft*. This is clearly not the case. In both the control and the at-risk group, children occasionally produced utterances with no auxiliary. This happened in both type A and type B sentences, suggesting that some children produced bare participles even when the sentence structure could not have been any simpler. The data therefore cannot be a mere reflection of children's ability to imitate; to some extent, it seems to also reflect the children's true productive abilities.

The second research question for this study was:

> (ii) Are preschool children at risk for dyslexia sensitive to the morphosyntactic relationship between the auxiliary *heeft* (*has)* and its complement (i.e the past participle)?

The results from the Chi-Square test indicate that the at-risk children are more likely than the control children to use a verb stem or an infinitive as main verb when the context requires of them to use the past participle. The verb stem and infinitive occurred in two types of responses. Firstly, these forms occurred as main verbs, with a subject NP as specifier, as in *de vrachtwagen bots / botsen*. Secondly, these forms occurred as complement of the auxiliary verb, as in *de vrachtwagen heeft bots / heeft botsen*. Both types of utterances are ungrammatical in Dutch. For the first type of response to be grammatical, the main verb has to be inflected for tense and agreement (it has to carry the features [+present tense; +singular; +3rdperson]). When the verb is not inflected, as is the case with verb stems and infinitives, the resulting utterance is tenseless and therefore ungrammatical. The combined results from the chi-square analyses and the t-tests suggest that the at-risk children were more likely to produce utterances of the type *de vrachtwagen*

stimulated the use of this form perhaps less relevant. However, it is not obvious that children would have responded with the past participle form instead of the simple past tense form. Typically, one would expect the responses to be more varied; with many responses containing a dummy auxiliary (as in *ging botsen*) or the auxiliary *gaat* + the infinitive (as in *gaat botsen*).

bots than the control children.[5] This result can be interpreted as follows: a sub-group of children in the at-risk group is not sensitive to the fact that all constructions must contain a finite (tensed) verb in order to be grammatical. Within language acquisition theory, these children fit the description of children who are in an optional infinitive stage (as suggested by Wexler, 1992, 1994). Note, however, that this behaviour is not unique to the at-risk group. A few control children produced utterances like these as well, but they did so significantly less often than the at-risk group. With regard to the second type of ungrammatical response: neither the verb stem nor the infinitive can be used as complement of auxiliary *heeft*. The head features of these verb forms do not match the [+Participle] complement feature of the auxiliary. Further analysis of the data show that the occurrence of a verb stem as the complement of the auxiliary *heeft* was not higher in the at-risk group than in the control group, but that the at-risk group did use significantly more infinitives in this position. The data thus provide evidence that some children in both groups are insensitive to the fact that the auxiliary *heeft* requires a complement that carries the head features [+participle], but that the proportion of children who are not sensitive to this fact is bigger in the at-risk group than in the control group. Summarizing, some children in both the control and the at-risk group demonstrate unstable knowledge of the morphosyntactic relation between the auxiliary *heeft* and its verbal complement. However, the proportion of these children is slightly bigger in the at-risk group than in the control group.

Interestingly, there is no difference between the groups with regard to their use of bare participles. This finding could indicate that roughly the same proportion of children in both the control and the at-risk group regards tense (sometimes) as optional and that they, as a result, do not produce the auxiliary *heeft*. Alternatively, it could be that these children have not acquired the knowledge that the past participle is a non-finite verb form, which has to be accompanied by a finite verb form. If a child mistakenly judges the past participle to be finite, the use of the auxiliary *heeft* will be redundant in the child's grammar. This interpretation seems plausible: if the proportion of control and at-risk children who regard tense as optional was similar, one would have expected just as many utterances of the type *de vrachtwagen bots / botsen* in the control group as in the at-risk group. The data show that this is not the case.

[5] This assumption follows from the fact that the at-risk children (overall) produced more verb stems than the control children, but they did not use these forms more often in combination with the auxiliary. Thus, they had to use it more often in combination with subject NP.

The final research question in this study was:

> (iii) Does an increased processing load affect the productive use of grammatical morphemes in normally developing children and in children at risk for dyslexia?

In order to answer this question, the children's use of two grammatical morphemes, namely the auxiliary *heeft* and the prefix *ge-* (used for the inflection of the past participle) is considered. The suffix *-t/-de* (also used in the inflection of the past participle) is left out of this discussion, as it is often impossible to discriminate this morpheme from the suffix *–t* (used to mark the third person singular on present tense verbs). The morphemes mentioned appeared in utterances containing an intransitive verb (in terms of processing the less demanding sentence structures) and in sentences containing a transitive verb (in terms of processing the more demanding sentence structures). Recall that in the Bock and Levelt sentence production model, grammatical morphemes could be subject to omission in structures that demand a large amount of processing (i.e. syntactically complex structures). In such structures, grammatical morphemes might be absent from the final output (i.e. the final sentence). In the present study, it is therefore more likely for grammatical morphemes to be omitted from sentences containing a transitive verb than from sentences containing an intransitive verb. The data match this expectation. In utterances containing intransitive verbs, there are no group differences in the production of the auxiliary *heeft* and the verbal prefix *ge-*. At this level of structural complexity, both groups seem to be equally capable in coping with the amount of processing needed to complete the structure in a grammatical way. In utterances containing transitive verbs, the two groups are again highly similar regarding their production of the auxiliary *heeft*. However, the at-risk group is significantly less successful than the control group in producing the verbal prefix *ge-* in this type of sentence. The utterances of the at-risk children do however contain just as many object NP's as the utterances of the control children. Semantically speaking, the object NP carries more information in these sentences than the verbal prefix *ge-*, seeing that it is an argument of the verb. In order to produce a sentence that is semantically acceptable, it is therefore more important to realise all the arguments of the verb than to realise all of the verbal morphology. Thus, it seems to be the case that the at-risk children are forced to make a processing trade-off at this point. In order to produce the object NP, they often have to omit something else, namely the verbal prefix *ge-*.

A question that comes to mind is why the verbal prefix *ge-*, instead of the auxiliary *heeft*, is dropped from the structure. Both are grammatical morphemes and both should be susceptible to omission in the case of a processing limitation. One possible answer is that the prefix *ge-* is an unstressed element; its prosodic weakness might be the reason why it is omitted from the structure. A second possibility is that the auxiliary verb is syntactically more important than the verbal prefix *ge-*, and that children are aware of this fact. Recall that the auxiliary carries the grammatical features of person, number and tense. The omission of the auxiliary from the syntactic structure results in an ungrammatical utterance since the head features on both the subject NP and the past participle remain unchecked. Furthermore, the structure would be “tenseless”, while the requirements of the syntactic system specify that all independent clauses in Dutch require a tensed verb. Omission of the verbal prefix *ge-* technically also leads to an ungrammatical utterance, but one could speculate that checking of the [+participle] features of the verb can still proceed via the suffix *-t/-d* (which almost always remains intact when the verbal prefix *ge-* is dropped from the verb). An argument along these lines would suggest that omitting the verbal prefix *ge-* from the structure violates fewer syntactic rules than dropping the auxiliary and that children intuitively choose to violate as few rules as possible when processing limitations force them to omit something from a syntactic structure.

Thirdly, it could be the case that the omission of the verbal prefix *ge-* saves more of the available processing resources than the omission of the auxiliary *heeft*. Traditional syntactic theories (like Chomsky’s) are not very helpful here, given that the past participle is considered a non-finite verb. It does not move from its base position as it does not carry tense, person or number features that have to be checked off. From this viewpoint, the deletion of the prefix *ge-* does not reduce the number of syntactic moves or checking operations. Pinker’s (1984) suggestion of how children build paradigms could be more useful. Pinker proposes that children first create word specific paradigms. With regard to inflections, word-specific paradigms contain both the stem and the inflectional item. Thus, initially, the (past participle) paradigm for the Dutch verb *botsen* contains six cells and can be represented as follows:

(1)

		NUMBER	
		singular	*plural*
PERSON	*first*	gebotst	gebotst
	second	gebotst	gebotst
	third	gebotst	gebotst

For each new word that a child learns, a new word-specific paradigm is created. Naturally, in time, children’s inflectional systems become productive. Word-specific paradigms change into general paradigms (i.e.

paradigms that contain inflections free of stems. The general paradigm for inflecting the past participle form in Dutch is given in (2):

(2)

		NUMBER	
		singular	*plural*
PERSON	*first*	ge- , -t	ge- , -t
	second	ge- , -t	ge- , -t
	third	ge- , -t	ge- , -t

Closed class items such as articles are initially also learned as word-specific paradigms, where after they are placed in general paradigms. In contrast, auxiliaries remain as entries in word-specific paradigms only. Pinker claims that in this framework, inflected forms such as the verb *gebotst* necessitate computations that uninflected forms or forms that remain in word-specific paradigms don't need. The child has to relate *gebotst* with *botsen* (by assuming that they belong to the same category), has to split the paradigm for *botsen* so that it includes a cell for the past participle and then has to place *gebotst* in this cell. In a child that suffers from a processing limitation, these additional computations can cause production flaws, such as the reduction of an inflected form to its bare-stem equivalent. It is possible that the at-risk children in this study omit *ge- (*in stead of *heeft*) from their productions in order to avoid the additional computations described above. This may well reduce the demand on their processing resources and enable them to (in this case) concentrate on the requirements dictated by the argument structure of the verb.

4.8. Summary

In chapter 4, three hypotheses were investigated. The first hypothesis stated that children at risk of dyslexia are not sensitive to the morphosyntactic relation between the auxiliary *heeft* (*has)* and its complement verb (the past participle). The third hypothesis stated that these children are sensitive to the morphosyntactic relation between these particular morphemes, but that this sensitivity is subject to processing demands. The experimental data gathered in this chapter provide evidence that children at risk for dyslexia are just as capable as normally developing children to produce the auxiliary *heeft* (*has)* and the past participle form of the verb. However, in situations where children fail to use the past participle form of the verb, the two groups use different strategies in order to complete a sentence. The control group generally opt for grammatical verb forms, forming grammatical utterances, while the at-risk children often uses ungrammatical verb forms (i.e. the stem or the infinitive), resulting in ungrammatical utterances. Furthermore, the at-risk children used significantly more infinitives in the complement position of the auxiliary verb *heeft* than the control children. This result suggests that the number of children who have an unstable grammatical representation of the morphosyntactic dependency under discussion is larger in the at-risk group than in the control group. Finally, the performance of the at-risk children is affected more than that of the control children when the task at hand requires a large amount of processing. Specifically, in sentences containing a verb with a complex argument structure, the at-risk children more frequently omitted verbal morphology and produced more ungrammatical utterances. Taken together, the results provide some evidence for accepting hypothesis a, but the evidence in favour of hypothesis c seem even stronger. Children at risk for dyslexia can use the past participle construction productively. However, an increased processing load influences their productive abilities negatively.

Chapter 5

The role of argument structure and working memory in the production of closed class items

A mentioned before, one of the main characteristics of children with SLI is their extraordinary problems with grammatical morphology. Most of the research conducted within the field of SLI has concentrated on this characteristic. However, these children do exhibit other (less familiar) characteristics. Some of these, including difficulties with phonology and working memory, have been studied quite extensively. Others, like problems with verb argument structure have not attracted the same amount of interest. Preliminary evidence (Grela, 2003; Grela & Leonard, 2000; de Jong, 1999) indicates that argument structure complexity does present children with SLI with a challenge. In chapter 4, argument structure complexity has been introduced as a possible factor influencing the production of grammatical morphemes. However, a potential problem in examining argument-structure complexity effects is that the more complex the argument structure of a verb, the greater the length of a sentence. For this reason, research outcomes attributed to complexity might be the result of increased sentence length demands. This dilemma forms the basis of the experiments conducted in chapter 5.

5.1. Outline of this chapter

This chapter has a two-fold character. In part one, argument structure complexity and its role in the perception and production of function words is discussed. In part two, research outcomes of part one are re-interpreted in light of additional information. Specifically, the possible influence of phonological working memory on the results as described in part one is assessed. The theoretical background, research questions, experimental design and results of part one and part two are introduced separately

Part One

5.2. Some background notes on verb argument structure

Traditionally, propositions (i.e. the semantic counterpart of simple clauses) are thought to comprise a predicate and a set of arguments (Radford, 1997). Predicates typically express activities or events, while arguments express the participant(s) in the relevant activity or event. The structure that surrounds the predicate (verb) can be described in syntactic as well as semantic terms. In syntactic terms, arguments are often noun phrases (NP's) and they fill the positions of the subject and the complement in a sentence.[1] For example, the verb *cook* requires two arguments; one that involves the entity *doing the cooking* and one that involves *whatever is cooked*. Thus, in the sentence *Peter cooked spaghetti* (example taken from Cook & Newson, 1996) the subject-NP *Peter* is the entity doing the cooking and the object-NP *spaghetti* is what is being cooked. Verbs differ with regard to the number of arguments that they require. The verb *die,* for instance, requires only one argument (as in *The policeman died)* whereas *arrest* requires two arguments (as in *The policeman arrested the criminal*) and *put* requires three arguments (as in *The policeman puts the criminal in jail*). Verbs that have a single argument are known as one-place predicates (or intransitive verbs), verbs that have two arguments are called two-place predicates (or transitive verbs) and verbs that select three arguments are known as three-place predicates (or ditransitive verbs).[2]

In semantic terms, the relation of an argument with respect to the predicate is described by the thematic structure. Each of the arguments of a verb fulfills a specific semantic role. These semantic roles are known as thematic roles (abbreviated as θ-roles). Well-known θ-roles include THEME, AGENT, RECIPIENT and GOAL.[3] Using these terms, the thematic roles in the sentence *The policeman arrested the criminal* are as follows: the argument *the policeman* is the agent while the argument *the criminal* is the theme. These θ-roles have to be mapped onto syntactic categories (i.e. they have to receive a syntactic function). Pinker (1989) states that this mapping process is accomplished through *linking rules*. Pinker assumes that thematic roles and syntactic functions exist in interrelated hierarchies, as in (1):

(1) Thematic roles: Agent, Theme, Location/Goal/Source
Syntactic functions: Subject, Object, Oblique Object[4]

The speaker first identifies the agent argument of the verb. The agent, first in the hierarchy of θ-roles, is then linked to the first syntactic function in the

[1] In X-bar theory, the complements of a verb are situated inside V-bar while the subject of a verb is situated ouside V-bar. For this reason, the complement(s) is said to be the **internal** argument(s) of a verb and the subject is said to be the **external** argument of a verb.

[2] Note however, that the same verb can have more than one possible argument structure. For instance, in *Peter cooked spaghetti* the verb *cook* is a two-place predicate. In *Peter was cooking all afternoon*, *cook* is a one-place agument (*all afternoon* being an adjunct). This is known as alternation.

[3] The term THEME is traditionally used to refer to the entity undergoing some action, AGENT is refers to the instigator of some action, RECIPIENT refers to an entity receiving some entity and GOAL refers to an entity towards which something moves.

[4] Pinker (1989) notes that there is disagreement on the particular order within these hierarchies past the first item.

syntactic functions hierarchy (the subject). The linking of further θ-roles to syntactic functions obeys the same linking rules.[5]
Some of the expressions associated with the predicate of a sentence are not obligatory arguments. Such expressions are known as adjuncts. Consider the sentences in (2):

(2a) The man is kissing the woman.
(2b) The man is kissing the woman in the barn

In (1b) the PP *in the barn* is an adjunct, since the argument structure for the verb *kiss* does not require a location. Adjuncts are *optional modifiers* of a sentence, as they do not provide syntactic or semantic information that is required by the verb. Thus, although adjuncts do provide additional information about the event described by a predicate, they do not contribute to the complexity of a verb's argument structure.

5.3. The acquisition of argument structure

In order to master the verb argument structure of her native tongue, a child has to (i) learn the relations of arguments to a verb, and (ii) learn how those arguments can be used in valid expressions. This is a complex task. Even so, children acquire the argument structure of common verbs quite early.[6] Furthermore, children are able to produce novel utterances that obey the mapping of arguments to the syntactic positions of their language, showing that they grasp argument structure regularities (Demuth et al., 2002; MacWhinney, 1995). This ability occasionally leads to overgeneralizations. For example, intransitive-only verbs (like *fall)* are sometimes used in a transitive construction, as in *Adam fall toy* (taken from MacWhinney, 1995). This is not an arbitrary error, but a generalization of the association between causative action and transitive form, to an intransitive action verb. The acquisition of argument structure thus exhibits the same U-shaped learning curve seen in other areas of language learning: correct use of a verb may be

[5] Pinker's account of how θ-roles are mapped onto syntactic categories is called canonical mapping, since it occurs in the absence of information to the contrary. Mapping can also be non-canonical, as is the case in passive constructions and in construction where dative shift occurs.
[6] Learning in this domain has been suggested to rely on rich innate knowledge of argument structure regularities (Pinker, 1989). However, recent psycholinguistic evidence has questioned this assumption, and a number of usage-based proposals have argued that children learn such regularities from the input alone (Bowerman, 1982; Akhtar, 1999; Tomasello, 2000; Demuth et al., 2002). In support of this view is evidence that children initially learn verb-argument patterns on an item-by-item (verb-by-verb) basis, before forming a conceptualization of more general syntactic structures (Tomasello, 2000).

followed by a period containing incorrect (overgeneralized) usages, where after the child shows adult behaviour.

Linking rules (as described in paragraph 2.5.) have implications for acquisition. How does a child come to understand the relationship between, for example, an agent and a subject? The literature offers two possible explanations. The first explanation (Pinker, 1989) favors a process of *semantic bootstrapping*, arguing that the child uses semantic roles as cues for learning syntactic categories. The second explanation (Gleitman, 1990) favors a process of *syntactic bootstrapping*, arguing that the child uses the syntactic categories as a framework for interpreting thematic roles. While theorists generally agree that semantic and syntactic bootstrapping are not mutually exclusive processes and that the child has both resources available, there is still disagreement about the relative importance of these processes in learning about the association between θ-roles and arguments.

5.4. Argument structure in sentence processing and production

Most psycholinguists studying language production presume that linguistic theory (as proposed by formal linguists) represents the knowledge that speakers consult when they create utterances (Bock, 1995). The psycholinguist's task, then, is to suggest models of how this knowledge is employed. Most utterances (equivalent to a sentence) typically consist of a combination of a verb, its arguments, and any optional modifiers. It seems obvious that any sentence production model should describe the role of verb argument structure in sentence production. In fact, the connection between verb, sentence form and sentence meaning has been one of the most important aspects of psycholinguistic models describing sentence processing.

Argument structure is thought to play a significant role in both sentence comprehension and sentence production. Studies on sentence comprehension have (for example) shown that the on-line processing of ambiguous sentences is affected by verb-specific statistical preferences for particular argument structures (Garnsey et al., 1997; Trueswell et al., 1993). Lexicalist models of sentence comprehension (Boland & Boehm-Jernigan, 1998; Juliano & Tanenhaus, 1994; MacDonald, Pearlmutter & Seidenberg, 1994) capture the effects of argument structure biases by assuming that argument structures are probabilistically associated with the lexical representation of verbs, and are available as soon as the verb is recognized.

With regard to sentence production, argument structure complexity is thought to affect the amount of processing resources needed in order to successfully produce a sentence. Argument-structure complexity refers to the number and kinds of structural information arrayed alongside a verb in its lexical entry. Sentences containing intransitive verbs (i.e. one-place predicates) are less complex than sentences with transitive verbs (two-place predicates), and both these types of sentences are less complex than sentences with ditransitive verbs (three-place predicates).[7] Evidence for this claim comes from studies showing that argument-structure complexity affects the amount of time needed to process the information in a sentence. In an experiment by Shapiro et al. (1987), for example, adults listened to sentences that differed with regard to their argument structure. After hearing a sentence, subjects had to indicate whether a string of letters presented on a computer screen was a word or a nonsense word. Shapiro et al. found that the subjects' reaction times increased as argument-structure complexity increased. In a more recent event-related potentials (ERP) study, Rubin, Newhoff, Peach and Shapiro (1996) replicated this finding when they were able to associate greater argument-structure complexity with an increased amplitude of the P300 component. They stated that the higher P300 amplitudes suggested an increased processing load for more complex verbs.

The question remains exactly how argument structure complexity influences the production of a sentence. To answer this question, it is useful to first explain the mechanisms that feature in the majority of current sentence production models. Over the years, leading theories of syntactic production included mechanisms for creating syntactic phrases, assigning grammatical functions to those phrases, and determining left-to-right order (Fromkin, 1971; Garrett, 1976,; Bock & Levelt, 1994). The typical design (see Bock & Levelt, 1994) uses two levels of processing to accomplish syntactic encoding in production. These are usually referred to as the *functional* and *positional* levels of processing. At the functional level, lemmas are selected and assigned grammatical roles such as subject and object (lemmas are the representations of words' syntactic and semantic aspects in the mental lexicon). Faulty processing at this stage could lead to an utterance like *I left my briefcase in my notebook,* where the lemmas for *briefcase* and *notebook* were accessed but their roles were assigned incorrectly. At the positional level, word forms (the phonological versions of words) are assigned to their linear position in the sentence.

