Chapter 4

Investigating precursors of developmental dyslexia in kindergarten: sensitivity to subject-verb agreement, phonological awareness, rapid naming and letter knowledge

4.1 Introduction

In this chapter it will be investigated whether children at pre-reading age, with an increased risk for developmental dyslexia due to their familial background, can be differentiated from children without a genetic risk factor on subject-verb agreement, phonological awareness, rapid naming and early literacy abilities. As has been discussed in chapter 1, developmental dyslexia is a trait that runs in families and it is estimated that children with at least one dyslexic parent have around 40% chance of developing dyslexia. This puts a child at a considerable higher than average risk, which is around 3-10%. Thus, the familial background of a child is one factor that indicates whether a child may become dyslexic or not, but of course one has to wait until the onset of reading acquisition to find out whether the child actually is dyslexic or not. Hopes have been raised, however, that the dyslexia status of children can be determined before they have already come across their reading difficulties. Early identification of reading problems may subsequently prompt early intervention of such reading difficulties. For example, training skills at kindergarten age that are important for reading acquisition, like phonological skills, may give children with dyslexia a head-start in the acquisition of reading (Torgesen et al., 1992). Thus, identification of precursors of reading difficulties is needed to make a more accurate guess as to whether a child is at risk for literacy difficulties or not, so that a child can benefit from some kind of training program.

Several studies have been carried out to investigate whether language skills at pre-school age are a predictor of reading success later on, and, if so, in what way such language abilities contribute to the process of reading acquisition. As dyslexia has been related to a deficit in the phonological domain (see chapter 2), many researchers have been questioning whether phonological skills at pre-reading age can predict reading success at a later stage. In such a search toward
reading predictors, different aspects of phonological abilities have been investigated. For instance, sensitivity to the phonological structure of a word (phonological awareness), phonological coding in short term memory (verbal working memory) and retrieval of phonological codes from the long term memory (needed for rapid naming of objects) are factors related to phonological processing, see chapter 2 for a discussion on how these skills are associated with reading. An important question is whether dyslexic children have problems with all factors related to phonological processing, and, related to the aim of this chapter, whether all aspects of phonological processing are predictors of reading success. Other researchers have not only focused on the predictive value of phonological processing, but have also investigated the role of syntactic skills. In the following section, studies will be discussed that have investigated phonological processing and syntax as predictors of reading.

4.2 Phonological processing as a predictor of reading success

Elbro et al. (1998) set out to test the predictive value of phonological processing skills of children in kindergarten with respect to reading achievement later on. In their aim to determine what kinds of phonological skills contribute to reading, they followed Danish children with a familial risk for dyslexia and control children from the beginning of kindergarten (which is at age 6 in Denmark) until the beginning of second grade. At the onset of the study, children were administered with several tests measuring early literacy skills (letter knowledge and word decoding), phonological awareness, verbal short term memory (digit span of the WISC-R), articulatory skills and distinctness of phonological representations. The last category was included to test the hypothesis that dyslexic subjects have more ‘fuzzy’ phonological representations which interfere with the development of phonological awareness. In this experiment, the child had to produce a word the clearest and most precise as possible, to see whether the phonological representation of a lexical item of a child matched the target representation. Furthermore, a test of rapid naming was also included to assess speed of retrieval of phonological representations from long term memory. The results showed that, when reading outcomes at second grade were entered, three statistically significant
predictors at kindergarten age were found: letter naming, phoneme identification (which taps phonological awareness) and distinctness of phonological representations. Moreover, it was shown that the distinctness of phonological representations contributed significantly to phonological awareness, suggesting that this is at least one of the factors underlying the development of phonological awareness.