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[7] Note however, that this assumption does not tell the whole truth about verbs. Some verbs can alternate their argument structure, meaning that the same verb can occur in different syntactic frames and thus contain different argument structures (Pinker, 1989). According to Shapiro et al. (1998), verbs that can allow two possible argument structures are representationally more complex than verbs that can allow only one argument structure since it takes more processing resources to activate a verb with multiple argument structures relative to a verb with a single argument structure. Thus, when an intransitve verb like *eat (*which can also be used in a transitive frame) is used in its intransitive frame, it is more complex than some other intransitive verb (like *work*) that can allow only one argument structure.

In older models (like the one by Garrett, 1976), the speaker are assumed to access pre-stored syntactic frames at the positional level; words are then inserted into these frames. Such a frame has open slots for the lemmas, but the closed class items needed for a sentence are an intrinsic part of the frame. Thus, for the phrase *in my notebook*, the frame would consist of the items *in* and *my*, and a slot for *notebook* (if the noun had been plural, the plural morpheme would have been present as well). Because closed class items are an intrinsic part of the syntactic frame in Garrett's model they cannot move. An error such as *it waits to pay* is therefore seen as the result of word forms that were assigned to the wrong locations. The notion that positional level syntactic frames include closed class items has been challenged. Stemberger (1985) detected the occurrence of inflectional exchanges, which should not be possible according to Garrett design (i.e. because inflections are intrinsic parts of the frame, it should not be possible for them to move). In a syntactic priming study, Bock (1989) found that positional level frames with different prepositions (a type of function word) were interchangeable, indicating that they are not necessarily part of the frame. Hence, the position of closed class items has been adapted in more recent sentence production models.

An example of such a model is the one by Bock and Levelt (1994; see also Bock, 1995). Their model includes three main parts: a message level component, a grammatical component and a phonological component. A slightly adapted version of this model (taken from Leonard, 1998) is schematically presented in figure 1.

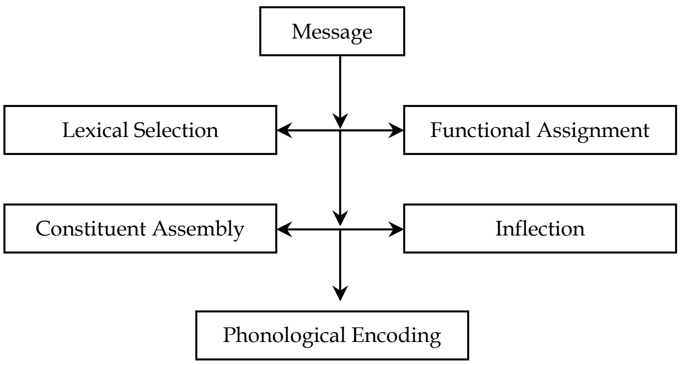

Figure 1. An adaptation of the sentence production model by Bock & Levelt (1994).

At the message level component the semantic intention behind an utterance is developed. The syntactic structure is encoded in the grammatical component and the sound of the utterance is created in the phonological component. The grammatical component has two distinct subparts: a module where functional processing takes place and a module where positional processing occurs. In the former module, the selection of lemmas occurs alongside the assignment of functional roles (i.e. establishment of grammatical roles such as subject and object). Importantly, it is at this stage that argument structure complexity is thought to play a significant role. The more complex the verb-lemma (the greater the number of arguments it requires), the longer the process of functional assignment will take to complete. The idea is that a sentence with ditransitive verb will take longer to compute and that it will use more of the available processing resources than an intransitive verb.

In the second module of the grammatical component, a syntactic frame that is compatible with the lemmas is retrieved. The lemmas are assembled into phrases and the closed class items (i.e. function words and grammatical morphemes) needed for the syntactic frame are retrieved from a separate lexical store and inserted. Importantly, these steps do not occur in isolation from one another; rather, they occur incrementally. One process is assumed to begin while the previous process is still in operation.

The final step in the production of a sentence occurs in the phonological component, when the different elements of the sentence are integrated into a prosodic structure. Following the Bock & Levelt model, theorists (e.g. Leonard, 1998) suggested that slow and/or deficient processing in children with SLI could lead to a struggle between completing the final steps of the grammatical component of the sentence production model and continuing with the actual production of the sentence. This may well be true in complex sentences (i.e. sentences containing a ditransitive verb) where the available processing resources might have been exhausted during the process of functional role assignment. The assumption is that when this happens, the child does not have sufficient recourses left to complete the final steps of the grammatical component and thus produces a sentence that misses function words and/or grammatical morphemes.

5.5. Argument structure in Specific Language Impairment

Previous studies have suggested that children with SLI do not master argument structure as efficiently as normally developing children.

In a case study of an eight-year-old boy, Fletcher (1992) found that even though the child understood verbs' argument structures, he could not produce them appropriately. For example, when using the verb *cut,* the boy omitted the theme theta-role required by *cut,* producing utterances such as *cut the knife* and *daddy cuts the knife.* In another study, Fletcher (1997) found that children with SLI were more likely to omit obligatory arguments when more complex verbs were used to describe an action than a control group. According to Fletcher, the thematic structure of a verb interacted with the SLI subjects' ability to form syntactic structures.

In their study of 3 children with SLI, Rice and Bode (1993) also found evidence of argument structure errors. In what they called 'transitivity errors', children sometimes omitted an obligatory object.

De Jong (1999) investigated spontaneous speech samples for complexity of verb complements and found that Dutch children with SLI were better at using verbs that required a simple argument structure. The SLI group produced fewer verbs that required more than one internal argument than the control children. De Jong (1999) also conducted an experimental study in which he elicited sentences with varying arguments structures from children with SLI. De Jong (1999: 160) summarizes the results of his experiment as follows: "Children with language impairment prefer to express the verbs' thematic structure in a simple argument structure. They produce many instances of bare verbs, even when the verbs are transitive. It is not clear whether this is caused by a superficial economy in the output…or by an uncertainty about the requirements of transitivity…". De Jong further notes that the SLI group preferred monotransitivity to ditransitivity and that this occasionally leads to violations of subcategorization constraints.

Of specific importance for this dissertation is a study by Grela and Leonard (2000). They examined the influence of argument structure complexity on the use of auxiliary *be* verbs in children with SLI and in normally developing children. They argued that within the framework of current sentence production models (e.g. Bock & Levelt, 1994), argument structure complexity should have an influence on the use of the auxiliary *be* forms. Specifically, verbs requiring a larger number of arguments should cause fewer auxiliaries to be used. Grela & Leonard found that the production of auxiliary *be* forms indeed varies as a function of argument-structure type. In the productions of the SLI group, auxiliary *be* forms were omitted more frequently in sentences with ditransitive verbs than in sentences with intransitive or transitive verbs. The authors furthermore controlled for the possibility that the increased *length* of sentences with more complex argument structures (and not the argument structure complexity itself) was responsible for this outcome. They elicited sentences from the children that contained adjuncts at each argument structure complexity level (see again the examples in (2)). A difference in production between (2a) and (2b) would indicate that linguistic complexity is (also) a function of sentence length. However, no length effect was found. The researchers noted that length might have played some role: the longest sentences in the study were ditransitives with adjuncts and these were the sentences that were associated with the greatest number of auxiliary omissions. However, length was not relevant for sentences up to eight words. For both intransitives and transitives, auxiliary omissions were not consistently higher in the adjunct than in the non-adjunct condition.

Grela & Leonard (2000) found additional signs of argument structure effects in children's productions. The SLI group and MLU controls more often omitted sentence elements (other than auxiliaries) when attempting constructions with ditransitive verbs. This was a surprising discovery, since spontaneous language data of the children revealed mastery levels for the elements in question (articles and the progressive *–ing*). Usually, processing limitations affects elements that are not fully mastered by children. Furthermore, Bock & Levelt's sentence production model predicts that the sentence elements most vulnerable to processing capacity constraints are those completed latest in the sentence generation process. Lexical items, arguments and inflections are presumably retrieved before function words such as auxiliaries.

5.6. Intermediate summary

Summarizing, several studies have indicated that children with SLI do not control argument structure as well as normally developing children. Most of these studies focused on children's ability to produce the arguments required by a verb. The influence of argument structure complexity on the production of other elements (e.g. grammatical morphemes) of the sentence has not been investigated very often. Given the framework of existing sentence production models, grammatical morphemes are at-risk of being omitted in constructions that contain a verb with a complex argument structure.

In this chapter, the effects of argument structure complexity on children's production of closed class items were studied in three groups of Dutch children, namely children at-risk for dyslexia, children with SLI and normally developing children. The main purpose of this study was to establish whether argument structure complexity has an influence on the production of closed class items in children at-risk for dyslexia. In contrast to SLI, argument structure complexity effects have not been studied in developmental dyslexia. A secondary purpose of the experiments conducted in this chapter was to replicate the findings Grela & Leonard (2000) in a language other than English. Using the sentence production model of Bock & Levelt as reference point, the main prediction of this study is that the more complex the argument structure of a sentence, the more likely children would be to omit closed class items (such as auxiliaries, determiners and verbal affixes) from their final productions.

5.7. Research questions (i) - (ii): part one

The above discussion leads to the following research questions:

> (i) Does verb argument structure complexity affect the ability of Dutch children at risk for dyslexia and of Dutch children with SLI to perceive and produce closed class items?
>
> (ii) Does sentence length affect the ability of Dutch children at risk for dyslexia and of Dutch children with SLI to perceive and produce closed class items?

Questions (i)-(ii) were addressed in experiment 1, using a sentence imitation task. Given the age of the subjects (especially of the SLI subjects), it was believed that an imitation task would yield more usable data than a production task. In line with previous studies, the prediction is that argument structure complexity should have an influence on the use of closed class items by children with SLI. Assuming that SLI and dyslexia are related disorders, the at-risk children should experience similar problems as the children with SLI.

Experiment 1

5.8. Method

5.8.1. Subjects

The three groups from the toddler cohort participated in this study. The control group consisted of 28 children (15 male; 13 female) with a mean age of 3;11. The at-risk group consisted of 49 children (33 male; 16 female) with a mean age of 3;10. The group of SLI subjects included 24 children (23 male, 1 female) with a mean age of 4;3. A one-way ANOVA (significance level set at .05) indicated that there was a significant difference in the average ages of the three groups ($F_{[2,98]} = 12.49$, $p < .00$). A Tukey HSD showed that the control and at-risk groups did not differ with respect to their ages, but that the SLI group was significantly older than the other two groups (SE = 1.14; p = .011). Data from subjects who failed to imitate at least two sentences in each of the six conditions were excluded from the final analysis (6 control children, 13 at-risk children and 3 children with SLI).

5.8.2. Stimulus Material

The stimuli consisted of six different sentence types. The sentences differed with regard to their verb category and length and are outlined in table 1.

Table 1. Overview of the sentences used in the stimulus material

Sentence Type	*Verb category*
Type 1	Intransitive verb
Type 2	Intransitive verb, with an adjunct
Type 3	Transitive verb
Type 4	Transitive verb, with an adjunct
Type 5	Ditransitive verb
Type 6	Ditransitive verb, with an adjunct

For each sentence type, three sentences were constructed, resulting in a set of 18 target sentences. The intransitive verbs *fietsen (to cycle)*, *rennen (to run)* and *werken (to work)* were used in sentence types 1 and 2. The transitive verbs *kopen (to buy)*, *bouwen (to build)* and *maken (to make)* were used in type 3 and 4 sentences. The ditransitive verbs *zetten (to put)*, *leggen (to lay)* and *scheppen (to scoop)* were used in sentence types 5 and 6. Type 2 sentences were of similar length as type 3 sentences, but their argument structure was less complex. The same holds for type 4 and 5 sentences; they are identical in length but not in argument structure complexity. The format of the sentences was controlled: each sentence had a NP (article + noun) in subject position, followed by the auxiliary verb *heeft* and the remaining arguments/adjuncts. The past participle form of the main verb was always in the final sentence position. To control for overall sentence complexity, all the obligatory arguments consisted of a NP (article + noun) or a PP (preposition + article + noun). All nouns and prepositions in the stimulus sentences were monosyllabic (i.e. *kind, koe, hond, poes, man, aan*, *in* ect.). Adjuncts always consisted of a PP (preposition + article + noun). Care was taken to avoid any structural complexity that was not related to the grammatical factor being tested. For example, only familiar nouns were used in the different NP's, as an unfamiliar NP referent can make a stimulus sentence cognitively more complex. The stimuli were recorded onto a DAT-recorder by a female native speaker of Dutch. This was done in order to assure that all subjects heard the same version of the sentences.[8] After recording, the sentences were edited with computer software (GIPOS) and burned onto compact disc. The stimulus sentences used in the imitation task are given in appendix D.

[8] Six people were responsible for the experimental sessions during which this task was conducted. As these experimenters all have different accents, it was decided to pre-record the sentences and to present them via a CD-player.

5.8.3. Design and procedure

The data for this study were gathered by means of elicited imitation (i.e. a sentence imitation task). The rationale behind this type of task is that in order for the child to imitate a specific structure, the structure must be part of the child's grammatical competence (Lust, Flynn & Foley, 1998). The test phase was preceded by a training phases. The three training items were fairly short and structurally distinct from the test items. The reason for this was to ensure that all subject attempted imitation during the training phase. Two stimuli lists (version A and version B) were created; both included the same 18 test items, but in different random order. This was done with the aim of controlling for the possible influence of order on the research outcome. Whether version A or B was presented to a child was a matter of chance, but care was taken to ensure that roughly the same number of subjects in each of the three groups was tested on both versions.

At the beginning of the task, the experimenter introduced the child to a toy robot. The child was then told that the toy robot could talk; where after the robot started a "conversation" with the child. The robot told the child her name, inquired about the child's name and asked the child whether he/she wanted to play a game with her. The experimenter explained that the game was to repeat every sentence that the robot spoke exactly the way she said it. The robot "spoke" by means of two hidden speakers that were connected to a portable CD-player. The CD-player was operated by the experimenter. During the training phase, subjects were allowed to get used to the "game". Pre-training was also used to break any response strategy (e.g. repeating only the last word). Coaching children (e.g. providing a missing word) was acceptable during the training phase and the training items were repeated as often as necessary for the child to start imitating sentences. During the test phase, children were not coached in any way. However, if a child did not respond or repeated only one word, the robot repeated the stimulus sentence one more time. If a child then still repeated only part of the sentence, this was accepted as answer. In cases where a child became distracted, testing was often broken up into shorter segments. The child's responses were recorded onto a DAT-tape for later transcription.

5.8.4. Scoring and reliability

After transcription, every imitation was examined for the presence or absence of particular sentence parts. For example, it was counted how often a child omitted the auxiliary verb, the main verb and verbal morphology. Other sentence parts that were scored for their presence or absence are the obligatory and optional argument and determiners. In each of the three groups, ten percent of the recordings were re-transcribed and re-scored for the purposes of a reliability check. Reliability was high, in 92% of the cases the original transcription and scoring were the same as the second transcription and scoring. Moreover, most differences that did emerge in the transcription were not crucial for the outcome of the study (for example, it was not important for the outcome of this study whether a determiner was realized correctly, but only if it was realized).

5.8.5. Data analysis

A mean percentage of omission was calculated for each individual subject for the following dependent variables: *auxiliary verb omission*; *ge- omission*; *determiner omission* and *subject omission*. *Argument structure* and *length* (within-subjects) and *group* (between subjects) were considered to be independent variables. The independent variables *argument structure* contained three levels in the analysis i.e. intransitive, transitive and ditransitive. Likewise, the independent variable *length* had three levels in the analysis, namely intransitive with adjunct, transitive with adjunct and ditransitive with adjunct. Each of the dependent variables was examined separately in a mixed model analysis of variance (ANOVA). Mauchly's test of sphericity was conducted for each of the ANOVA's. In all cases where Mauchly's W resulted in a significant p-value, Huynh-Feldt corrections were applied. The level of significance was set at 0.05 throughout the analysis. The Tukey HSD test was used for post hoc testing in cases where one or both of the main effects were significant.

5.9. Results

The mean percentages omission (per sentence type) and standard deviations for the dependent variables *auxiliary verb omission*, *ge-omission* and *determiner omission* are given in table 2. For each of these variables, the same general pattern emerges. The control group has the lowest omission score, the SLI group has the highest omission score and the score of the at-risk group lies somewhere in between the other two groups. In the following sections, the results are discussed separately for each of the dependent variables.

5.9.1. Auxiliary verb omission

A mixed model ANOVA with group as between-subjects factor and verb argument structure as within-subjects factor revealed that both group ($F_{(2, 98)} = 7.82$, $p = .001$) and argument structure ($F_{(1.8, 183.5)} = 16.9$, $p < .000$) had a significant effect on auxiliary verb omission. An interaction between group and argument structure ($F_{(3.75, 183.5)} = 3.37$), $p = .013$) was also found. Post hoc testing indicated that the mean percentage of auxiliary verb omission was

Table 2. Mean percentages of omission of closed class items per sentence type.

Measure	Group	Intransitive		Intransitive + Adjunct	
		Mean	SD	Mean	SD
Auxiliary omission	Control	0	*(0)*	11.9	*(24.36)*
	At-risk	12.92	*(27.06)*	29.59	*(36.63)*
	SLI	21.53	*(35.6)*	50	*(40.53)*
ge- omission	Control	0	*(0)*	0	*(0)*
	At-risk	12.24	*(25.18)*	9.18	*(24.78)*
	SLI	26.38	*(32.57)*	32.64	*(34.93)*
Determiner omission	Control	14.28	*(29.3)*	19.95	*(25.49)*
	At-risk	34.01	*(40.54)*	33.84	*(36.5)*
	SLI	63.20	*(42.84)*	63.2	*(38.06)*
		Transitive		**Transitive + Adjunct**	
		Mean	SD	Mean	SD
Auxiliary omission	Control	7.14	*(18.94)*	15.48	*(33.31)*
	At-risk	15.31	*(30.02)*	33.33	*(41.39)*
	SLI	43.75	*(44.46)*	55.56	*(44.69)*
ge- omission	Control	1.19	*(6.29)*	1.19	*(6.29)*
	At-risk	10.88	*(28.37)*	10.54	*(26.94)*
	SLI	31.25	*(38.17)*	25.69	*(36.11)*
Determiner omission	Control	9.53	*(20.5)*	20.23	*(26.2)*
	At-risk	28.06	*(32.39)*	34.01	*(34.9)*
	SLI	53.83	*(35.94)*	59.95	*(32.24)*
		Ditransitive		**Ditransitive + Adjunct**	
		Mean	SD	Mean	SD
Auxiliary omission	Control	9.52	*(23.76)*	19.05	*(35.64)*
	At-risk	32.31	*(43.09)*	39.80	*(43.81)*
	SLI	42.36	*(37.11)*	54.17	*(36.21)*
ge- omission	Control	2.38	*(8.73)*	1.19	*(6.29)*
	At-risk	9.52	*(27.22)*	14.62	*(26.49)*
	SLI	33.34	*(42.85)*	29.17	*(39.70)*
Determiner omission	Control	16.77	*(22.91)*	35.04	*(25.36)*
	At-risk	36.81	*(30.7)*	50.85	*(25.63)*
	SLI	57.46	*(29.58)*	69.67	*(21.66)*

significantly higher in the SLI group than in the control group ($p < .000$, SE = 7.67) while the mean difference in the percentage of auxiliary verb omission between the control and at-risk group was approaching significance ($p = .07$, SE = 6.53). In all three groups, subjects were most likely to omit the auxiliary verb in sentences containing a ditransitive verb. However, post hoc testing shows no significant effect of argument structure on the omission of the auxiliary verb in the control group or in the SLI group. In contrast, the at-risk group omitted significantly more auxiliary verbs in sentences containing a ditransitive verb than in sentences containing an intransitive verb ($p = .015$, SE = 6.89) or a transitive verb ($p = .039$, SE = 6.89). There were no differences between the percentage of auxiliary verb omission in the intransitive and transitive conditions.

A mixed model ANOVA with group as between-subjects factor and sentence length as within-subjects factor found no interaction between group and length. Furthermore, length had no significant effect on the percentage of auxiliary omission. A significant main effect for group was established ($F_{(2, 98)} = 7.903$, $p < .001$). Post hoc testing reveals that the percentage of auxiliary verb omission was significantly higher in SLI group than in the control group ($p < .000$, SE = 9.51). The at-risk group also omitted more auxiliaries than the control group; the mean difference between these groups was approaching significance ($p = .058$, SE = 8.10).

5.9.2. ge- omission

A significant main effect for group ($F_{(2, 98)} = 11.259$, $p < .000$) was found in the mixed model ANOVA with *ge-* omission as dependent variable and argument structure as within-subjects variable. Post hoc testing revealed that the SLI group differed significantly from the other two groups, the former group omitted the prefix *ge-* significantly more often than the control group ($p < .000$, SE = 6.24) and significantly more often than the at-risk group ($p = .002$, SE = 5.59). No group difference was observed between the control group and the at-risk group. The omission of *ge-* was not influenced significantly by verb argument structure and no interaction between group and argument structure was found. Likewise, the analysis with group as between-subjects factor and sentence length as within-subjects factor found a significant main effect for group ($F_{(2, 98)} = 10.61$, $p < .000$), but no significant effect for sentence length and no significant interaction between group and length. Again, post hoc testing showed that the SLI group omitted the prefix *ge-* significantly more often than the other two groups: SLI – control: $p < .000$, SE = 6.2 and SLI – at-risk: $p = .005$, SE = 5.56.

5.9.3. Determiner omission

A significant main effect for group ($F_{(2, 98)} = 14.46$, $p < .000$) and a significant main effect for argument structure ($F_{(1.8, 179)} = 4.95$, $p = .010$) was found in the mixed model ANOVA with determiner omission as dependent variable. There was no interaction between group and argument structure. A Tukey HSD indicated that the mean percentage of determiner omission was significantly different between the three groups: the at-risk group omitted significantly more determiners than the control group ($p = .019$, SE = 7.07) while the SLI group had a higher percentage of determiner omission than both the control and the at-risk groups ($p < .000$, SE = 8.3 and $p = .003$, SE = 7.44). A mixed model ANOVA with sentence length as within-subjects factor illustrated that both group ($F_{(2, 98)} = 12.59$, $p < .000$) and length ($F_{(2, 196)} = 26.9$, $p < .000$) had a significant main effect on determiner omission in sentences where length was manipulated by adding an adjunct. No interaction between the main effects was found. A Tukey HSD indicated that the SLI group omitted significantly more determiners than the other two groups (SLI - control: $p < .000$, SE = 7.87; SLI - at-risk: $p = .002$, SE = 7.05). Sentence length had no significant effect on the omission of determiners in the control and SLI groups, but it significantly affected the omission rate of determiners in the at-risk children. The at-risk subjects omitted significantly more determiners in sentences containing a ditransitive verb and an adjunct than in sentences containing an intransitive verb with an adjunct or a transitive verb with an adjunct.

5.9.4. Subject omission

The mean percentages of subject omission and standard deviations are displayed in table 3.

Table 3. Mean percentages of omission of the subject NP per sentence type

Group	**Intransitive**		**Intransitive +Adjunct**	
	Mean	SD	Mean	SD
Control	0	*(0)*	8.33	*(19.51)*
At-risk	4.08	*(16.16)*	21.09	*(30.77)*
SLI	5.55	*(12.68)*	24.3	*(33.69)*
	Transitive		**Transitive + Adjunct**	
	Mean	SD	Mean	SD
Control	8.33	*(23.35)*	13.10	*(27.73)*
At-risk	12.24	*(27.8)*	23.47	*(35.02)*
SLI	18.05	*(31.05)*	34.73	*(39.01)*
	Ditransitive		**Ditransitive + Adjunct**	
	Mean	SD	Mean	SD
Control	11.31	*(26.47)*	17.86	*(36.830*
At-risk	28.23	*(39.41)*	28.91	*(35.97)*
SLI	24.3	*(36.44)*	32.64	*(35.85)*

a Mixed model ANOVA with subject omission as dependent variable and group (between-subjects) and argument structure (within-subjects) as independent variables revealed a significant main effect for argument structure complexity ($F_{(1.9,\ 186.6)} = 16.831$, $p < .000$) but no main effect for group ($F_{(2,\ 98)} = 1.79$, $p = .172$). There was no interaction between group and argument structure ($F_{(3.8186.6)} = 1.26$, $p = .289$). Post hoc testing showed that subject omission did not differ significantly as a function of argument structure in the control and in the SLI groups. The at-risk group, however, omitted significantly more subjects in the ditransitive condition than in the other two conditions. The same scenario arose in the analysis with length as within-subjects variable. A significant main effect was found for length ($F_{(2,196)} = 4.98$, $p < .008$) but not for group ($F_{(2,\ 98)} = 2.37$, $p = .099$). There was no interaction between length and group. Post hoc testing showed that sentence length did not significantly effect subject omission in the control and SLI children, but that the at-risk children omitted significantly more subjects in sentences containing a ditransitive and an adjunct than in the other two sentence types.

Part two

5.10. Structural complexity versus length: the role of short-term memory capacity

The ability to imitate sentences is not only influenced by the structural complexity of a sentence, but also by a person's ability to retain a sentence in his/her short-term memory. This ability differs from one individual to the next and is heavily influenced by the length of the sentence that is to be retained. Complex sentences are generally longer than simple ones; and thus harder to process and to remember. Individuals with good short-term memory abilities will be better at imitating sentences. Several researchers have investigated the role of short-term memory in language processing. In what follows, an overview is given of the study of short-term memory in normal language development, in SLI and in developmental dyslexia.

5.11. The role of short-term memory in language development

5.11.1. The working memory model

The most influential model of short-term memory, the working memory model, was developed by Baddeley (1986; 1996). This model is believed to be closely involved in general cognitive functioning and it comprises three distinct components (the central executive, the phonological loop and the visual spatial sketchpad). The central executive is a limited capacity system that provides an interface with information stored in long-term memory. Furthermore, it controls the processing of the two sub-systems i.e. the phonological loop and the visual spatial sketchpad. The sub systems are employed in specific information processing domains: the phonological loop in the verbal domain and the visual-spatial sketchpad in the visual-spatial domain. Neurological correlates of the different working memory components have also been found– the central executive in the frontal lobes, the phonological loop ('inner ear') in the left hemisphere and the visual–spatial sketchpad ('inner eye') in the right hemisphere (Carter, 1998).

The system that has been implicated most strongly in studies of normal language development is the phonological loop. Blake et al. (1994) found a relation between verbal memory span for words and specific developmental characteristics of spontaneous speech in 3-year-old children. Adams and Gathercole (1996) found that differences in phonological memory abilities in 4- and 5-year-old children were associated with differences in the spoken narrative skills of these children. In yet another study, Adams and Gathercole (2000) showed that the phonological working memory skills of 3-year-olds and 4-year-olds are related to the size of their productive vocabulary, the length of their utterances in terms of grammatical morphemes and the range of syntactic constructions that they employed in spontaneous speech. According to Adams and Gathercole (2000), "evidence of an association is relatively uninteresting without an account of exactly how difference in phonological working memory might affect language development". They proceed to describe two possible accounts. The first states that phonological working memory affects the efficiency and accuracy with which stable long-term memory phonological representations are created. This account is often used to explain the contribution of phonological working memory in acquiring new words (Baddeley et al. 1988, 1998, Gathercole and Baddeley 1990). According to Speidel (1989; 1993) and Speidel and Herreshoff (1989) the account also explains the involvement of phonological working memory in the acquisition of syntax. Not all syntactic constructions have to be generated from scratch; many are constructed from previously stored templates (i.e. canonical forms). In order to successfully imitate canonical forms used by adults, a child needs an efficient phonological memory. Through efficient phonological working memory processes, adult representations of language are integrated into a long-term store of linguistic patterns. These stored patterns are subsequently available to support spontaneous speech, and being stored representations, their production is less demanding of processing resources. On the basis of such an account, an association would be expected between a child's phonological working memory skills and productive vocabulary, utterance length and range of grammatical constructions.

A second account maintains that performance limitations control the degree of complexity that a child can achieve in his/her speech. In other words, children's errors in (for example) spontaneous speech occur when the complexity of the planned utterance surpasses the child's existing production resources. Such performance accounts have been put forward by Gerken (1991) and Valian (1991). The Template Model of Speech production (Gerken: 1991) will be discussed shortly as it represents one of the most comprehensive performance accounts. According to this account, a child has a limited pool of resources available to produce an utterance. Constructing sentences from previously stored templates (e.g. canonical forms) requires fewer processing resources than constructing sentences that apply rules (e.g. tense forms of verbs). For this reason, children often resort to the application of templates. Ohala & Gerken (1997) showed that children were more likely to omit weak syllables and function morphemes when limited resources were available to construct the prosodic form. In such instances, weak syllables were omitted in favor of the child's canonical prosodic template. It is thus not improbable that individual variation in processing resources (indexed by working memory skills) may lie behind the effectiveness of speech production processes in children.

5.11.2. Working memory in children with dyslexia

A common feature of specific learning difficulties like dyslexia, dyspraxia and ADHD are difficulties in learning and remembering. These difficulties are often referred to as deficits in short-term memory. Some researchers even believe that an inefficient working memory is an underlying factor in dyslexia. McLoughlin *et al*. (2002), for example, have proposed a definition of dyslexia based on working memory theory:

> 'Developmental dyslexia is a genetically inherited and neurologically determined inefficiency in working memory, the information-processing system fundamental to learning and performance in conventional educational and work settings. It has a particular impact on verbal and written communication as well as on organization, planning and adaptation to change' (p.19).

Several studies have established a link between deficits in working memory and dyslexia. Specifically the phonological loop component of working memory has been implicated. Pickering (2000) concluded that dyslexics seem to use the phonological loop component less efficiently and have problems translating visual information into phonological form. According to Pickering, this can affect their ability to learn new words when reading. Furthermore, dyslexics have difficulty with phonological repetition (for example repeating multi-syllabic or non-words) and they do not seem to use phonological memory strategies as readily as non-dyslexic people. Similar findings came from Jeffries and Everatt (2003; 2004). They compared the performance of adults and children with dyslexia on measures designed to evaluate the functioning of the phonological loop and the visual spatial sketchpad. They found that dyslexics were (compared to controls) impaired on recall tasks involving the phonological loop, but that they were just as proficient as controls on visual-spatial sketchpad measures. The dyslexic children also showed evidence of a deviant central executive component.

Recent research has suggested a link between the phonological loop and temporal processing and also time perception (Venneri, 2000). This may explain why some dyslexic people have problems with time keeping/management. Mortimore (2003) suggests that dyslexic learners may have difficulties in another area of memory function: automatization. Dyslexic people may have difficulty maintaining material in temporary memory storage while carrying out another skill, so a person may need to focus on decoding letter–sound links, thus reducing the attention available for the process of understanding what has been read. This links to research into automaticity.

Given these phonological processing weaknesses, many dyslexic individuals may develop strong compensatory processes and come to rely more on visual codes for memory processing. This is linked to the idea that dyslexic people may have superior visuo–spatial skills.

5.11.3. Working memory in children with SLI

The phonological working memory abilities of children with SLI have been studied quite extensively over the past 14 years. Gathercole and Baddeley (1990) introduced the notion of a causal link between phonological working memory and language impairment. Using a non-word repetition task, they showed that children with SLI found it significantly harder to repeat three and four syllable non-words than two groups of normally developing children (matched for age and MLU respectively). Their finding has been replicated by many researchers (see Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer et al., 2000; Montgomery, 1995a). Generally, these findings have been taken to indicate reduced phonological working memory ability in children with SLI. However, it has also been argued that poorer repetition of non-words rather reflects phonological encoding problems or difficulty with the demands of the task (Snowling et al., 1991; Edwards & Lahey, 1996). It is possible that a non-word repetition task measures more than just phonological memory; probably it also measures phonological processing. De Bree, Wilsenach and Gerrits (2004) for example found that some children with SLI have difficulty with repeating non-words, but no difficulty with repeating strings of digits, suggesting that these children failed on a non-word repetition task even though their phonological working memory seemed reasonably intact. Nevertheless, some researchers have argued that phonological working memory is a core feature of specific language impairment, as problems in this domain persist even after language problems have resolved (Bishop, 1997).

5.12. Research questions (iii) and (iv) : part two

(iv) What is the nature of phonological working memory skills in children at-risk for dyslexia and in children with SLI?

(v) Is there a relation between phonological working memory skills and the omission of closed class items?

Question (iv) was addressed by means of a digit span task, while the final question was addressed by comparing the results of experiment 1 and experiment 2.

Experiment 2

Experiment 2 was conducted with the aim of testing the phonological working memory ability of children at-risk for dyslexia and to compare this ability to that of normally developing children and of children with SLI. The subjects were tested with a digit span test. This task assesses a person's immediate memory for auditory sequences and requires the ability to recall separate items of sound that have no meaning as a group.

5.13. Method

5.13.1. Subjects

31 normally developing children (14 females, 17 males), 58 at-risk children (19 females, 39 males) and 24 children with SLI (3 females, 21 males) participated in experiment 2. The average ages of the three groups were 4;6 (control group), 4;4 (at-risk group) and 4;8 (SLI group) respectively. The data of three subjects (one control child and two at-risk children) were not used as these subjects showed a lack of concentration during testing. The data of one SLI subject was discarded as his profile did not fit that of a child with SLI (IQ < 80).

5.13.2. Design and procedure

A version of the digit span test (forwards) was used[9] (see appendix E). This task involves asking a child to repeat a series of digits; ranging from two to seven digits. All digits from 'one' to 'ten', with the exception of 'zeven' (seven) and 'negen' (nine) were used in the test. 'Zeven' and 'negen' were excluded as they are two syllables long and phonetically similar to one another. Their length and phonetic similarity make them potentially more taxing to perceive and to remember than the other digits used; possibly resulting in a flawed outcome. The experiment included a training and a test phase. During the training phase, subjects were asked to repeat one 'string' containing one digit and one string containing two digits. The training items

[9] The digit span task can also be administered backwards. Given the age of the subjects, it was decided to use only a digit span forwards task. The digit span test used is provided in appendix B. This version of the task is not standardized. A standardized version of the test does exist in Dutch, but it contains design errors that were excluded from the test used in this study.

were presented more than once (if necessary) but generally not more than twice. In order to continue with the test phase, a subject had to successfully repeat both training items. The test phase consisted of 5 blocks. Each of these blocks contained three strings. In block 1, these strings were two digits long, in block 2 they comprised of three digits and so forth. The final block (block 5) contained three six-digit strings. All subjects entered the test at block 1. The test items were generally presented only once. The test was terminated if a subject failed on two of the three items in any given block.

5.13.3. Scoring and reliability

As this version of the digit span test is not standardized, only raw scores were obtained. A subject received one point for every correct repetition. The raw score was then obtained by adding up these points. A raw score of 3 thus means that a subject correctly repeated three two-digit strings, while a raw score of 6 indicates that a subject correctly repeated three two-digit strings and three three-digit strings. The subjects' responses were scored on-line and test sessions were tape-recorded for later reference.

5.13.4. Data Analysis

For each of the three groups, a mean raw score and standard deviation were calculated. The means were compared with a one-way ANOVA. In order to gain insight into the distribution of raw scores over the three groups, the data were also plotted in a histogram.

5.14. Results

5.14.1. Phonological working memory

The mean raw score of the control group was 6.81, the mean raw score of the at-risk group was 5.29 and the mean raw score of the SLI group was 4. A one-way ANOVA revealed a significant effect for group ($F_{(2, 110)} = 13.9$; $p < 0.000$). Post hoc testing (Tukey) indicated that the mean raw scores were significantly different between the groups: Control–At-risk, $p = 0.002$; Control–SLI, $p < 0.000$; At-Risk–SLI, $p = 0.022$. The mean raw scores are graphically presented in figure 2.

The individual raw scores were also plotted in a histogram (see figure 3.) to inspect the distribution of raw scores across the three groups. The control group appears to have a normal distribution, with 13 of the subjects achieving a raw score of 6. Similarly, the SLI has a normal distribution that is situated to the left of the control group, with 8 of the subjects achieving a raw score of 3. The at-risk group appears to have a bimodal distribution, indicated by the presence of two peaks in the histogram (one at raw score 4 and another at raw score 6). 12 at-risk subjects obtained a score of 4 and 13 at-risk subjects obtained a score of 6. This result fits the expectation that about half of the at-risk children will experience early problems in memory/language related tasks, as only 40% of the at-risk children will eventually become dyslexic.

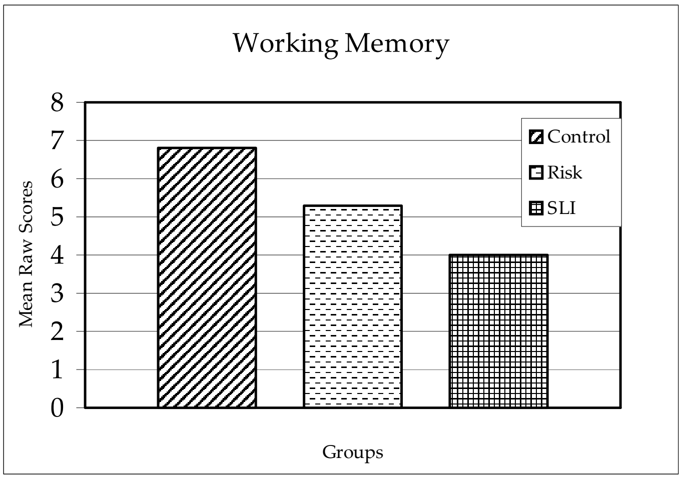

Figure 2. Mean raw scores for digit span test for control, at-risk and SLI groups.

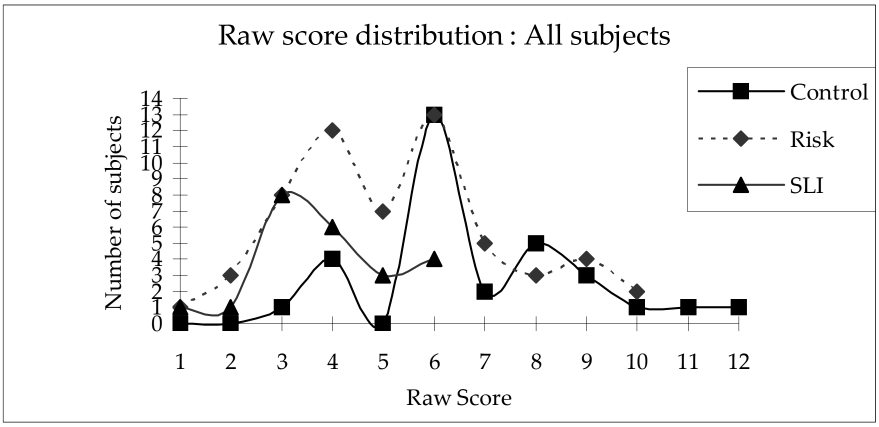

Figure 3. Distribution of the raw scores obtained in digit span across the three groups.

5.14.2. Phonological working memory and the omission of closed class items

Recall that whereas argument structure complexity affected both the omission of the auxiliary *heeft* and of determiners, the length of a sentence affected only determiner omission. Thus, subjects were more likely to omit closed class items from sentences containing complex argument structures than from sentences containing less complex argument structures (but of similar length). Since sentence length did not seem to particularly affect the production of closed class items, one could conclude that phonological working memory skills also did not crucially affect performance in the sentence imitation task. Alternatively, one could argue that working memory *has to* influence sentence imitation (this seems logical, as remembering a sentence is a prerequisite for imitating it) and that working memory accounts for at least some of the variance that is observed between the different groups (specifically with regard to the omission of closed class items).

In order to examine the possible effect of phonological working memory skills on the omission of closed class items, a subset of the data from both experiments was compared. This subset included those subjects that successfully completed both experiments and comprised of 24 control children, 43 at-risk children and 20 children with SLI. The raw score obtained by each of the subjects on the digit span task was compared to the percentages of *auxiliary omission*, *ge- omission* and *determiner omission* (across all sentences) by the same subject. Statistical analysis confirms that a child's working memory capacity indeed affects the omission of closed class items. Analyses of Covariance (ANCOVA's) with *auxiliary verb omission, ge-omission* and *determiner omission* as dependent variables, *group* as independent variable and *working memory* as covariate indicate that both group ($F_{(2,83)}$ = 4.03, p = .021) and working memory ($F_{(1,83)}$ = 4.81, p = .03) have significant effects on the omission rate of the auxiliary verb *heeft*. Likewise, both group ($F_{(2,83)}$ = 3.77, p = .027) and working memory ($F_{(1,83)}$ = 4.82, p = .035) significantly affect the omission of the verbal prefix *ge-*. Finally, both the independent variable *group* ($F_{(2,83)}$ = 5.62, p = .005) and the covariate *working memory* ($F_{(1,83)}$ = 9.29, p = .003) significantly affect the omission of determiners.

Thus, when all sentences used in the imitation task are collapsed, it is clear that both working memory skills and group affected a child's ability to imitate closed class items. This raises the question of exactly how important working memory skills are (in relation to group) for a child to successfully imitate closed class items. A partial correlation (correlating *working memory* and *auxiliary omission*, whilst controlling for *group*) indicates that working memory and auxiliary verb omission are significantly correlated (R = -.236, p = .014). Similar correlations between *working memory* and *ge-omission* and between *working memory* and *determiner omission (*again controlling for group), indicate that there is a significant correlation between working memory and ge-omission (R = -.229, p = .017). Likewise, working memory and determiner omission is significantly correlated (R = -.316, p = .002). In terms of variance, the values of R2 for the different partial correlations are 0.05, 0.05 and 0.09 respectively. This means that, when the effect of group on the omission of closed class items are held constant, working memory can account for 5% of the variance in auxiliary omission and ge- omission and for 9% of the variance in determiner omission.

A multiple regression model with *auxiliary omission* as dependent variable and *working memory* and *group* as independent variables indicates that both of the independent variables significantly predicts the outcome of auxiliary verb omission. Similarly, both working memory and group are significant predictors of the outcome of ge-omission and of determiner omission. The statistics obtained from the multiple regression model are summarized in table 4.

Table 4. Multiple regression statistics

		B	*SE B*	*β*
Auxiliary verb omission	Step 1			
	Constant	56.56	8.72	
	Working memory	-5.51	1.51	-.37*
	Step 2			
	Constant	19	15.63	
	Working memory	-3.57	1.6	-.24**
	Group	13.93	4.9	.30**
		B	*SE B*	*β*
Ge- omission	Step 1			
	Constant	31.88	5.97	
	Working memory	-3.66	1.04	-.36*
	Step 2			
	Constant	6.98	10.74	
	Working memory	-2.38	1.10	.23**
	Group	9.24	3.34	-.29**
		B	*SE B*	*β*
Determiner Omission	Step 1			
	Constant	73.55	7.90	
	Working memory	-6.39	1.37	-.45*
	Step 2			
	Constant	34.64	13.97	
	Working memory	-4.38	1.44	-.31**
	Group	14.43	4.38	.33*

Note: *p ≤ .001; **p < .05

The above analyses show that phonological working memory does affect a child’s ability to imitate/produce closed class sentences in a sentence imitation task. However, the multiple regression analysis also shows that phonological working memory does not entirely predict whether or not a closed class item will be imitated or not. Other variables (of which group is one example) also partly predict this outcome.