A Dutch study to predicting reading success comes from De Jong and Van der Leij (1999). They studied the relation of three types of phonological abilities - phonological awareness, verbal working memory and rapid naming- to reading. Conflicting evidence exists on whether all three phonological skills specifically contribute to reading acquisition. To elucidate the relationship between the three types of phonological abilities and reading acquisition, a longitudinal study was carried out, following children from kindergarten (second year of kindergarten) until the end of grade 2. It was found that above all, the relationship between reading and phonological ability depended on the time of measurement. Rapid naming at kindergarten age was the only predictor of reading achievement in grade 1 and 2, but during the beginning of grade 1 (a time point at which a few months of reading instruction had passed) phonological awareness and verbal working memory were found to contribute to later reading achievement. However, at the end of grade 1 and onwards, phonological awareness, rapid naming and verbal working memory did not account for any variance in reading achievement in grade 2 after the reading skills of grade 1 had been controlled for. Thus, phonological abilities seem to be influential on the process of reading acquisition, but this influence is limited in time. According to the authors, the observation that phonological awareness only started to play a role after some months of reading instruction supports the hypothesised reciprocal relationship between phonological awareness and learning to read. A strong correlation was found between phonological awareness and letter knowledge, which has also been reported by other researchers (Bowey, 1994; Johnston et al., 1996). This suggests that phonological awareness may be a by-product of the development of literacy skills, or that at least it develops alongside the ability to read, or at least alongside the ability to recognise letters of the alphabet.
4.3 Syntax as a predictor of reading success

Scarborough (1990; 1991) set out to find predictors of reading achievement in children at genetic risk of dyslexia and compared them to children without such genetic background (see chapter 2). She found that phonological awareness, assessed with a phoneme discrimination task administered at 30 and 36 months of age, did not differentiate between children who later appeared to be dyslexic and those whose reading and spelling skills developed normally. Instead, she found significant between-group effects for syntactic skills, measured with an index of productive syntax and with calculating the mean length of utterances (MLU). Dyslexic children produced significantly shorter and syntactically more simple utterances relative to controls when they were 30, 36 and 48 months old, but this difference between the two groups disappeared at 60 months old. This recovery may suggest that the acquisition of syntactic skills is delayed in children with developmental dyslexia and that in the course of time, dyslexic children catch up with their normally developing peers. However, Scarborough (1991) offers two alternative explanations for her findings. First, it could be that the assessments were not sufficiently sensitive to reveal any morphosyntactic difficulties in 5 year olds. Another possibility is that both groups of children reached a temporary plateau in their developmental track at 60 months, but that the group differences will re-emerge at a later stage of their language development. In this chapter, sensitivity to agreement morphology will be assessed in 5 and 6 years olds (approximately one year older than the subjects in the Scarborough study) using a grammaticality judgement task, addressing the question whether at these ages, children show problems with inflectional morphology.

The conflicting evidence on phonological awareness as a predictor (significant in Elbro’s and De Jong & Van der Leij’s studies, not significant in the study of Scarborough (1990; 1991)) may have been brought about because of the difference in the age of the children at which the assessments were administered. De Jong & Van der Leij (1999) suggest that phonological awareness may only play a role when children start to learn to read and start to learn the letters of the alphabet. This was the case for the children who participated in the Elbro study (1998). However, this was clearly not the case for the subjects that Scarborough assessed when they were 30 and 36 months old. Thus, the predictive value of
phonological awareness may vary as to where children are in their stage of reading acquisition.

Gallagher et al. (2000) also aimed to find predictors of reading success. They started to follow children at genetic risk for developmental dyslexia at 45 months old and included measures of vocabulary and syntactic development, next to that of phonological processing skills. Literacy skills were assessed at 6 years old: a time at which the participants had received reading instruction for one year. Using regression analyses, predictors of literacy skills at 6 years old were established. The strongest predictor was found to be letter knowledge at 45 months. A composite score of the results on tasks tapping speech and language skills also contributed significantly to literacy skills. The factor ‘language’ consisted of several components such as vocabulary, syntax (measurement of sentence length), nonword repetition and rhyme knowledge and represented thus lexical-semantic, syntactic and phonological skills. The language composite score was not broken down into the three categories, therefore, it is not clear whether all three types of language abilities (syntactic, semantic and phonological skills) were equally important and whether they all predict at 45 months early reading achievement.