The relationship between working memory and the omission of closed class items is graphically presented in figure 4.

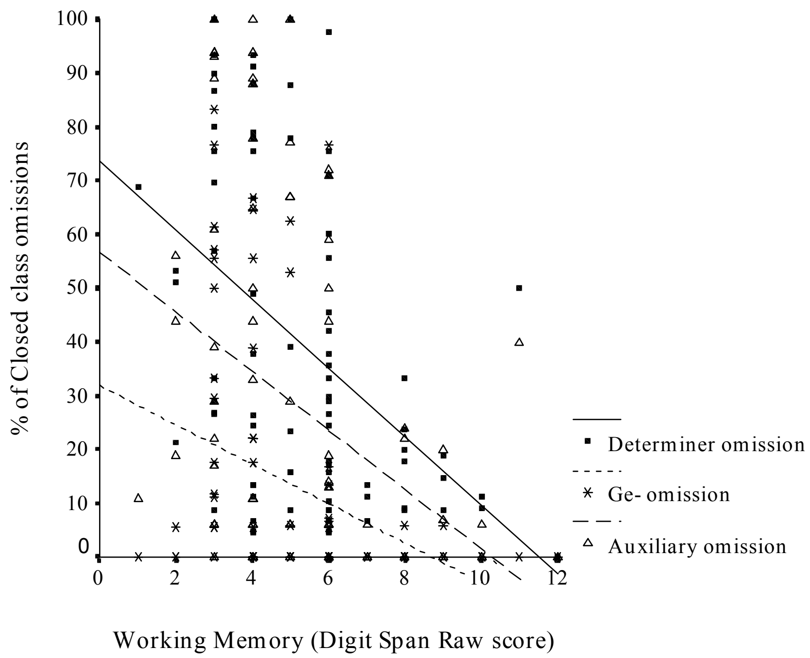

Figure 4. Correlation between phonological working memory and the omission of closed class items

5.15. Discussion

Four research questions were put forward in this chapter. Each of them will be discussed in turn. The first research question was:

(i) Does verb argument structure complexity affect the ability of Dutch children at risk for dyslexia and of Dutch children with SLI to perceive and produce closed class items?

In order to answer this question, children's ability to imitate the auxiliary verb *heeft*, the verbal morpheme *ge-* and determiners were studied in sentences containing varying verb argument structures. Argument structure complexity had a significant effect on the omission rate of the auxiliary and the determiners in a sentence, but no such effect was found for the prefix *ge-*. With regard to the omission of the auxiliary, the effect of argument structure complexity was best seen in the ditransitive condition. An interaction between the main effects (argument structure and group) was also present, suggesting that the effect of argument structure complexity on auxiliary verb omission was not the same for the three groups. Even so, in all three groups, subjects were more likely to omit the auxiliary verb in sentences containing a ditransitive verb than in sentences containing an intransitive or a transitive verb. The difference in auxiliary omission was not significant in the control group or in the SLI group. The at-risk group, however, omitted significantly more auxiliary verbs in sentences containing a ditransitive verb than in sentences containing an intransitive verb or a transitive verb. This finding is similar to that of Grela & Leonard (2000). They also found that ditransitives, in particular, were associated with the omission of auxiliaries in the sentence production of children with SLI. Grela & Leonard's results are thus replicated in the at-risk children in the present study but not in the SLI children. It is not clear why this effect was not found in the SLI subjects. One explanation is that the SLI children in this study were younger than those in the Grela & Leonard study. It might be the case that they have not fully mastered the auxiliary verb *heeft* and therefore had difficulty in imitating it, even in the most simple of sentences. As a result, their auxiliary omission rate in the intransitive and transitive conditions was too high to cause a significant difference with the ditransitive condition.

The fact that argument structure had a significant effect on the omission of auxiliaries and determiners, but not on the omission of the prefix *ge-*, is compatible with current sentence production models. The sentence elements most likely to be vulnerable to processing capacity constraints (and thus to omission) are those that are to be completed late in the sentence generation process, after resources have already been used for the retrieval of other elements. Lexical items, arguments and inflections are all presumably retrieved *before* function words such as auxiliaries and determiners. Thus, in situations where the structural complexity of a sentence demands a processing trade-off, function items will be the first to be omitted.

Interestingly, the present finding that *ge-* omission is not affected by argument structure diverges from the finding regarding *ge-* in chapter 4. In chapter 4, the both groups of children were more likely to omit the prefix *ge-* in sentences containing a transitive verb than in sentences containing an intransitive verb.

It is difficult to explain this discrepancy. Obvious factors that differed between the two studies are the age of the children, the sample of children and the type of experiment used. The children studied in chapter 4 were younger than those studied in chapter 5. Although normally developing children acquire the past participle construction (and thus the representation of the prefix *ge-)* around the age of 3;0, this is not necessarily the case for children at-risk for dyslexia. Possibly, at the age of 3;3 (the average age of the at-risk subjects in chapter 4), these children still had an unstable representation of the prefix *ge-,* making it more susceptible to omission (especially in cases where the child's processing resources are taxed). The finding of chapter 5 (where the at-risk infants had an average age of 3;10) suggests that this 'problem' dissolves with age. The implication is that the past participle construction is only fully acquired by children at-risk for dyslexia around the age of 3;6, some 6 months after their normally developing peers. Alternatively, it might be that it is not per se argument structure that affected the omission of *ge-* in chapter 4, but the increased length of sentences containing a transitive verb. It could simply be the case that the working memory capacities of the at-risk children in chapter 4 were not sufficient to successfully produce the longer sentences. Working memory capacity increases with age, which would explain why the older at-risk children no longer needed to omit *ge-*. Regarding the type of experiment used, the children were more successful with the production of the prefix *ge-* in elicited imitation than in elicited production. It's not clear why this is the case, as an imitation task is not necessarily easier than a production task. That being said, it is plausible that sentence imitation uses less of a child's available processing resources, since the child needs to select only those concepts prescribed by the experimenter. In elicited production, concepts are not prescribed in the same way; the child has to conceptualize the message by him/herself. Thus, conceptualizing the message of a sentence possibly takes less time and uses less of the available processing resources in elicited imitation than in elicited production. If this is true, the children in chapter 5 had more processing resources available to complete their sentences, which explains why they were successful in producing *ge-*, even in sentences containing a verb with a complex argument structure.,

For all three categories of closed class items, a significant main effect for group was also found. Post hoc testing indicated that the mean percentage of auxiliary verb omission was significantly higher in the SLI group than in the control group. The at-risk group also omitted more auxiliaries than the control group, but this difference was not significant yet. Unfortunately, quite a lot of potentially interesting data from the at-risk group had to be excluded from the analysis, for reasons described earlier in this chapter. Most of the at-risk children that were excluded from the analysis had high omission rates of the auxiliary. The mean percentages of auxiliary omission are most probably skewed in the ditransitive condition. The SLI group differed significantly from the other two groups with regard to their imitation of the prefix *ge-*, the former group omitted the prefix significantly more often than the control and the at-risk groups. The control group and the at-risk group did not differ with regard to the use of the prefix *ge-*. The at-risk group omitted significantly more determiners than the control group, while the SLI group had a higher percentage of determiner omission than both the control and the at-risk groups.

During transcription, a noticeable pattern was that omission of the subject NP in a sentence almost always resulted in the omission of the auxiliary. In these cases, children imitated only the VP-shell (not necessarily the whole of it). A higher rate of subject omission in one of the groups would thus also result in a higher rate of auxiliary omission in that group. Auxiliary verb omission could then be seen as a function of subject omission and not as a function of argument structure complexity or of group. However, the data provide no evidence that this was the case. Omission of the subject NP occurred in all conditions, but the groups were not significantly different with regard to subject omission.

The second question was:

> (ii) Does sentence length influence the perception and production of closed class items in the same way as verb argument structure?

In order to answer this question, children's ability to imitate the auxiliary verb *heeft*, the verbal morpheme *ge-* and determiners were studied in sentences with varying sentence length. No main effect for length was found: the length of a sentence had no significant influence on the percentage of auxiliary omission or on the percentage of *ge*-omission. A main effect of length was however found for determiner omission. Sentence length affected determiner omission in the same way in the three groups of children, as no interaction was found between sentence length and group. The effect of sentence length on the omission of determiners was most apparent in the at-risk subjects; this group omitted significantly more determiners in sentences containing a ditransitive verb and an adjunct than in sentences containing an intransitive verb with an adjunct or a transitive verb with an adjunct. The control and SLI subjects also omitted the highest percentage of determiners in this condition, but the difference in determiner omission between the three conditions did not reach significance in these groups. The groups did not differ significantly in sentences of varying length with regard to their omission of the subject NP. Sentence length did however have a significant effect on the omission rate of the subjects NP. This effect was again most apparent in the at-risk group than in the other tow groups; the at-risk children omitted significantly more subjects in sentences with a ditransitive and an adjunct than in the other two sentence types.

The third question was:

> (iii) What is the nature of phonological working memory skills in children at-risk for dyslexia and in children with SLI?

The phonological working memory skills of the at-risk children and the children with SLI, as measured with a digit span task, are significantly poorer than those of the control group. This finding is not surprising, given previous research with dyslexic children and children with SLI. However, it seems clear that not all of the at-risk children in this sample have deficient phonological working memory skills. A subgroup of the at-risk subjects performed very much like the control group, while another subgroup of at-risk subjects performed more like the SLI group. This is another predictable finding, given the estimate that around 40-50% of the at-risk children will eventually develop dyslexia. As mentioned earlier, phonological memory skills are believed to be associated with language development in both normally developing and language impaired children. Children with good phonological working memory skills generally have a larger vocabulary size, a longer MLU and a bigger array of syntactic constructions, in comparison to children with poorer phonological working memory skills. In view of sentence production models such as that of Bock and Levelt (1994) and theoretical accounts of SLI such as the limited processing account, one would expect children with poor phonological working memory skills to struggle with the perception and reproduction of long complex sentences. Recall that according to Bock & Levelt, when many operations are required for the construction of a sentence, some of these operations might not be completed. Especially grammatical morphemes and closed class lexical items should be prone to omission in the productions of these children, as these items are retrieved last in the process of constructing a sentence. In, for example, sentences containing a ditransitive verb, the intrinsic complexity of the sentence might be enough to cause the omission of grammatical morphemes. Poor phonological working memory skills can then be seen as an extra burden on the production of a complex sentence. The finding that the at-risk children and the children with SLI have poor phonological working memory skills corresponds to the fact that these groups, in general, experienced more difficulties in the sentence imitation task than the control children. Some would even want to argue that poor phonological working memory skills caused the omission of grammatical morphemes and function words in the imitation task, as it might well be the case that processing limits are exceeded not because of complexity but because of the added length that is a consequence of complexity. This possibility cannot be ruled out completely, as the length of a sentence did have an effect on the percentage of determiner omission in experiment 1.

The final question was:

> (iv) Is there a relation between phonological working memory skills and the omission of closed class items?

The data provides evidence that this is indeed the case. A significant correlation was found between the score obtained on the digit span task and the percentages of auxiliary omission, ge-omission and determiner omission. A regression analysis showed that phonological working memory is a significant predictor of the omission of closed class items.

Statistically speaking, there is evidence of a correlation between the two tasks, but this correlation is poor. Phonological working memory does not account for a large percentage of the variance in children's ability to imitate closed class items. There are several reasons why this could be the case. One possible reason is that the association between working memory skills and language development does not reflect the effect of working memory on language acquisition but the effect of language proficiency on phonological memory tasks. In other words, the impaired phonological working memory skills of children with developmental language disorders could be seen as a consequence of rather than a cause of linguistic difficulties. The current direction of the association (i.e. language development is effected by phonological working memory) is based mainly on studies where phonological working memory was measured with a non-word repetition task. Van der Lely and Howard (1993) suggested that poor language skills will constrain a child's ability to assemble and produce multi-syllabic non-words and to assign prosody to them. They formulated the 'mutual output constraints' hypothesis, according to which previous associations between non-word repetition performance and spoken language reflect the phonological processing and particularly the output requirements of the non-word repetition task. Another possibility is that one (or both) of the tasks used in this study does not reflect the true abilities of the children. Possibly, the digit span task does not provide a sensitive enough measure of a child's phonological working memory skills. This interpretation is unlikely; the digit span task is a widely used task of which many standardized versions exists. Furthermore, all of the subjects who participated in this study were also tested on a non-word repetition task (see De Bree, Wilsenach & Gerrits, 2004). The correlation between the scores obtained on the digit span task and the non-word repetition task was strong, suggesting that for most of the subjects, both tasks measured phonological working memory skills. Alternatively, some of the outcomes could be attributed to the experimental methodology (sentence imitation task) that was used in this study. Especially in the group of SLI children it is conceivable that the task influenced the outcomes. All of the children with SLI in this study were receiving speech- and language therapy and as a result were accustomed to tasks that required them to imitate language. Their training/therapy could have provided them with a strategy to imitate language successfully despite poor phonological working memory skills. This would explain, at least partly, why some children were quite successful on the sentence imitation task despite poor phonological working memory skills.

5.16. Summary

In this study, the effect of verb argument complexity on the production of closed class items in an elicited imitation task was examined. As an increase in the complexity of the argument structure of the verb also causes a sentence to increase in length, the effect of sentence length and short term memory on the production of closed class items was also investigated. Argument structure complexity had an effect on the percentage of auxiliary omission and on the percentage of determiner omission, but not on the percentage of *ge-* omission. In sentences with varying argument structure complexity, the SLI group omitted significantly more closed class items than the control and the at-risk groups. The effect of argument structure was however, most evident in the at-risk group; as these children omitted significantly more auxiliaries in sentences containing a ditransitive verb than in sentences containing a intransitive or a transitive verb. Sentence length had no effect on the percentage of auxiliary omission or on the percentage of *ge-* omission, but it did have an effect on determiner omission. The length effect was again most evident in the at-risk group; these children found it significantly harder to produce determiners in sentences containing a ditransitive verb and an adjunct. The SLI group had the highest rate of omission of closed class items in sentences with varying length; they omitted significantly more grammatical morphemes and function words as the other two groups.

Phonological working memory and the ability to imitate the closed class items in a sentence imitation task are poorly (yet significantly) correlated. Furthermore, working memory is a significant predictor of the percentage of closed class items that will be omitted in a sentence imitation task, but again it accounts for only a small percentage of the variance in the data.

Chapter 6

Sensitivity to morphosyntactic agreement in school-going children at-risk for developing dyslexia

Infants predisposed for developing dyslexia are delayed (compared to normally developing infants) in their ability to detect morphosyntactic dependencies (chapter 3, this dissertation). A question that comes to mind is whether decreased sensitivity to grammatical patterns is a persistent problem in older children at-risk for dyslexia and in children diagnosed with dyslexia. Thus, the aim of this chapter is to examine the syntactic processing abilities of Dutch school-going children with a genetic risk for dyslexia. Very few studies focusing on the syntactic abilities of at-risk children have targeted this age-group (i.e. between the ages of five and six). Sensitivity to two similar (but syntactically and semantically distinct) syntactic structures is assessed in this chapter. The past participle construction, which has been a focal point in this book, is compared to a construction containing a modal auxiliary. More specifically, sensitivity to the dependency between the temporal auxiliary and the past participle is compared to sensitivity to the relation between the modal *kan (can)* and the infinitival form of the verb.[1] The choice of a structure containing the modal *kan (can)* was not random. The reason for including specifically this structure is that children with SLI have been shown to experience no (or at least fewer) problems with modal auxiliaries than with temporal auxiliaries. If the language difficulties of children at-risk for dyslexia resemble those of children with SLI, these children should also experience more problems with constructions containing temporal auxiliaries than modal auxiliaries.

Thus, children with SLI are also included in the comparison: on the one hand to further investigate the possible relation between dyslexia and SLI and on the other hand to explore the capacity of different linguistic theories of SLI to account for the language problems of children at-risk for dyslexia. Children with SLI have well-documented problems in the use of tense-related grammatical morphemes. However, in English (and in Dutch), tense often overlaps with aspect and modality. Previous studies of SLI suggest that morphemes tied to modality and/or aspect are not impaired in the same way as morphemes tied to tense. This is also true of auxiliary verbs. Hadley (1993) found that children with SLI did not have difficulties with the entire auxiliary system: the modals *can* and *will* were first to emerge in the speech of her subjects and were not particularly challenging for the children with SLI. In contrast, the subjects in Hadley's study had severe

[1] In the context of the present study, the term 'sensitivity' means 'ability to discriminate between grammatical and ungrammatical dependency relations'.

problems with the tense-related auxiliary *be*. In the same vein, Conti-Ramsden & James (1997) found that the SLI children in their sample used the modal auxiliary *can* more frequently than any other auxiliary. Leonard et al. (2003b) found that 5-year-old children with SLI used the morphemes *-ing* to mark progressive aspect in both past and present contexts, even though they were relatively poor in using the tense morphemes (auxiliary *was/were*) that should accompany the progressive inflection. Furthermore, these children's use of the modal *can* was comparable to that of typically developing children. Leonard et al. (2003b) raised the possibility that the modality function of 'possibility' had been learned without necessarily acquiring the tense feature of the modal auxiliary. The proficiency that children with SLI demonstrate with *can* suggests that bare verb stem productions (also known as 'root infinitive' productions) by these children should probably not be re-interpreted as cases of missing modals. Leonard et al. hypothesized that while children with SLI are seriously impaired in expressing temporal relations through tense-related morphology, their ability to express temporal relations using aspectual and modality markers seems to be less impaired. In the present chapter, this hypothesis of Leonard & colleagues (2003b) is tested in children with SLI and in children with a genetic risk for dyslexia.

6.1. Outline of this chapter

This chapter starts with a discussion of previous studies that investigated (morpho)-syntactic skills in dyslexic children (section 6.2.). This discussion leads to section 6.3., which contains the specific research questions for this chapter. In section 6.4., the experimental set-up of the present study is described. The obtained results are presented in section 6.5. This is followed by a discussion of the results in section 6.6. and a summary of the main findings in section 6.7.

6.2. Syntactic processing in developmental dyslexia

Although the majority of studies on language development in developmental dyslexia have focused on phonological skills, some researchers have explored (morpho)-syntactic skills in children with dyslexia.

During the eighties, dyslexic children's comprehension of relative clauses was studied by several researchers. Relative clauses (like *The girl who pushed the boy tickled the clown*) are typically analyzed as sentences missing one of their NP's. In this particular example, it is the subject that is 'missing'. As figuring out who did what to whom is more complicated in relative clauses than in other types of sentences, these structures are more difficult to process than many other syntactic structures. For this reason, the relative clause is a potentially interesting structure to study in both normal and abnormal populations. Byrne (1981) established that dyslexic children had more trouble understanding relative clauses than normal readers. He assumed that this was the result of delayed syntactic development. However, Mann et al. (1984) showed that dyslexics were also more impaired compared to normal readers in repeating relative clauses, suggesting that working memory played a role in their misinterpretations of relative clauses. In yet another study on relative clauses, Bar-Shalom et al. (1993) found that dyslexic children produced fewer relative clauses with object movement than normal control children.

Other areas in the field of syntax that have been investigated in children with dyslexia include the construction of passive sentences and binding theory. The interpretation of passive sentences has been shown to be problematic in dyslexic children compared to non-dyslexic children; but overall, dyslexics seem to be competent in their use of the passive structure (Stein et al., 1984). Binding theory was studied by Waltzman & Cairns (2000). They found that dyslexic children made errors with the interpretation of pronouns in sentences such as *Pig*$_i$ *is drying her*$_{j,}$ suggesting problems with binding principles.

Recent studies in the field of morphosyntax suggest that dyslexic children experience problems in this area too. Joanisse et al. (2000) compared speech perception-, phonological- and morphological skills in dyslexic children (aged around 8;0) and found that the dyslexic children experienced difficulties with the inflection of past tense verbs. Rispens (2004) studied sensitivity to subject-verb agreement in dyslexic children and in dyslexic adults. The dyslexic children (mean age 8;9) were tested with a judgment of grammaticality task while the adults were tested in an ERP study. Rispens conducted two separate studies with the dyslexic children. In the first study, the dyslexic children were outperformed in their ability to detect subject-verb agreement violations by both an age-matched and a reading-matched control group. This finding excluded the possibility that *reading experience* plays a key role in the syntactic skills of dyslexic children. In the second study, Rispens (2004) tested the possibility that problems with subject-verb agreement correlate with phonological processing difficulties. Sensitivity to subject-verb agreement violations was again assessed via a judgment of grammaticality task, while phonological processing abilities were tested with a task measuring phonological awareness (phoneme deletion task), a digit span task, a non-word repetition task and a sentence recall task. Rispens' results showed that the dyslexic children performed more poorly on the judgement of grammaticality task than a group of control children. Furthermore, phonological awareness and verbal working memory were highly correlated with subject-verb agreement, suggesting that phonological

processing skills are related to morphosyntactic performance (in this case specifically to agreement marking).
Rispens (2004) studied the same phenomenon (sensitivity to subject-verb agreement) in adult dyslexics. In an ERP study, the presence and properties of the P600 component and of the ELAN (Early Left Anterior Negativity) component (elicited by presenting subjects with phrase structure violations) were investigated. The ELAN component of the dyslexic subjects did not differ from the control subjects in strength or in distribution, but the peak latency occurred earlier in the dyslexics than in the controls. Conversely, the P600 component tended to peak later in the posterior region of the left hemisphere in the dyslexics compared to the controls. Rispens concluded that the combined data from the ELAN and the P600 components indicated that automatic parsing of word category information is unaffected in dyslexics, but that the more controlled process of syntactic repair tends to be slower in dyslexics than in non-dyslexics. Interestingly, Rispens found that the adult dyslexics were capable of discriminating between grammatical and ungrammatical agreement relations in a judgement of grammaticality task. Thus, the problems experienced by dyslexic children regarding subject-verb agreement are no longer evident in behavioural data obtained from dyslexic adults.

Summarizing, apart from the study by Rispens (2004) very little is known about the way in which dyslexic individuals process morphosyntactic agreement relations. Knowledge of the syntactic relation between an auxiliary and its verbal complement has not been investigated at all in children at-risk for dyslexia or in children with dyslexia.[2] Such information is potentially interesting seeing that it can add to our knowledge of the linguistic typology of developmental dyslexia.

6.3. Research questions

The following research questions will be addressed in this chapter:

(i) Are Dutch school-going children (age 5;1) at-risk for dyslexia as sensitive to the morphosyntactic relation between an auxiliary and its verbal complement as their normally developing peers?

(ii) Are Dutch children with SLI as sensitive to the morphosyntactic relation between an auxiliary and its verbal complement as their normally developing peers?

[2] Preliminary data from Wijnen (personal communication with the author) show that dyslexic adults are significantly slower in detecting agreement errors between an auxiliary and its verbal complement than non-dyslexics adults.

(iii) Do the at-risk children resemble the children with SLI and if so, can their behaviour be explained in terms of the linguistic theories of SLI?

These questions were addressed by means of a discrimination task. The main question in such a task is whether subjects can discriminate linguistic stimuli as being either 'the same as' or 'different from' a target stimulus. In this study, children were presented with two sentences. The first of these was always a grammatical sentence in which the relation between two dependent morphemes was maintained. The second sentence was either identical to the first sentence (i.e. grammatical) or different from the first sentence (ungrammatical in that the relation between the dependent morphemes was violated). Children were required to judge whether the second sentence was 'the same' or 'different' from the first sentence. The children were tested with two separate sets of stimulus material (set A and set B). The stimuli in set A tested sensitivity to the morphosyntactic dependency between the temporal auxiliary *heeft* and the past participle, while the stimuli in set B were designed to assess sensitivity to the morphosyntactic dependency between the modal *kan* and the infinitive.

6.4. Method

6.4.1. Subjects

All three groups from the toddler cohort took part in the experiment. In total, the discrimination test was administered to 57 children at-risk for dyslexia, 24 normally developing (control) children and 21 children with SLI. With regard to subtest A (*heeft*), data from 3 at-risk children were discarded. For subtest B (*kan*), data obtained from 6 at-risk children, 1 control child and 1 child with SLI were discarded. Data were discarded for one of two reasons: the subject either clearly paid no attention to the task or the subject refused to complete the task. Thus, the results presented for subtest A included data from 54 at-risk children (mean age 5;1), 24 control children (mean age 5;1) and 21 children with SLI (mean age 5;4). The results presented for subtest B incorporated data from 51 at-risk children (mean age 5;2), 23 control children (mean age 5;1) and 20 children with SLI (mean age 5;4).

6.4.2. Stimuli

The stimulus material consisted of 24 items and were divided into two separate sets (set A and set B). For both sets of stimuli, *target* and *test* sentences were created. The target sentences were always grammatical. The test sentences incorporated three conditions and were either grammatical or ungrammatical (i.e. each of the three conditions represent a type of test sentence). For both sets of stimuli, a total of four target sentences were created. Each of these target sentences appeared with each of the three types of test sentences. In table 1 an overview is given of the different target and test constructions.

Table 1. Overview of the stimulus material.

	Target sentence	**Test sentences**	**Condition**
Set A	heeft geblaft *(has barked)*	heeft geblaft *(has barked)*	Grammatical (Aux + Participle)
	heeft geblaft *(has barked)*	*kan geblaft *(*can barked$_{part}$)*	Ungrammatical (Modal + Participle)
	heeft geblaft *(has barked)*	*_geblaft *(*_barked$_{part}$)*	Ungrammatical (Bare Participle)
Set B	kan blaffen *(can bark)*	kan blaffen *(can bark)*	Grammatical (Modal + Infinitive)
	kan blaffen *(can bark)*	*heeft blaffen *(*has bark$_{inf}$)*	Ungrammatical (Aux + Infinitive)
	kan blaffen *(can bark)*	*_ blaffen *(*_bark$_{inf}$)*	Ungrammatical (Bare infinitive)

Thus, the target sentence *De hond heeft geblaft (The dog has barked)* appeared in combination with each of the following test sentences: *De hond heeft geblaft*, **De hond kan geblaft* and **De hond geblaft*. Similarly, the target sentence *De hond kan blaffen* appeared in combination with *De hond kan blaffen, *De hond heeft blaffen* and **De hond blaffen.* The stimulus sentences were short (all target sentences were four words long) in order to ensure that the children would be able to remember them.

The stimuli were recorded by a female native speaker of Dutch. Care was taken to ensure that the prosodic structures of the different target and test sentences were comparable. The recorded stimuli were edited in GIPOS (primarily, to remove the speaker's breathing when it was audible) and stored as sounds files on a compact disc.

6.4.3. Design and Apparatus

The experiment was designed as a discrimination task[3]. Children were presented with a target sentence; read by the experimenter. The target sentence was repeated by a toy-robot (test sentence); either in exactly the same way (the grammatical condition) or in a different way (one of the ungrammatical conditions).[4] The child's task was to judge whether the robot's imitation was the same as or different from the target sentence. The experiment was conducted as two sub-tests; sub-test A (consisting of the stimuli from set A) always preceded sub-test B (consisting of the stimuli from set B). The stimuli in both sub-tests were presented in a fixed order. In order to control for a possible effect of order, two versions (with different orders) were created of each sub-test. Subjects were randomly assigned to one of the two test versions.

The experiment consisted of a training phase and a test phase. The training phase preceded sub-test A and was generally not repeated before sub-test B. During the training phase, subjects were presented with target sentences entirely different from those used during the test phase. In order to continue with the test phase, a subject had to correctly discriminate two of the three training items. In addition, three filler items (similar to the training items) were included in each sub-test. These items served the purpose of testing subjects' attention during the course of the experiment. The discrimination task is included in appendix F.

The subjects' responses were scored on-line and the test-sessions were recorded onto DAT-tapes. Any additional remarks uttered by the subjects were also documented. Typically, such remarks included spontaneous corrections of ungrammatical sentences.

6.4.4. Procedure

The experiment was conducted as part of a two hour session. Several other perception and production experiments were conducted during this same session. Sub-test A of the discrimination task was generally presented as the second task in a series of 6 experimental tasks, while sub-test B was generally presented fourth or fifth in this series. At the onset of the

[3] A more suitable way of assessing knowledge of a particular morphosyntactic dependency is to conduct a judgement of grammaticality task. In such a task, subjects have to give a conscious judgement of the syntactic structure itself, which is not the case in a discrimination task. However, piloting revealed that even the age of 5; 0 (and slightly older), many of the normally developing children in this sample were unable to think about language in the abstract way required in order to successfully complete a judgement of grammaticality task.

[4] The toy-robot "spoke" by means of two speakers that were hidden under its cardboard body. The speakers were connected to a portable CD-player which was operated by the experimenter.

discrimination task, the child was told that the toy-robot was practicing her Dutch and that she needed some help doing so. The subject was informed that the robot sometimes correctly and sometimes incorrectly imitates Dutch sentences and that a correct imitation is 'the same' as the experimenter's utterance while an incorrect utterance is 'different' from the experimenter's utterance. The child was then instructed to listen carefully to the robot's imitation and to judge whether the robot's imitation was 'the same' as or 'different' from the sentence produced by the experimenter. Every trial started with the experimenter reading the target stimulus twice; this was done to ensure that the child remembered it. The robot imitated the target sentence after a pause of a few seconds. During the training phase, the child was corrected if he/she made an incorrect judgment. Training items were repeated until the experimenter was confident that the child understood the task. During the test phase, children were generally not corrected. Test items were repeated only when the child clearly paid no attention to the target stimulus or when noise interfered with the presentation of the target stimulus.

6.4.5. Scoring and Reliability

The children's responses were scored online. One point was awarded for each correct discrimination, resulting in a maximum score of 12 points for each of the two sub-tests. A separate score (out of 4) was calculated for each of the three test conditions. These scores were transformed into percentages of correct discriminations. From these individual subject scores, a mean percentage of correct discrimination was calculated per group for each of the test conditions.

6.4.6. Data Analysis

The data obtained from the two sub-tests were analyzed separately. In sub-test A, *discrimination ability* (i.e. % of correct discriminations) was considered to be the dependent variable, while *test condition* (within-subjects) and *group* (between subjects) were considered to be independent variables. The independent variable *test condition* contained three levels in the analysis i.e. grammatical, ungrammatical I (modal + participle) and ungrammatical II (bare participle). Likewise, for subtest B, the dependent variable was *discrimination ability*. Again, *test condition* (within-subjects) and *group* (between subjects) were considered to be independent variables. The independent variable *test condition* contained three levels in the analysis, namely grammatical, ungrammatical I (auxiliary + infinitive) and ungrammatical II (bare infinitive). The dependent variables in both subtests were examined in a general linear model (repeated measures) analysis of variance (ANOVA). Mauchly's test of sphericity was conducted in the ANOVA's. In all cases where Mauchly's W resulted in a significant p-value; Huynh-Feldt corrections were applied. The level of significance was set at 0.05 throughout the analyses. The Tukey HSD test was used for post hoc testing in cases where one or both of the main effects were significant.

6.5. Results

6.5.1. The relation between 'heeft' and the past participle

In table 2 the mean percentages of correct discriminations and standard deviations obtained in subtest A are given separately for each of the test conditions (the target construction contained auxiliary *heeft* + past participle).

Table 2. Mean percentages of correct discriminations (per test condition) for the target construction '*heeft* + past participle'.

	Test Conditions					
	Grammatical (aux + participle)		**Ungrammatical I (modal + participle)**		**Ungrammatical II (bare participle)**	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Control	97.92	(7.06)	96.88	(15.31)	96.88	(8.45)
At-Risk	93.83	(14.76)	99.07	(4.77)	79.09	(34.04)
SLI	90.48	(14.74)	83.33	(25.41)	75	(26.22)

A repeated measures analysis with group as between-subjects factor and test condition as within subjects factor revealed that both main effects (Group: $F_{(2,\ 96)}$ = 6.38, p = .003; Test condition: $F_{(1.6.,150)}$ = 9.17, p = .001) had a significant effect on subjects' ability to correctly discriminate incorrect agreement relations from correct agreement relations. A significant interaction between the two factors was also found ($F_{(3.13,\ 150)}$ = 3.70, p = .012), suggesting that the effect of the different test conditions was not similar in the three groups.

Post hoc testing showed that the SLI group differed significantly from the control group: the mean scores (generalized over all three test conditions) of the SLI group were significantly lower than the means of the control group (p = .002, SE = 4). Considering all three test conditions simultaneously, the at-risk group did not differ significantly from the control group. Nevertheless, these children scored noticeably lower than the control group on the *bare participle* test condition. Post hoc testing (Tukey HSD) confirmed that the at-risk group scored significantly lower on this condition than on the other two test conditions (aux-participle vs. bare participle, p =.001, SE = 4.16; modal-participle vs. bare participle, p < .000, SE = 4.16). In the control and SLI groups, no such effect was found; although the mean differences between the aux-participle and bare participle conditions was approaching significance (p = .078, SE = 7.02) in the SLI group.

The distribution of the mean percentages obtained on the bare participle condition is shown in figure 1. Whilst the control group showed no variation in their ability to discriminate this ungrammatical condition from the grammatical condition, there is a substantial degree of variability in the at-risk group which resembles that of the group of SLI children.

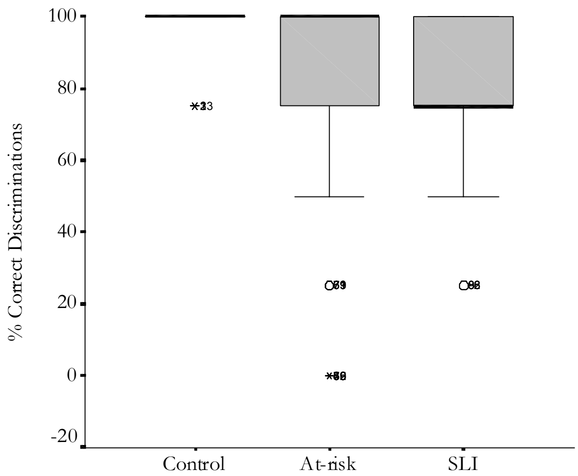

Figure 1. The distribution of the percentages of correct discrimination for the test condition 'bare participle' across the three groups.

It is important to note however, that only a sub-set of children in the at-risk group experienced difficulties with this test condition (this is also true of the SLI group, but this point is discussed in section 6.6.). In figure 2, the distribution of the test scores for sub test A is shown in a histogram. The obtained scores are divided into 5 categories and are represented on the x-axis. Category 1 represents a score of 0/4, category 2 represents a score of 1/4, category 3 represents a score of 2/4, category 4 represents a score of 3/4 and category 5 represents a score of 4/4 (the condition was tested on four occasions) .

Figure 2 clearly shows that the majority of subjects in the at-risk group scored in the high range, similar to the subjects in the control group. Given that only around 40% of the at-risk children will develop dyslexia, one expects more than half of the at-risk children to behave like the control children. This expectation is realized here. Still, the group differences are noticeable. Whereas 87.5% of the control children scored full marks on this condition, only 57.4% of the at-risk subjects and 38.1% of the SLI subjects obtained full marks. Furthermore, none of the remaining control children scored lower than ¾, while some of the remaining subjects in the other two groups clearly scored in the lowest ranges.

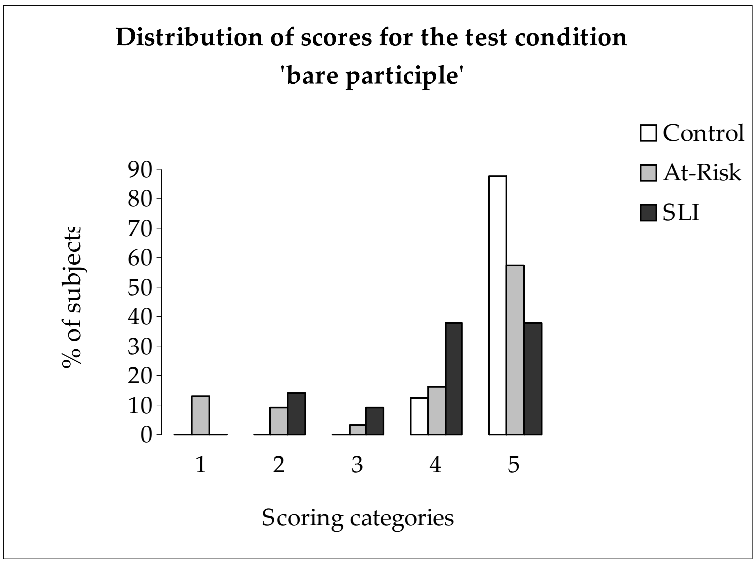

Figure 2. Distribution of scores for the condition 'bare participle' per group.

6.5.2. The relation between 'kan' and the infinitive

Table 3 contains the mean percentages of correct discriminations and standard deviations obtained in subtest B. The means are again given separately for each of the test conditions (the target construction contained modal *kan* + infinitive).

Table 3. Mean percentages of correct discriminations (per test condition) for the target construction '*kan* + infinitive'.

	Test Conditions					
	Grammatical (modal + infinitive)		Ungrammatical I (aux + infinitive)		Ungrammatical II (bare infinitive)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Control	98.91	(5.21)	98.91	(5.21)	100	(0)
At-Risk	97.88	(7.42)	97.55	(7.51)	96.57	(12.26)
SLI	88.75	(15.12)	77.5	(28.75)	82.5	(25.77)

A repeated measures analysis with group as between-subjects factor and test condition as within subjects factor showed a significant effect for group ($F_{(2, 91)} = 24.06$, $p < .000$), while no effect was found for test condition ($F_{(1.9, 173.3)} = 2.05$, $p = .135$). Furthermore, there was no significant interaction between the main effects, suggesting that the different test conditions did not interfere in different ways with children's ability to discriminate ungrammatical constructions from grammatical constructions. Post hoc testing showed that the SLI group was significantly different from the other two groups. The mean scores of the SLI group were significantly lower than the mean scores obtained by the control- and at-risk groups (Control-SLI: $p < .000$, $SE = 2.65$; At-risk-SLI: $p < .000$, $SE = 2.29$). Figures 3 and 4 give an indication of the different distribution of scores in the SLI group compared to those of the control and at-risk groups. Note that the variability in the SLI group is bigger for the test condition 'aux-infinitive' than in the test condition 'bare infinitive'. Thus, the children with SLI more often considered a construction like *het paard heeft rennen* to be the same as *het paard kan rennen* than that they considered a construction like *het paard rennen* to be the same as *het paard kan rennen*.

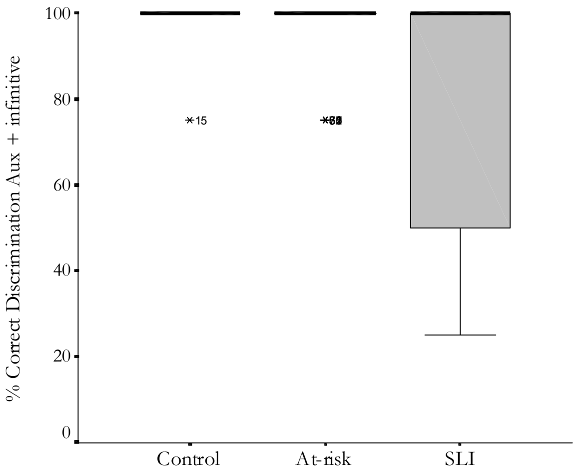

Figure 3. The distribution of the percentages of correct discrimination for the test condition 'aux + infinitive' across the three groups.

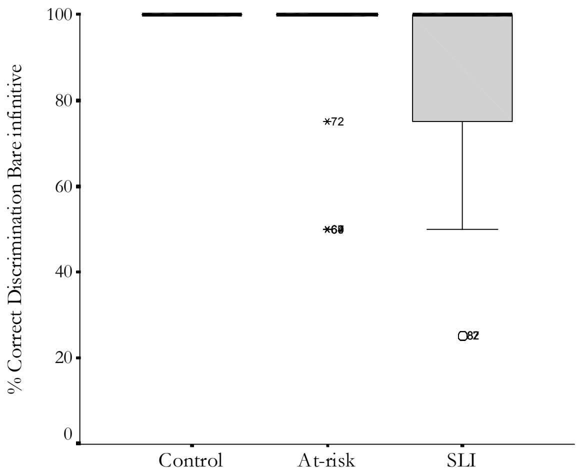

Figure 4. The distribution of the percentages of correct discrimination for the test condition 'bare infinitive' across the three groups.

There were no significant differences between the control and at-risk groups, even though the at-risk group did have more outliers than the control group.

6.6. Discussion

In this chapter, three specific research questions were raised. Each of these questions is discussed here in turn.

The first question was:

> (i) Are Dutch school-going children at-risk for dyslexia as sensitive to the morphosyntactic relation between an auxiliary and its verbal complement as their normally developing peers?

This question has a twofold answer. With regard to the morphosyntactic relation between the modal auxiliary *kan* and the infinitive form of the main verb, the data clearly show that the at-risk children *are* sensitive to the dependency between these elements (i.e. they know that the modal *kan* takes an infinitive as its complement). The at-risk children experienced no problems in judging sentences containing a temporal auxiliary together with an infinitive or a bare infinitive as different from sentences containing a modal together with the infinitive. In this sense, the at-risk children resemble the normally developing children.

Regarding the morphosyntactic relation between the temporal auxiliary *heeft* and the past participle form of the main verb, the findings are different. Overall (i.e. looking at the outcome for all of the test conditions combined), the at-risk group did not statistically differ from the control group in their ability to discriminate ill-formed relations from well-formed relations. Even so, the test condition itself did have an effect on this ability; and the presence of an interaction between *group* and *test condition* indicated that this effect was not the same for the three groups. Indeed, post hoc testing confirmed that the at-risk subjects found it significantly more difficult to distinguish between a grammatical and an ungrammatical sentence when the ungrammatical sentence contained the bare participle condition. This effect was not significant in the other two groups. In other words, the at-risk children had no problem in judging a sentence containing a modal *kan* together with the past participle as different from a sentence containing the auxiliary *heeft* and the past participle, but a subset of at-risk children failed to judge sentences containing a bare participle as different from sentences containing *heeft* and the past participle. Essentially, these children did not seem to notice the absence of the temporal auxiliary and therefore did not notice the ungrammaticality of such sentences. In effect, they accepted ungrammatical sentences as correct.

This finding can provide insight into our knowledge of the linguistic typology of developmental dyslexia. Clearly, only some areas of language (as far as morphosyntax goes) are affected in dyslexia. This point will be discussed further in the final paragraph of this discussion.

The second question was:

> (ii) Are Dutch children with SLI as sensitive to the morphosyntactic relation between an auxiliary and its verbal complement as their normally developing peers?

The children in the SLI group were clearly outperformed by the normally developing children and (to a lesser extent) by the at-risk children. The children with SLI were reasonably successful in correctly judging the grammatical test condition to be the same as the target structure. Apart from this, no clear pattern emerged from the data. A small subset of the children with SLI (7 out of 21 subjects) had no problems with the task and scored similar to the normally developing children on all of the conditions. But the remainder of the children with SLI seemed to arbitrarily assign the labels 'the same' or 'different' to the different test sentences. Experimenter reports indicated that the remaining 14 SLI subjects were either not concentrated or did not grasp the task. The experimenters typically reported on their behaviour with written remarks such as *"Michiel zat in zijn stoel te draaien en* *leek maar wat te doen" (Michiel moved around on his chair and seemed unconcentrated).* The performance of these children caused the group of SLI children to perform significantly more poorly in both subtests than the normally developing children. One could conclude that the group of children with SLI is thus less sensitive to the relation between both sets of dependent morphemes tested in this study. Decreased sensitivity to the temporal auxiliary *heeft* is to be expected, given the fact the children with SLI often have problems with tense-related morphemes. However, the conclusion that the children with SLI are also less sensitivity to the modal *can* is somewhat surprising. Previous studies have found modals to be acquired relatively early and effortless in SLI. One possibility is that this is not the case for Dutch children with SLI. Most probably, however, the group of SLI children comprised many subjects whose apparent problems reflect their inability to answer to the demands of the task rather than a decreased sensitivity to the morphosyntactic dependencies under investigation. This is not to say that they are sensitive to these relations, but to stress that the task probably measured something else/additional in these children. Working memory abilities and attention span (to name two obvious factors) most likely interfered with the outcome of the task in the SLI group.

The final research question was:

> (iii) Do the at-risk children resemble the children with SLI and if so, can their behaviour be explained in terms of the linguistic theories of SLI?

Excluding their ability to discriminate constructions such as **het paard gerend* from *het paard heeft gerend*, the at-risk children closely resembled the normally developing children (and not the children with SLI). Based on the results of this study developmental dyslexia and SLI seem to be quite different one another. The at-risk children clearly demonstrated that they understood the task and had no significant problems in completing it. The SLI children, on the other hand, produced unclear data and created the impression that they did not fully grasp the task. The problems that the SLI children encountered cannot simply be explained as a deficit in working memory, as the at-risk children in this study also suffer from impaired working memory abilities (chapter 5, this dissertation). Some other cognitive dysfunction is apparently implicated in the SLI group, related to their inability to grasp the demands of the task. Nevertheless, the finding that the at-risk children were significantly impaired in one of the test conditions requires an explanation.

One possible explanation for the at-risk children's failure to discriminate between constructions such as *het paard heeft gerend* and **het* *paard gerend* is that the phonetic properties of the auxiliary cause this item to be less salient and therefore more prone to omission. It could be that some at-risk children do not perceive items like auxiliaries properly and that they therefore did not detect the lexical gap in constructions like **het paard gerend.* Such an explanation is in line with the surface hypothesis account of SLI. For at least two reasons, this explanation is not feasible. The first is that the at-risk children had no problems in discriminating between constructions like *het paard kan rennen* and **het paard rennen*. In terms of phonetic salience, the modal *kan* is similar to the auxiliary *heeft* and is just as prone to omission. If it is only a matter of surface properties, constructions like **het paard rennen* and **het paard gerend* should have been equally difficult to discriminate from their grammatical counterparts. Yet, the data indicate that this is not the case. The second reason why this explanation cannot hold is that the at-risk children in this study *are* capable of perceiving and producing auxiliaries. The results from the sentence imitation task (chapter 5 of this dissertation) indicated that the at-risk children were not significantly different from normally developing children in their ability to perceive and produce the temporal auxiliary *heeft*. Processing demands (specifically a complex argument structure) did influence the production of the auxiliary; but such processing demands were not a factor in this study.

A second explanation is that the at-risk children consider Tense to be an optional feature of the language and that they are therefore less sensitive to the omission of a tense-related morpheme such as *heeft*. Such an explanation is in line with the Extended Optional Infinitive (EOI) account of SLI. Admittingly, the modal *kan* is also marked for Tense. So why is *heeft* affected and *kan* not? Leonard et al.'s (2003) proposal that the modal and aspectual properties of grammatical morpheme can be acquired without necessarily acquiring the tense feature of this morpheme provides a straightforward explanation for the behaviour of the at-risk children. The aspectual features of the past participle construction are not only marked by the temporal auxiliary but also by the verbal morphology of the past participle form of the main verb. Thus, in a construction such as *het paard heeft gerend,* the semantic role of the auxiliary (i.e. conveying the aspectual notion perfective) is not essential. This aspectual notion is also incorporated in the affixes *ge-* and *–d* that attach to the main verb. Thus, if tense is considered to be optional, the auxiliary becomes redundant. For constructions containing a modal, the optionality of Tense does not lead to the same scenario. In constructions such as *het paard kan rennen*, the semantic function of the modal auxiliary (i.e. conveying the notion possibility) is not supported by verbal morphology on the main verb. The infinitive is not marked for tense, but also does not express modality. Thus, even when Tense is considered to be optional, the auxiliary *kan* remains essential as it expresses dynamic modality in the sentence. The behaviour of the at-risk children can be explained by the EOI account; it appears as if these children go through a prolonged period in which they consider tense to be optional. However, the EOI account also predicts the omission of tense related morphemes in language production. The various studies of this dissertation have found little evidence that the auxiliary *heeft* is omitted in production, at least not within the experiments conducted here. Thus, even though the EOI account can explain the results of this chapter, it does not seem like a logical explanation when the results from the rest of this dissertation are also taken into account.

Finally, as also suggested in previous chapters, it could be that the at-risk children suffer from a general processing limitation and that they are therefore constantly trying to reduce the load on their processing resources. One could argue that (semantically speaking) the auxiliary *heeft* does not play a crucial role in the interpretation of a sentence like *het paard heeft gerend*. The subject NP and the past participle are sufficient elements for understanding the message that someone/thing is doing something at a given moment in time. In this sense the auxiliary *heeft* can be seen as redundant as it does not add anything to the meaning of the sentence. Its function is purely syntactic. It is possible that the at-risk children intuitively opt not to process such 'redundant' material as it gives them more time to focus on the essential information in a message.

The results of the present study suggest that morphosyntactic deficits are still present in the language of children at-risk for dyslexia when these children reach school-going age. This finding is in line with previous studies that also found (morpho)-syntactic deficits in school-going children at-risk for dyslexia and children diagnosed with dyslexia. As mentioned earlier, this finding also adds to our understanding of type of linguistic deficits that are to be expected in developmental dyslexia. Regarding their sensitivity to morphosyntactic dependencies, children at risk for dyslexia are only selectively impaired. It seems as if syntactic elements are easily 'lost' (i.e. it is not processed sufficiently to be retained in memory) when they are not critical for the comprehension of a sentence. As a result, children at risk for dyslexia are expected to commit errors in their perception and production of morphosyntactic dependencies when such dependencies include 'redundant' elements. In Dutch, apart from the dependency discussed in this thesis, the dependency between the subject NP and the main verb would (for example) also be at risk. With regard to the linguistic typology of developmental dyslexia, one could conclude that dyslexics are more likely to commit perception and production errors in areas of language that contain 'redundant' morphosyntactic information.

6.7. Summary

In this chapter, school-going children with a genetic risk for developing dyslexia were assessed on their ability to discriminate well-formed morphosyntactic dependencies from ill-formed morphosyntactic dependencies. The at-risk children were compared to normally developing children and to children with SLI. Sensitivity to two structures was tested; namely to the relation between the temporal auxiliary *heeft* and the past participle and to the relation between the modal *kan* and the infinitive. The normally developing children proved to be sensitive to both dependencies; these children had no problems discriminating grammatical from ungrammatical morphosyntactic dependencies. Statistically, the at-risk children did not differ from the normally developing children as a group, but a sub-set of these children experienced striking difficulties in discriminating sentences containing the temporal auxiliary *heeft* and the past participle from sentences containing a bare participle. The group of SLI children performed significantly more poorly than the other two groups. Unfortunately, it is less clear whether this outcome reflects decreased sensitivity to the structures, as the experimental outcome was most likely influenced by the demands of the task.

Chapter 7

Summary and Conclusions

7.1. Summary of the experimental work

The main objective of the experimental work described in this dissertation was to uncover linguistic precursors of developmental dyslexia. Specifically, early signs of dyslexia were sought in the morphosyntactic domain of language. Most of the present experiments assessed children's ability to *perceive* morphosyntactic dependency relations, although the *production* of such dependencies was also tested. The perception and production of the past participle (which constitutes a morphosyntactic dependency between the auxiliary *hebben* and the past participle form of the verb) was highlighted in this dissertation. Dutch children acquire the past participle early (around the age of 3:0), which makes this specific morphosyntactic construction ideal for discovering early deficits in the syntactic competence of children at risk for developing dyslexia. A secondary goal of this dissertation was to study the relation between developmental dyslexia and specific language impairment. Consequently, three groups of children took part in the experiments, namely children with an increased genetic risk for dyslexia, children with specific language impairment and normally developing children.

As mentioned in the introductory chapters of this dissertation, only around 40% of the children at risk for dyslexia will eventually develop the syndrome. For this reason, the expectation was that, if linguistic precursors were present in the at-risk group, they would manifest only in a subgroup of the at-risk group. In the following paragraphs, the at-risk group is often said to be *different* from the control group. The assumption is always, however, that only a sub-group of the at-risk children are responsible for the different behaviour of the group as a whole.

In chapter 3, Dutch children's ability to discriminate between a grammatical and an ungrammatical morphosyntactic agreement relation was studied. The main finding of this chapter is that the at-risk children with a genetic risk for dyslexia (aged 19 months) seem to be less sensitive to a discontinuous morphosyntactic dependency than their normally developing peers. When presented with sentences containing either a grammatical morphosyntactic dependency or an ungrammatical morhosyntactic dependency, normally developing children prefer to listen to the sentences containing the grammatical dependency (i.e. sentences containing the auxiliary *heeft* and the past participle). At-risk children, on the other hand, show no such preference. Additionally, it was established that the perceptual language development of the at-risk children is delayed by at least six months and that normally developing children's ability to detect a discontinuous dependency is limited. Under strenuous conditions, normally developing children's perceptual behaviour is similar to that of the at-risk children.

The experimental data collected in chapter 4 provide evidence that, in general, children at risk for dyslexia (aged 3;6) are as capable as their normally developing peers to produce the auxiliary *heeft* (*has)* and the past participle form of the verb. However, at this age, at-risk children generate significantly fewer instances of the complete past participle construction than their normally developing peers. This is especially true in situations where processing resources are taxed. Furthermore, when they fail to use the past participle form of the verb (where this form is the expected form), the at-risk children (as a group) use different strategies to complete a sentence than normally developing children. Whereas normally developing children generally opt for grammatical verb forms, some at-risk children produce ungrammatical verb forms. For example, at-risk children use significantly more infinitives in the complement position of the auxiliary verb *heeft* than normally developing children. This suggests that the representation of the morphosyntactic dependency between *heeft* and the past participle is less stable in children at risk for dyslexia than in normally developing children. Finally, productive performance is affected more in at-risk children than in normally developing children when processing resources are taxed. Specifically, in sentences containing a verb with a complex argument structure, at-risk children omit verbal morphology more frequently and they produce more ungrammatical utterances than normally developing children.

The effect of verb argument structure complexity on the production of functional items was further examined in chapter 5 (the study in chapter 4 included only normally developing and at-risk children, while the study in chapter 5 also included a group children with SLI). Additionally, the effect of sentence length and of short term memory on the production of functional items was also investigated (seeing that an increase in argument structure complexity also causes a sentence to increase in length). The influence of verb argument structure complexity was assessed with a sentence imitation task. Statistical analyses of the data gathered from this experiment indicate that argument structure complexity has an effect on auxiliary omission and on determiner omission, but not on the omission of *ge-* (where *ge-* is a verbal prefix). The effect of argument structure is most evident in the at-risk group as these children omit significantly more auxiliaries in sentences containing an intransitive verb than in sentences containing an intransitive or a transitive verb. Sentence length has no effect on auxiliary omission or on *ge-*

omission, but it does have an effect on determiner omission. The length effect is again most evident in the at-risk group; these children produce significantly fewer determiners in the longest sentences. In a second experiment, verbal working memory was assessed by means of a digit span task. The results of this experiment show that children with SLI and children at risk for dyslexia have significantly poorer short term memory skills than normally developing children, a factor that could have influenced their performance in the sentence imitation task. However, statistical analysis shows that the capacity of a child to imitate sentences is weakly correlated to short term memory. Short term memory can therefore not be the sole factor influencing the omission of functional items.

In chapter 6, school-going children (average age 5; 1) with a genetic risk for developing dyslexia were assessed on their ability to discriminate well-formed morphosyntactic dependencies from ill-formed morphosyntactic dependencies. The at-risk children were compared to normally developing children and to children with SLI. Sensitivity to two structures was tested; namely to the relation between the temporal auxiliary *heeft* and the past participle and to the relation between the modal *kan* and the infinitive. Normally developing children (aged 5:0) are sensitive to both dependencies; these children have no problems discriminating grammatical from ungrammatical morphosyntactic dependencies. As a group, the at-risk children are not significantly different from the normally developing children with regard to their discriminative abilities. Even so, a sub-set of the at-risk children have striking difficulties in discriminating sentences containing the temporal auxiliary *heeft* and the past participle from sentences containing a bare participle. The group of SLI children performed significantly more poorly than the other two groups, suggesting a problem in their grasp of the linguistic demands of the task.

7.2. Theoretical implications

A secondary aim of this dissertation was to investigate the possible link between developmental dyslexia and SLI. Therefore, an area of language (i.e. morphosyntax) that is known to be problematic in children with SLI was also investigated in children at-risk for dyslexia. Difficulties in the area of morphosyntax are undisputed in SLI, which is not the case in dyslexia. For this reason, a linguistic category that is typically problematic in SLI (auxiliaries) was studied in children at-risk for dyslexia. In other words, morphosyntactic difficulties that are typical in SLI were used as a yardstick of possible morphosyntactic difficulties in dyslexia. Consequently, theories of SLI could be potentially useful in understanding developmental dyslexia if children with dyslexia are found to have similar difficulties as children with SLI.

With regard to the perception and production of the past participle, theories of SLI that presume a deficit in grammatical competence are not very helpful in explaining the data of the at-risk children in this study. The at-risk subjects do not seem have a deviant morphosyntactic system, which would be the prediction of accounts such as the missing feature hypothesis, the missing agreement hypothesis and the RDDR hypothesis. Theories of SLI that presume a deficit in processing capacity are more useful in explaining the behaviour of the at-risk children in this sample. Children with a genetic risk for dyslexia clearly suffer from a limitation in their ability to process complex information, a symptom which would be predicted by theories such as the limited processing account and the surface hypothesis. Some of the data produced by the at-risk children, notably the data in chapter 6, are compatible with the predictions of the Extended Optional Infinitive Account of SLI. It is thus possible that specific developmental stages (such as the optional infinitive stage) are prolonged in developmental dyslexia. If this is indeed the case, one can at most say that specific aspects of the language development of dyslexic children are delayed.

In the end, a limited processing account seems to be the only theory that can account for *all* of the findings in this dissertation. It is useful to summarize how a limited processing capacity theory can explain the various findings regarding the at-risk children in this study. When the results of the various studies conducted in this thesis are viewed simultaneously, one could interpret the findings as follows. Children at-risk for dyslexia suffer from a limitation in their general processing capacity. Such a limitation potentially affects (i) the size of the computational region of memory (i.e. the available work space), (ii) the energy available for computational processes and (iii) the rate at which information can be processed. In chapter 3, the at-risk children were not able to detect a discontinuous morphosyntactic dependency when the dependent morphemes were separated by a two-syllable interval. This could be seen as a result of the size of their processing window. In other words, the at-risk children were not able to process (and remember) large enough pieces of the input in order to discover that the input sometimes contained a discontinuous dependency. It is also possible that the at-risk children's processing rate was inadequate. When incoming information is not processed quickly enough, it is susceptible to decay and to interference from further incoming information. The results of chapters 4 and 5 can be explained in terms of energy. In these studies, the at-risk children showed evidence of being able to perceive and produce closed class items; however, this ability decreased when argument structure complexity increased. In these situations, the task of constructing a sentence is started but all of the energy available is exhausted before the sentence construction can be completed. In chapter 6, the at-risk children failed to identify an ungrammatical morphosyntactic dependency, but only when the ungrammaticality did not hinder the semantic interpretation of the sentence. Because they suffer from a general processing limitation, the at-risk children 'choose' to omit information during sentence processing if it is redundant for comprehending or conveying the intended message. Along these lines, a theory of limited processing capacity can account for the findings described in this thesis.

Since the relationship between developmental dyslexia and SLI was a main focus point in this dissertation and since morphosyntactic problems are generally accounted for by theories of SLI, it was (to begin with) considered whether a theory of SLI could also account for the findings described in this dissertation. In theory, it should also be possible to interpret the findings within the framework of a current theory of developmental dyslexia. However, the findings of this dissertation are not easily explained with any of the traditional theories of dyslexia. The phonological deficit theory focuses exclusively on the phonological problems experienced by dyslexics. The link between a pure phonological deficit and a general processing limitation is definitely not straightforward. Theories that do mention a processing deficit, like the temporal processing deficit theory and the magnocellular theory assume dyslexia to be the result of a very specific processing deficit (namely an inability to perceive and process short or rapidly varying acoustic events adequately). In contrast to the predictions of such theories, the at-risk children in this study *are* capable of perceiving and processing (relatively) short acoustic events, but they sometimes fail to do so when their processing resources (in general) are severely taxed. It might be possible to explain a general processing deficit with the cerebellar deficit hypothesis. Seeing that the cerebellum is involved in language processes such as lexical retrieval (Marien et al., 2001) and the linking of nouns to verbs (Gebhart et al., 2002) one could argue that a (mildly) dysfunctional cerebellum will cause slow/inefficient language processing and that this, in turn, will force dyslexics to omit certain aspects of a syntactic structure during sentence production. However, given the present results, one would then also have to assume that the dysfunction in the cerebellum does not affect language production at all times, but only when complex syntactic structures have to be processed.

7.3. Clinical implications

The results of this study have several clinical implications. Developmental dyslexia is commonly described as a phonological deficit. As a result, early identification of and intervention in dyslexia frequently concentrates on the field of phonological awareness. Yet, the experiments conducted in this dissertation clearly show that children at-risk for dyslexia (and by hypothesis children with dyslexia) suffer from a general processing limitation, which affects their perception and production of morphosyntactic structures. Whilst the fact that dyslexics suffer from a phonological deficit is not disputed here, it is not clear how such a deficit could explain a general processing limitation. Intervention that concentrates only on phonological awareness may well strengthen dyslexics' reading ability, but other complex tasks (such as the processing of long/complex sentences) will remain problematic in dyslexic individuals. With regard to the early identification of dyslexia, clinicians might benefit from a language test that includes a section assessing syntactic processing.

As mentioned in the general introduction of this dissertation, researchers have recently questioned the division between developmental dyslexia and specific language impairment. This dissertation provides evidence that such a division is essential. The performance of the children with SLI is noticeably *different* from that of the children at-risk for dyslexia. This difference is clearest in the experiment conducted in chapter 6, where some of the children with SLI experienced noticeable difficulties with the linguistic demands of the task. It is not clear how researchers or clinicians would benefit from a situation where dyslexia and SLI are seen as different manifestations of the same disorder. Such an amalgamation would cause yet another heterogeneous group of children with language disorders; making it even more difficult to decide what type of clinical intervention a child needs.

Finally, one has to wonder if intervention can ever cure a dyslexic suffering from a general processing limitation. It turns out that, in spite of intense remediation, some dyslexics still struggle with sentence formulation as adults. A general processing limitation which remains as a life-long deficit, even after reading skills have been improved, could explain such problems. A general processing limitation could also explain why the early (often mild) language problems reported in dyslexic children seem to resolve in adulthood, as processing capacity is assumed to increase with age (up to a certain age at least).

7.4. General conclusion

The work presented in this thesis provides evidence that the morphosyntactic development of children with a predisposition for dyslexia is different from that of normally developing children. Although at-risk children do not, in general, exhibit *deviant* morphosyntactic development, their representation of specific morphosyntactic dependencies seems vulnerable. In taxing situations, for example in sentences containing a verb with a complex argument structure, these children are more likely (than their normally developing peers) to generate ungrammatical constructions, to omit functional items such as auxiliaries and determiners and to omit verbal morphology. Rather than having a deficient morphosyntactic system, children at risk for dyslexia have a limited processing capacity that affects their control over morphosyntactic dependency relations. An inability to discriminate between well-formed and ill-formed morphosyntactic dependency relations in taxing situations could thus be described as a possible linguistic precursor of developmental dyslexia.

Appendices

Appendix A
Stimulus material: chapter 3, experiment 1.

1. Grammatical passages

i.) 8 sentences, 49 words, 78 syllables
De zon heeft helder geschenen. Het vrolijke meisje heeft buiten gerend. Mama heeft heerlijk gezwommen. De hond heeft dorstig gedronken uit zijn bak. De jongen heeft keihard geschreeuwd toen hij uit de boom viel. Zijn zusje heeft hardop gelachen. De hamster heeft eenzaam gepiept, want iedereen heeft elders gespeeld.

ii.) 8 sentences, 48 words, 78 syllables
Het heeft vandaag geregend. De jongen heeft ’s ochtends gehuild, omdat hij niet naar buiten mocht. Het kleine meisje heeft binnen gespeeld. Mama heeft vluchtig gestofzuigd in de kamer. Papa heeft echter gelezen. De jongen heeft lekker gedoucht. De poes heeft alweer gemiauwd. De hond heeft ineens gegromd naar de poes.

iii.) 8 sentences, 49 words, 78 syllables
De familie heeft ‘s avonds gegeten. Iedereen heeft samen gekletst. Papa heeft even geproefd van de soep. Het meisje heeft meteen gezegd dat het goed smaakte. Haar broer heeft gulzig gesmuld. Oma heeft altijd gedacht dat mama niet kon koken. Mama heeft later geglimlacht en oma heeft bijna gebloost.

iv.) 8 sentences, 51 words, 78 syllables
De haan heeft ’s morgens gekraaid op de boerderij. De stoute hond heeft aaneen geblaft. Het paard heeft ‘s midags gehinnikt. Het vieze varken heeft slordig gevreten. De koe heeft doodstil gestaan in de wei. De boer heeft harder gewerkt dan gisteren. De boerin heeft gezond gekookt en haar man heeft genoeg gegeten.

v.) 8 sentences, 48 words, 78 syllables
De wind heeft zachtjes gewaaid in het bos. De tijger heeft vreedzaam gelegen, maar een leeuw heeft ergens gebruld. Het hert heeft gespitst geluisterd. De haas heeft zierlijk gesprongen. De giraffe heeft rustig gedronken bij de waterbron. De olifant heeft luidkeels getrompetterd en de vogel heeft prachtig gezongen.

vi.) 8 sentences, 47 words, 78 syllables
De familie heeft dikwijls gewandeld. Iedereen heeft ervan genoten. Opa heeft langzaam gelopen. Het kind heeft vooral gehuppeld. Mama heeft meestal gezocht naar eenden. De baby heeft verschrikt gehuild. Haar broer heeft gemeen gezegd dat zij eenden eng vond. Papa heeft verbaasd gezien dat het donker werd.

vii.) 8 sentences, 50 words, 77 syllables
De agent heeft zoveel gezien! De auto heeft sneller gereden dan de bus. Het kind heeft netjes gewacht op het stoplicht. De vrachtauto heeft linksaf gereden. De fietser heeft steunend gefietst. De dief heeft zowaar geprobeerd een tas te stelen. De vrouw heeft angstig geroepen. Een man heeft bijtijds geholpen.

viii.) 8 sentences, 47 words, 77 syllables
Iedereen heeft vannacht geslapen. Opa heeft snurkend gedroomd over biefstuk en frietjes. Het kind heeft doodmoe gegaapt. Oma heeft snuivend gedut. De wekker heeft 's ochtends gerinkeld. Papa heeft daarna gedoucht. De jongen heeft botweg geweigerd om op te staan. Mama heeft liefjes gezegd dat het toch moest.

2. Ungrammatical passages

i.) 8 sentences, 49 words, 78 syllables
De zon kan helder geschenen. Het vrolijke meisje kan buiten gerend. Mama kan heerlijk gezwommen. De hond kan dorstig gedronken uit zijn bak. De jongen kan keihard geschreeuwd toen hij uit de boom viel. Zijn zusje kan hardop gelachen. De hamster kan eenzaam gepiept, want iedereen kan elders gespeeld.

ii.) 8 sentences, 48 words, 78 syllables
Het kan vandaag geregend. De jongen kan 's ochtends gehuild, omdat hij niet naar buiten mocht. Het kleine meisje kan binnen gespeeld. Mama kan vluchtig gestofzuigd in de kamer. Papa kan echter gelezen. De jongen kan lekker gedoucht. De poes kan alweer gemiauwd. De hond kan ineens gegromd naar de poes.

iii.) 8 sentences, 48 words, 78 syllables
De familie kan 'savonds gegeten. Iedereen kan samen gekletst. Papa kan even geproefd van de soep. Het meisje kan meteen gezegd dat het goed smaakte. Haar broer kan gulzig gesmuld. Oma kan altijd gedacht dat mama niet kon koken. Mama kan later geglimlacht en oma kan bijna gebloost.

iv.) 8 sentences, 51 words, 78 syllables
De haan kan 's morgens gekraaid op de boerderij. De stoute hond kan aaneen geblaft. Het paard kan 's midags gehinnikt. Het vieze varken kan slordig gevreten. De koe kan doodstil gestaan in de wei. De boer kan harder gewerkt dan gisteren. De boerin kan gezond gekookt en haar man kan genoeg gegeten.

v.) 8 sentences, 48 words, 78 syllables
De wind kan zachtjes gewaaid in het bos. De tijger kan vreedzaam gelegen, maar een leeuw kan ergens gebruld. Het hert kan gespitst geluisterd. De haas kan zierlijk gesprongen. De giraffe kan rustig gedronken bij de waterbron. De olifant kan luidkeels getrompetterd en de vogel kan prachtig gezongen.

vi.) 8 sentences, 47 words, 78 syllables

De familie kan dikwijls gewandeld. Iedereen kan ervan genoten. Opa kan langzaam gelopen. Het kind kan vooral gehuppeld. Mama kan meestal gezocht naar eenden. De baby kan verschrikt gehuild. Haar broer kan gemeen gezegd dat zij eenden eng vond. Papa kan verbaasd gezien dat het donker werd.

vii.) 8 sentences, 50 words, 77 syllables

De agent kan zoveel gezien! De auto kan sneller gereden dan de bus. Het kind kan netjes gewacht op het stoplicht. De vrachtauto kan linksaf gereden. De fietser kan steunend gefietst. De dief kan zowaar geprobeerd een tas te stelen. De vrouw kan angstig geroepen. Een man kan bijtijds geholpen.

viii.) 8 sentences, 47 words, 77 syllables

Iedereen kan vannacht geslapen. Opa kan snurkend gedroomd over biefstuk en frietjes. Het kind kan doodmoe gegaapt. Oma kan snuivend gedut. De wekker kan 's ochtends gerinkeld. Papa kan daarna gedoucht. De jongen kan botweg geweigerd om op te staan. Mama kan liefjes gezegd dat het toch moest.

Appendix B
Stimulus material: chapter 3, experiment 3.

Grammatical passages

i.) 8 sentences, 57 words, 93 syllables
De zon heeft vandaag helder geschenen. Het kleine meisje heeft vrolijk buiten gerend. Mama heeft 's middags heerlijk gezwommen. De hond heeft heel erg gulzig gedronken uit zijn bak. De jongen heeft hartverscheurend gehuild toen hij uit de boom viel. Zijn zusje heeft bijna hardop gelachen. De hamster heeft opgewonden gepiept, want iedereen heeft samen buiten gespeeld.

ii.) 8 sentences, 58 words, 94 syllables
Het heeft vandaag keihard geregend. De jongen heeft 's ochtends snikkend gehuild, omdat hij niet naar buiten kon. Het kleine meisje heeft rustig binnen gespeeld. Mama heeft eerst ijverig gestofzuigd in de kamer. Papa heeft ongetwijfeld gelezen. De jongen heeft 's avonds lekker gedoucht. De poes heeft alweer klagend gemiauwd. De hond heeft ineens dreigend gegromd naar de poes.

iii.) 8 sentences, 55 words, 94 syllables
De familie heeft 's avonds samen gegeten. Iedereen heeft opgewonden gekletst. Papa heeft eerst voorzichtig geproefd van de soep. Het meisje heeft echter liefjes gezegd dat het goed smaakte. Haar broer heeft naar hartelust gesmuld. Oma heeft zoals altijd gedacht dat mama niet kon koken. Mama heeft later schuchter geglimlacht en oma heeft bijna dieprood gebloosd.

iv.) 8 sentences, 59 words, 94 syllables
De haan heeft 's morgens verwaand gekraaid op de boerderij. De stoute hond heeft herhaaldelijk geblaft. Het paard heeft zenuwachtig gehinnikt. Het vieze varken heeft onwijs slordig gevreten. De koe heeft heel tevreden gestaan in de wei. De boer heeft zeker harder gewerkt dan gisteren. De boerin heeft daarom heerlijk gekookt en haar man heeft meer dan genoeg gegeten.

v.) 8 sentences, 56 words, 94 syllables
De wind heeft vannacht zachtjes gewaaid in het bos. De tijger heeft lekker vreedzaam gelegen en een leeuw heeft ergens ver weg gebruld. Het hert heeft almaar gespitst geluisterd. De haas heeft uitbundig hoog gesprongen. De giraffe heeft 's morgens rustig gedronken bij de waterbron. De olifant heeft geweldig hard getrompetterd en de vogel heeft ontzettend mooi gezongen.

vi.) 8 sentences, 56 words, 94 syllables
De familie heeft zondag buiten gewandeld. Iedereen heeft er heel veel van genoten. Opa heeft echter moeizaam gelopen. Het kind heeft vrolijk vooraan gehuppeld. Mama heeft natuurlijk weer gezocht naar eenden. De baby heeft ineens doodsbang gehuild. Haar broer heeft onsympathiek gezegd dat zij eenden eng vond. Papa heeft later verbaasd gezien dat het donker werd.

vii.) 8 sentences, 58 words, 94 syllables
De agent heeft vandaag zoveel gezien! De auto heeft ietsje sneller gereden dan de bus. Het kind heeft gelukkig braaf gewacht voor het stoplicht. De vrachtauto heeft snel achteruit gereden. De fietser heeft heel erg langzaam gefietst. De dief heeft alweer stiekem geprobeerd een tas te stelen. Een vrouw heeft meteen benauwd geroepen. Haar man heeft schijnbaar angstig geholpen.

viii.) 8 sentences, 56 words, 93 syllables
Iedereen heeft vannacht rustig geslapen. Opa heeft erg onrustig gedroomd over biefstuk en frietjes. Het kind heeft 's avonds doodmoe gegaapt. Oma heeft vreselijk hard gesnurkt. De wekker heeft 's ochtends keihard gerinkeld. Papa heeft daarna haastig gedoucht. De jongen heeft alweer botweg geweigerd om op te staan. Mama heeft een beetje boos gezegd dat het toch moest.

Ungrammatical passages

i.) 8 sentences, 57 words, 93 syllables
De zon kan vandaag helder geschenen. Het kleine meisje kan vrolijk buiten gerend. Mama kan 's middags heerlijk gezwommen. De hond kan heel erg gulzig gedronken uit zijn bak. De jongen kan hartverscheurend gehuild toen hij uit de boom viel. Zijn zusje kan bijna hardop gelachen. De hamster kan opgewonden gepiept, want iedereen kan samen buiten gespeeld.

ii.) 8 sentences, 58 words, 94 syllables
Het kan vandaag keihard geregend. De jongen kan 's ochtends snikkend gehuild, omdat hij niet naar buiten kon. Het kleine meisje kan rustig binnen gespeeld. Mama kan eerst ijverig gestofzuigd in de kamer. Papa kan ongetwijfeld gelezen. De jongen kan 's avonds lekker gedoucht. De poes kan alweer klagend gemiauwd. De hond kan ineens dreigend gegromd naar de poes.

iii.) 8 sentences, 55 words, 94 syllables
De familie kan 's avonds samen gegeten. Iedereen kan opgewonden gekletst. Papa kan eerst voorzichtig geproefd van de soep. Het meisje kan echter liefjes gezegd dat het goed smaakte. Haar broer kan naar hartelust gesmuld. Oma kan zoals altijd gedacht dat mama niet kon koken. Mama kan later schuchter geglimlacht en oma kan bijna dieprood gebloosd.

iv.) 8 sentences, 59 words, 94 syllables
De haan kan 's morgens verwaand gekraaid op de boerderij. De stoute hond kan herhaaldelijk geblaft. Het paard kan zenuwachtig gehinnikt. Het vieze varken kan onwijs slordig gevreten. De koe kan heel tevreden gestaan in de wei. De boer kan zeker harder gewerkt dan gisteren. De boerin kan daarom heerlijk gekookt en haar man kan meer dan genoeg gegeten.

v.) 8 sentences, 56 words, 94 syllables

De wind kan vannacht zachtjes gewaaid in het bos. De tijger kan lekker vreedzaam gelegen, maar een leeuw kan ergens ver weg gebruld. Het hert kan almaar gespitst geluisterd. De haas kan uitbundig hoog gesprongen. De giraffe kan 's morgens rustig gedronken bij de waterbron. De olifant kan geweldig hard getrompetterd en de vogel kan ontzettend mooi gezongen.

vi.) 8 sentences, 56 words, 94 syllables

De familie kan zondag buiten gewandeld. Iedereen kan er heel veel van genoten. Opa kan echter moeizaam gelopen. Het kind kan vrolijk vooraan gehuppeld. Mama kan natuurlijk weer gezocht naar eenden. De baby kan ineens doodsbang gehuild. Haar broer kan onsympathiek gezegd dat zij eenden eng vond. Papa kan later verbaasd gezien dat het donker werd.

vii.) 8 sentences, 58 words, 94 syllables

De agent kan vandaag zoveel gezien! De auto kan ietsje sneller gereden dan de bus. Het kind kan gelukkig braaf gewacht voor het stoplicht. De vrachtauto kan snel achteruit gereden. De fietser kan heel erg langzaam gefietst. De dief kan alweer stiekem geprobeerd een tas te stelen. Een vrouw kan meteen benauwd geroepen. Haar man kan schijnbaar angstig geholpen.

viii.) 8 sentences, 56 words, 93 syllables

Iedereen kan vannacht rustig geslapen. Opa kan erg onrustig gedroomd over biefstuk en frietjes. Het kind kan 's avonds doodmoe gegaapt. Oma kan vreselijk hard gesnurkt. De wekker kan 's ochtends keihard gerinkeld. Papa kan daarna haastig gedoucht. De jongen kan alweer botweg geweigerd om op te staan. Mama kan een beetje boos gezegd dat het toch moest.

Appendix C
Stimulus material used in the sentence completion task, chapter 4.

Text in normal print: Experimenter's input during movie. Text in italic print: Experimenter's prompt. Text in bold print: Child's (anticipated) response.

Training items

1. De kikker springt / Het konijn rent
   De kikker heeft gesprongen / Het konijn ***heeft gerend***
2. De boot vaart / De trein rijdt
   De boot heeft gevaren / De trein ***heeft gereden***

Testitems

Sentences containing intransitive verbs:

A1. Katrien tekent / Zwartbaard verft
Katrien heeft getekend / Zwartbaard ***heeft geverfd***
A2. Het paard drinkt / De kip eet
Het paard heeft gedronken / De kip ***heeft gegeten***
A3. Jan Klaassen trommelt / De jongen leest
Jan Klaassen heeft getrommeld / De jongen ***heeft gelezen***
A4. Katrien roert / Zwartbaard veegt
Katrien heeft geroerd ***/*** *Zwartbaard* ***heeft geveegd***
A5. De auro rijdt / De vrachtwagen botst
De auto heeft gereden / De vrachtwagen ***heeft gebotst***

Sentences containing transitive verbs:

B1. Het konijn schopt de bal / Het paard duwt het hek
Het konijn heeft de bal geschopt / Het paard ***heeft het hek geduwd***
B2. Zwartbaard slaat de muis / De jongen aait de hond
Zwartbaard heeft de muis geslagen / De jongen ***heeft de hond geaaid***
B3. Katrien geeft de muis een kusje / Jan Klaassen bouwt een toren
Katrien heeft de muis een kusje gegeven / Jan Klaassen ***heeft een toren gebouwd.***
B4. Jan Klaassen maakt de toren kapot / De jongen gooit de bal
Jan Klaassen heeft de toren kapot gemaakt / De jongen ***heeft de bal gegooid***
B5. Katrien schenkt het water in / De jongen poetst een schoen
Katrien heeft het water ingeschonken / De jongen ***heeft een schoen gepoetst***

Appendix D
Stimulus material used in sentence imitation task, chapter 5.

Training items	
De baby slaapt. Het kind loopt naar huis. De jongen aait de poes.	
Test Items	
Verb category	Sample sentences
Intransitive; with no adjunct	*De vrouw heeft gefietst.* *De koe heeft gerend.* *De boer heeft gewerkt.*
Intransitive; with adjunct	*Het kind heeft op de stoep gefietst.* *Het paard heeft in de wei gerend.* *De man heeft in de tuin gewerkt.*
Transitive; with no adjunct	*De vrouw heeft een boek gekocht.* *De boer heeft een huis gebouwd.* *De man heeft een stoel gemaakt.*
Transitive; with adjunct	*De man heeft in de stad een taart gekocht.* *De man heeft in de stad een brug gebouwt.* *De vrouw heeft in het huis een bloes gemaakt.*
Ditransitive; with no adjunct	*De vrouw heeft een boek op de kast gezet.* *De man heeft een vork op het bord gelegd.* *Het kind heeft het zand in de bak geschept.*
Ditransitive; with adjunct	*Het kind heeft in de tuin een schep op de grond gelegd.* *De boer heeft in de stal het voer in een bak geschept.* *De vrouw heeft in het huis het fruit in een mand gezet.*

Appendix E

Digit Span Test, chapter 5.

Oefenitems

(a.) 3

(b.) 8 2

Blok1
(intro)
(a.) 6 2

(b.) 4 8

(c.) 1 5

Blok 2
(intro)
(a.) 3 5 8

(b.) 2 4 1

(c.) 10 6 3

Blok 3
(intro)
(a.) 8 10 2 4

(b.) 6 1 3 5

(c.) 2 6 10 8

(pauze)

Blok 4
(intro)
(a.) 1 4 8 5 2

(b.) 6 3 1 10 4

(c.) 5 8 2 6 3

Blok 5
(intro)

(a.)	2	1	4	3	10	8
(b.)	5	8	6	2	4	1
(c.)	10	6	4	8	3	2

(pauze)

Ruwe score:

Appendix F

Discrimination Task, Version A, chapter 6

Discriminatietaak Versie A

Naam Kind: Datum:

Groep: Leeftijd:

Sub-test A

Oefenitems Testleider	Robota		Oordeel kind
1. Het kind slaapt.	1. Het kind slaapt.	H	
2. De vogel vliegt.	2. De het vogel vliegt.	A	
3. De baby huilt.	3. De het baby huilt.	A	
Testitems Testleider	Robota		
4. Het paard heeft gerend.	4. Het paard heeft gerend.	H	
5. De man heeft gewerkt.	5. De man kan gewerkt.	A	
6. De hond heeft geblaft.	6. De hond geblaft.	A	
7. De baby huilt (F).[1]	*7. De baby huilt.*	H	
8. De haan heeft gekraaid.	8. De haan heeft gekraaid	H	
9. Het paard heeft gerend.	9. Het paard kan gerend.	A	
10. De man heeft gewerkt.	10. De man heeft gewerkt.	H	
11. De vrouw zit op de stoel (F).	*11. De vrouw zit op de het stoel.*	A	
12. De hond heeft geblaft.	12. De hond heeft geblaft.	H	
13. De haan heeft gekraaid.	13. De haan kan gekraaid.	A	
14. Het paard heeft gerend.	14. Het paard gerend.	H	
15. Het kind slaapt (F)..	*15. Het kind slaapt.*	H	
16. De man heeft gewerkt.	16. De man gewerkt.	A	
17. De hond heeft geblaft.	17. De hond kan geblaft.	A	
18. De haan heeft gekraaid.	18. De haan gekraaid.	A	

Pauze

[1] *(F)* represents a filler item.

Sub-Test B

Testleider	Robota		Oordeel kind
19. Het paard kan rennen.	19. Het paard heeft rennen.	A	
20. De man kan werken.	20. De man kan werken.	H	
21. De hond kan blaffen.	21. De hond heeft blaffen.	A	
22. *De vrouw zit op de stoel (F).*	*22. De vrouw zit op de stoel.*	H	
23. De haan kan kraaien.	24. De haan kraaien.	A	
24. Het paard kan rennen.	24. Het paard rennen.	A	
25. De man kan werken.	25. De man heeft werken.	A	
26. *De vogel vliegt (F).*	*26. De vogel vliegt.*	H	
27. De hond kan blaffen.	27. De hond blaffen.	A	
28. De haan kan kraaien.	28. De haan kan kraaien	H	
29. Het paard kan rennen.	29. Het paard kan rennen.	H	
30. *Het kind slaapt (F).*	*30. De het kind slaapt.*	A	
31. De man kan werken.	31. De man werken.	A	
32. De hond kan blaffen.	32. De hond kan blaffen.	H	
33. De haan kan kraaien	33. De haan heeft kraaien	A	

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Samenvatting in het Nederlands

Geschreven taal speelt een zeer belangrijke rol in moderne (westerse) communicatie. De meeste kinderen hebben geen moeite met leren lezen en schrijven, maar een klein deel van de populatie heeft hier wel problemen mee. Kinderen die moeite hebben met het leren lezen (ondanks voldoende onderwijs en een normale intelligentie), worden dyslectisch genoemd. Dyslexie is een erfelijke stoornis. De schatting is dat de stoornis ongeveer bij 3-10% van de kinderen voorkomt, maar bij kinderen met één dyslectische ouder ligt de kans om de stoornis te ontwikkelen tussen de 40 en 50%. Heeft een kind twee dyslectische ouders, dan stijgt de kans dat het kind dyslexie ontwikkelt tot zelfs 80%. Het is dus duidelijk dat er een genetisch risico bestaat. Onduidelijk echter is hoe men de kinderen die werkelijk dyslectisch zullen worden kan herkennen voordat het lees- en schrijfonderwijs is begonnen. Preventief ingrijpen bij dyslectische kinderen (in de vorm van vroege interventie) is om die reden nog niet mogelijk. Vroege interventie kan een positief effect hebben op het leesniveau van een dyslectisch kind. Dit maakt onderzoek naar voorlopers en vroege voorspellers van dyslexie uiterst relevant.

Naast kinderen die moeite hebben met het leren lezen is er ook een (kleine) groep kinderen die moeite heeft met het leren praten. Kinderen die moeizaam leren praten (ondanks een normale intelligentie en een normaal cognitief profiel) worden taalgestoord (*Specifically Language Impaired*) genoemd. De incidentie van *Specific Language Impairment* (SLI) wordt op ongeveer 3-7% geschat. In de verleden beschouwden onderzoekers dyslexie en SLI als twee afzonderlijke stoornissen. Onderzoek naar dyslexie werd hoofdzakelijk uitgevoerd door opvoedkundige psychologen, terwijl onderzoek naar SLI door spraak-taalpathologen en klinisch linguïsten werd uitgevoerd. De wenselijkheid van deze scheiding wordt sinds kort om twee redenen betwijfeld. Ten eerste wordt dyslexie sinds de jaren zeventig van de vorige eeuw als een *taalstoornis* gedefiniëerd (daarvoor dacht men dat dyslexie primair een visuele stoornis was) en kwamen onderzoekers er steeds vaker achter dat dyslectische kinderen vroeger (milde) taalproblemen hadden. De tweede reden is dat kinderen met SLI de taalproblemen van hun kleuterjaren vaak ontgroeien, om vervolgens op latere leeftijd leesproblemen (Leonard 1998). Er lijkt sprake te zijn van een 'schijnbaar herstel' bij kinderen met SLI; problemen treden weer op als er nieuwe eisen (zoals het leren lezen) aan de taalvaardigheid worden gesteld (Scarborough & Dobrich 1990). In het licht hiervan zijn enkele hypothesen over het verband tussen dyslexie en SLI tot stand gekomen. De hoofdgedachte onderliggend aan deze hypothesen is dat dyslexie en SLI verschillende gradaties vormen van eenzelfde continuum van taalstoornissen en dat dyslexie een mildere vorm van SLI is. In deze 'mildere' vorm van de stoornis ontwikkelen veel kinderen pas problemen wanneer ze een complexe taak tegenkomen, zoals het leren lezen.

Deze studie had (ten minste) twee doelen. Het belangrijkste doel was om vroege voorspellers van dyslexie in de taalontwikkeling van Nederlandssprekende kinderen te identificeren. Een secondair doel van deze studie was om een bijdrage te leveren aan de discussie over het verband tussen dyslexie en SLI.

Het ligt voor de hand om bij voorlopers van dyslexie te denken aan de vroege taalontwikkeling, aangezien dyslexie een *taal*stoornis is. Een goede strategie bij het onderzoek naar linguïstische voorlopers van dyslexie is studie te maken van kinderen met een verhoogd genetisch risico voor dyslexie (zg. risicokinderen). Het experimentele werk in dit proefschrift werd uitgevoerd binnen het kader van het project *Early language development in SLI and dyslexia: A prospective and comparative study*. In dit project werd de taalontwikkeling van kinderen met een genetisch risico voor dyslexie breedvoerig bestudeerd (zowel de fonologische als de morfosyntactische ontwikkeling werd onderzocht) en vergeleken met de ontwikkeling van normaal ontwikkelende kinderen en kinderen met SLI. In totaal hebben 250 kinderen aan het project deelgenomen. De kinderen zijn in drie groepen verdeeld (risicokinderen, controlekinderen en kinderen met SLI) en in twee leeftijdcohorten ('baby's en 'kleuters'). De kinderen in de babygroep waren bij aanvang van de studie tussen 18 en 22 maanden oud. Deze groep bestond uit 70 risicokinderen en 40 controlekinderen (er zijn geen kinderen met SLI in de babygroep, aangezien SLI pas na de leeftijd van 3;0 gediagnostiseerd kan worden). De kinderen in de kleutergroep waren tussen de leeftijden van 3;0 en 3;6 bij aanvang van de studie. Deze groep bestond uit 70 risicokinderen, 40 controlekinderen en 30 kinderen met SLI. De kinderen werden longitidunaal gevolgd over een periode van ongeveer twee jaar.

Deze dissertatie richt zich voornamelijk op grammaticale ontwikkeling in kinderen met een genetisch risico voor dyslexie. Er werd specifiek gekeken naar de waarneming en productie van morfosyntactische relaties, en met name naar de relatie tussen een hulpwerkwoord en een hoofdwerkwoord. De relatie tussen het hulpwerkwoord *heeft* en het voltooide deelwoord staat centraal in dit proefschrift. De voltooid-verledentijdsvorm is één van de eerste werkwoordvormen die Nederlandssprekende kinderen verwerven na het infinitief. Dit maakt deze vorm bij uitstek geschikt voor een inventarisatie van de eerste stappen in de verwerving van morfosyntactische kennis in het werkwoordsdomein.

Hoofdstuk 1 en 2 van dit proefschrift vormen een bespreking van de theoretische achtergrond van deze studie. In hoofdstuk 1 worden de stoornissen dyslexie en SLI besproken: de aard van beide stoornissen en de belangrijkste theorieën over dyslexie en SLI worden beschreven. Opmerkelijk genoeg slaagt geen van de heersende theorieën over dyslexie of SLI erin om de stoornissen volledig te verklaren. Het verband tussen dyslexie en SLI wordt bechreven aan de hand van een studie van Bishop & Snowling (2004).

Een bekend fenomeen bij kinderen met SLI is dat zij moeite hebben met de verwerving van grammaticale morfemen. Eén voorbeeld van zo 'n grammaticaal morfeem is het hulpwerkwoord. In hoofdstuk 2 wordt het hulpwerkwoord gedefinieerd en de functie van het hulpwerkwoord in de syntaxis wordt kort uitgelegd. Het hoofdstuk geeft verder een samenvatting van cross-linguistische studies met betrekking tot het hulpwerkwoord in SLI. Deze studies laten zien dat kinderen met SLI in veel talen (bijv. in Engels, Duits, Zweeds, Frans en Italiaans) problemen ondervinden met de verwerving van hulpwerkwoorden. Opmerkelijk genoeg vonden Bol en De Jong (1992) geen bijzondere afwijkingen op dit gebied bij Nederlandssprekende kinderen met SLI. Deze bevinding lijkt tegenstrijdig te zijn met de literatuur; het is niet duidelijk waarom Nederlandssprekende kinderen met SLI geen moeite hebben met het huilpwerkwoordsysteem, terwijl dat wel het geval is in andere Germaanse talen. Deze contradictie is één van de redenen waarom het hulpwerkwoord centraal staat in deze dissertatie; er is meer onderzoek nodig is op dit gebied.

Hoofdstuk 3 beschrijft drie experimentele studies (voorkeur-luistertaak experimenten) met jonge kinderen. Het vermogen van kinderen om een grammaticale van een ongrammaticale morfosyntactische 'agreement' relatie te onderscheiden werd bestudeerd op 19 en op 25 maanden. De kinderen luisterden naar grammaticale passages (waarin iedere zin het hulpwerkwoord *heeft* en het voltooide deelwoord bevatte) en naar ongrammaticale passages (waarin iedere zin het modale hulpwerkwoord *kan* en het voltooide deelwoord bevatte). De verwachting is dat kinderen een voorkeur zullen hebben voor de grammaticale passages (d.w.z. dat zij langer zullen luisteren naar zinnen zoals *de hond heeft geblaft* dan naar zinnen zoals *de hond kan geblaft*), mits zij grammaticale en ongrammaticale morfosyntactische relaties van elkaar kunnen onderscheiden. De belangrijkste bevinding van dit hoofdstuk is dat risicokinderen op de leeftijd van 19 maanden grammaticale en ongrammaticale morfosyntactische 'agreement' relaties minder goed van elkaar kunnen onderscheiden dan kinderen in de normaal ontwikkelende controlegroep. Normaal ontwikkelende kinderen laten, zoals verwacht, een voorkeur voor de grammaticale passages zien (d.w.z. ze luisterden significant langer naar de passages waar de relatie tussen de afhankelijke morfemen (*heeft* + voltooide deelwoord) gehandhaafd wordt). De risicokinderen, daarentegen, laten geen voorkeur zien.

Dit hoofdstuk heeft twee belangrijke bijkomende bevindingen. Ten eerste lijkt het zo te zijn dat de perceptuele taalontwikkeling van de risicokinderen ten minste zes maanden vertraagd is. Bij 25 maanden kunnen deze kinderen nog niet tussen de grammaticale en de ongrammaticale passages onderscheiden. Ten tweede is het vermogen van normaal ontwikkelende kinderen om tussen een grammaticale en een ongrammaticale morfosyntactische relatie te onderscheiden beperkt. In moeilijke condities (bijvoorbeeld wanneer de afhankelijke morfemen in een morfosyntactische relatie verder van elkaar af staan), laten de normaal ontwikkelende kinderen geen voorkeur voor de grammaticale passages zien.

Er zijn twee interpretaties van deze bevindingen mogelijk. Ten eerste is het mogelijk dat de risicokinderen een taalachterstand hebben en dat ze dus nog geen kennis hebben over de relatie tussen het hulpwerkwoord en het voltooid deelwoord. Ten tweede is mogelijk dat hun grammaticale competentie in principe adequaat is, maar dat ze deze kennis als gevlog van een verwerkingsprobleem niet volledig kunnen toepassen. Welke van deze interpretaties de juiste is werd in hoofstukken 4 en 5 verder onderzocht.

In hoofdstuk 4 werd het vermogen van risicokinderen (leeftijd 3;6) om de volledige voltooid-verledentijdsvorm te produceren bekeken. Om een indruk te krijgen van de invloed van de verwerkingsdruk op de productie van deze constructie, werd gebruik gemaakt van verschillende typen werkwoorden: intransitieve, die alleen een grammaticaal onderwerp vereisen (bv. *het konijn heeft gerend*) en transitieve, die de uitdrukking van zowel een onderwerp als een lijdend voorwerp vereisen (bv. *de jongen heeft de bal gegooid*). Om de voltooid-verledentijdsvorm uit te lokken is gebruik gemaakt van een zinsvoltooingstaak. De resultaten laten zien dat de risicokinderen het hulpwerkwoord *heeft* en het voltooide deelwoord ongeveer net zo goed als de controlekinderen kunnen produceren. Echter, de risicokinderen zijn beduidend slechter in hun productie van de *volledige* voltooid-verledentijdsvorm (d.w.z. *heeft* + een correct gevormd voltooid deelwoord (het deelwoord met name gekenmerkt door het prefix *ge-*)) dan normaal ontwikkelende kinderen. Overigens gebruiken de risicokinderen andere strategieën dan de controlekinderen om een zin af te maken wanneer ze de verwachte vorm van het werkwoord (het voltooide deelwoord) niet produceren. De controlekinderen kiezen in deze gevallen voor een grammaticale werkwoordvorm, terwijl de risicokinderen soms voor een ongrammaticale vorm kiezen. De risicokinderen gebruiken bijvoorbeeld significant meer infinitieven in de complementpositie van *heeft* dan de controlekinderen. De suggestie is dat de onderliggende representatie van de morfosyntactische relatie tussen *heeft* en het voltooide deelwoord minder stabiel is in risicokinderen dan in normaal ontwikkelende kinderen. Een verdere bevinding is dat een hoge verwerkingsdruk de prestatie van vooral de risicokinderen negatief beïnvloedt. In zinnen met een complexe werkwoord-argumentstructuur zijn de risicokinderen meer geneigd (dan de controlekinderen) om werkwoordsmorfologie (het prefix *ge-*) weg te laten. De resultaten suggereerden dat de risicokinderen wel competent zijn in hun productie van de voltooid-verledentijdsvorm, maar dat hun kennis minder stabiel is dan die van normaal ontwikkelende kinderen.

Het effect van werkwoord-argumentstructuur op de productie van grammaticale morfemen werd verder onderzocht in hoofdstuk 5 (deze studie omvatte naast risicokinderen en controlekinderen ook kinderen met SLI). Argumenten zijn entiteiten die (verplicht) deelnemen aan de actie zoals beschreven door het werkwoord. Aangezien een toename in de complexiteit van de argumentstructuur van het werkwoord ook een toename in zinslengte betekent (intransitieve hebben slechts één verplicht argument, terwijl transitieve twee en ditransitieve drie verplichte argumenten hebben), werd het effect van zinslengte en het werkgeheugen op de productie van grammaticale morfemen ook bestudeerd. De invloed van argumentstructuur en zinslengte werd met een zinsimitatietaak getest. De kinderen moesten zinnen met wisselende werkwoord-argumentstructuren imiteren, bijvoorbeeld: *de vrouw heeft gefiets* (intrasitief) tegenover *de man heeft een stoel gemaakt* (transitief) tegenover *het kind heeft het boek op de kast gelegd* (ditransitief). Daarnaast moesten kinderen zinnen zoals *de vrouw heeft op de stoep gefietst* imiteren. Deze zin bevat een intransitief werkwoord en naast het verplichte argument (*de vrouw*) ook een adjunct (*op de stoep*). Adjuncten zijn 'niet verplichte argumenten'. In termen van argumentstructuur is *de vrouw heeft op de stoep gefietst* dus minder complex dan een zin met een transitief werkwoord, maar het is in feite net zo lang. Op die manier werd de invloed van zinslengte onderzocht. De resultaten laten zien dat argumentstructuurcomplexiteit een effect heeft op het weglaten van het hulpwerkwoord *heeft* en op het weglaten van lidwoorden, maar niet op het weglaten van het prefix *ge-*. Het effect van argumentstructuur is het duidelijkst in de groep risicokinderen; deze kinderen laten significant meer hulpwerkwoorden weg in zinnen met een ditransitief dan in zinnen met een intransitief of een transitief werkwoord. Zinslengte heeft geen effect op het weglaten van het hulpwerkwoord of op het weglaten van *ge-*, maar het heeft wel een effect op het weglaten van lidwoorden. Het effect van zinslengte is wederom prominenter in de groep risicokinderen. Bij de kinderen met SLI zijn effecten van argumentstructuur complexiteit en zinslengte minder goed zichtbaar, aangezien deze kinderen ook de kortste zinnen slecht imiteerden (er is dus sprake van een vloereffect bij deze groep).

Een tweede experiment testte het werkgeheugen van de risicokinderen, controlekinderen en kinderen met SLI door middel van een 'digit-span' taak. In zo 'n taak wordt van kinderen verwacht dat ze reeksen cijfers nazeggen. De resultaten van dit experiment laten zien dat de risicokinderen en de kinderen met SLI een significant slechter werkgeheugen hebben dan normaal ontwikkelende kinderen. Dit aspect van hun ontwikkeling kan mogelijk hun prestatie op de zinsimitatietaak beïnvloeden. Toch laat een statistische analyse zien dat er slechts een zwakke correlatie is tussen de capaciteit van een kind om grammaticale morfemen te imiteren en het werkgeheugen van het kind. Het werkgeheugen heeft dus een beperkte invloed op het weglaten van grammaticale morfemen.

Hoofdstuk 6 bevat een studie die vergelijkbaar is met de studie in hoofdstuk 3. Dezelfde hoofdvraag, namelijk of kinderen tussen grammaticale en ongrammaticale morfosyntactische relaties kunnen onderscheiden, werd in dit hoofdstuk bij oudere risicokinderen (gemiddelde leeftijd 5;1), bij kinderen met SLI en bij normaal ontwikkelende kinderen onderzocht. Perceptuele gevoeligheid voor twee verschillende morfosyntactische relaties werd gestest, namelijk voor de relatie tussen het hulpwerkwoord *heeft* en het voltooid deelwoord en voor de relatie tussen het modale hulpwerkwoord *kan* en de infinitief. Het experiment bestond uit een tweedelige discriminatietaak; kinderen hoorden eerst een zinnetje (bijvoorbeeld *Het paard heeft gerend)* en moesten vervolgens beoordelen of de imitatie van het zinnetje door een robot *hetzelfde* of *anders* was (De robot reageerde met een van de volgende uitingen: *het paard heeft gerend*; *het paard kan gerend*; *het paard gerend*). In het tweede deel van het experiment hoorde kinderen weer een zinnetje (bijvoorbeeld *Het paard kan rennen)* en moesten ze wederom beoordelen of de imitatie door een robot hetzelfde of anders was (De robot reageerde met een van de volgende uitingen: *het paard kan rennen*; *het paard heeft rennen*; *het paard rennen*). Normaal ontwikkelende kinderen (leeftijd 5:0) zijn gevoelig voor beide morfosyntactische relaties; zij hebben geen moeite om grammaticale en ongrammaticale relaties van elkaar te onderscheiden. De prestatie van de risicokinderen als groep is soortgelijk aan die van de normaal ontwikkelende kinderen, maar een sub-groep van deze kinderen heeft opvallend veel moeite om zinnen met het hulpwerkwoord *heeft* en het voltooid deelwoord te onderscheiden van zinnen met een 'bare participium' (d.w.z. deze kinderen kunnen niet onderscheiden tussen constructies zoals *het paard heeft gerend* en *het paard gerend*). De prestatie van de SLI kinderen was beduidend slechter dan die van de twee ander groepen (voor beide morfosyntactische relaties en voor alle testcondities). In feite lijkt het alsof de SLI kinderen problemen hadden met het bevatten van de linguïstische eisen van de taak.

Het onderzoek in dit proefschrift toont aan dat de morfosyntactische ontwikkeling van kinderen met een genetisch risico voor dyslexie anders verloopt dan die van normaal ontwikkelende kinderen. De risicokinderen vertonen in het algemeen geen afwijkend taalgedrag, maar hun representatie van de morfosyntactische relatie tussen een hulpwerkwoord en hoofdwerkwoord lijkt onstabiel te zijn. In belastende situaties, bijvoorbeeld bij een hoge verwerkingsdruk, produceren deze kinderen meer ongrammaticale constructies dan even oude kinderen in de normaal ontwikkelende controlegroep en laten ze grammaticale morfemen vaker weg. De risicokinderen hebben een beperkt verwerkingsvermogen dat hun controle over morfosyntactische relaties beïnvloedt. Een onvermogen om grammaticale en ongrammaticale morfosyntactische relaties van elkaar te onderscheiden bij een hoge verwerkingsdruk is dus een mogelijke vroege voorspeller van dyslexie. Wat betreft het verband tussen dyslexie en SLI suggereert deze studie dat dyslexie en SLI waarschijnlijk wel twee aparte stoornissen zijn. De prestatie van de kinderen met SLI in hoofstukken 5 en 6 is opmerkelijk anders dan die van de risicokinderen. De resultaten van de risicokinderen in hoofdstuk 5 en 6 suggereren dat de grammaticale competentie van deze kinderen in principe in tact is. De prestatie van de kinderen met SLI in deze studies suggereert dat er bij deze kinderen niet alleen sprake is van een beperkt verwerkingsvermogen; ze hadden ook opmerkelijke problemen met het uitvoeren van de taken. Aangezien het samenvoegen van kinderen met dyslexie en SLI tot een zeer heterogene groep zal leiden, lijkt het vooralsnog niet zinnig het verschil tussen dyslexie en SLI op te heffen.

Curriculum Vitae

Carien Wilsenach was born on the 26th of June 1975 in Pretoria, South Africa. She matriculated in 1993 from Hartbeespoort High School and started her undergraduate studies in 1994 at the University of Stellenbosch (South Africa). She obtained her B.A. degree in 1996 and continued her postgraduate studies at the same university. In 1999, she obtained her M.A. (General Linguistics) with distinction. While studying towards her Master's degree, she also worked as a junior lecturer at the Department of General Linguistics at the University of the Western Cape.

In 2000, Carien came to the Netherlands, joining the Advanced Master's Programme of the Holland Institute of Generative Linguistics at Leiden University. In October of the same year, she started her PhD research as an AiO (Assistent in Opleiding) at the Utrecht Institute of Linguistics OTS (based at Utrecht University). For the past five years, she worked on the research programme entiteld *Early Language development in Specific Language Impairment and dyslexia: A prospective and comparative study.* This dissertation contains the results of her research.