In the study of Gallagher et al. (2000), children who showed a delay in their development of literacy skills at 6 years significantly fell behind on tasks administered at 45 months measuring receptive and expressive vocabulary, sentence length, nonword repetition, rhyme knowledge, digit span and letter knowledge compared with their peers showing normal progress in their development of reading skills. Gallagher et al. (2000) therefore conclude that dyslexia may not only be associated with a pure phonological deficit, but that children of dyslexic families tend to show a general language delay which is, however, too subtle to be diagnosed as a developmental language disorder.

According to the authors, language skills play an important role in learning to read, in the sense that semantic and syntactic skills can be employed for the process of word decoding. The ability to make use of the linguistic context of the words that need to be decoded is of course dependent on the status of the language skills that one needs to refer to. For instance, vocabulary knowledge contributes to decoding attempts as a child knows the meaning and the pronunciation of the word s/he is trying to decode. Sensitivity to the grammatical
structure of the sentence and the grammatical categories of words furthermore aids the child in his expectations about the words that are likely to come next, which supports the decoding of printed words. Thus, weaknesses in those areas may prevent a child to use semantic and syntactic skills to bootstrap learning to read.

Lyytinen et al. (2001) also suggest that developmental dyslexia is associated with a delay in language acquisition. In their longitudinal study of language development in children with a genetic risk factor for dyslexia, they found that such children produced shorter sentences at 2 years old than non-risk children and that at 3.5 years of age they were more impaired in inflectional morphology\(^1\).

As mentioned in chapter 2, children with SLI have a higher risk than average on experiencing impairments in literacy skills: around 50% of the SLI population can also be classified as developmentally dyslexic (McArthur et al., 2000). Again, an important question is whether problems with the acquisition of literacy skills can be predicted in SLI. In other words, can we identify precursors of literacy skills in children with language impairment? Catts et al. (2002) investigated variables related to reading outcomes in a mixed population of children with SLI and non-specific language impairment. The children were assessed at kindergarten age with tasks measuring grammar, vocabulary and phonological processing skills and the results were related with second and fourth grade results on word recognition and comprehension tasks. It turned out that, again, letter identification at kindergarten age was a strong predictor of reading (both recognition and comprehension). In addition, non-verbal IQ, grammatical abilities, rapid naming and phonological awareness accounted for unique variance in word recognition at second and or fourth grade word recognition.

In sum, results of several studies have shown that measures of a number of skills can predict variance in reading outcomes. Phonological awareness, rapid naming, letter knowledge and syntactic skills have proven to be related to reading achievement. In the following experiment, such predictors will be evaluated in Dutch children of 5-6 years old at familial risk for developmental dyslexia. A grammaticality judgement task was developed to assess sensitivity to subject-verb agreement in spoken language. It was decided to focus on this type of morphosyntactic skill as no data as yet are available on subject-verb agreement in

\(^1\) An inflectional morphology task was used, assessing both verb morphology and derivational morphology with words unknown to the children.
pre-schoolers at risk for developmental dyslexia. In children with oral language impairment, morphosyntactic deficits often occur in their language. The recent interest in comparing developmental dyslexia with SLI makes agreement marking an interesting topic of research in dyslexia (see the next chapter for a direct comparison between dyslexia and SLI).

Children with and without familial risk for developmental dyslexia are assessed with tasks tapping phonological awareness, letter knowledge, rapid naming and sensitivity to subject-verb agreement at kindergarten age. Reading achievement after one year of reading instruction was followed for a portion of the children to investigate which measures differentiate between dyslexic and non-dyslexic children at kindergarten age.

4.4 Research questions

The following questions will be addressed in this chapter.

(1) Can children at risk for developmental dyslexia at pre-reading age be differentiated from control subjects on the basis of phonological awareness, letter knowledge, rapid naming and sensitivity to subject-verb agreement?

(2) Are results on the tasks tapping phonological awareness, letter knowledge, rapid naming and sensitivity to subject-verb agreement administered at kindergarten age related to reading achievement after a year of formal reading instruction?
4.5 **Methods**

4.5.1 **Subjects**

*Children at-risk for developmental dyslexia*

Twenty children at familial risk of developmental dyslexia participated in this study. All children were tested during their second year of kindergarten ('*groep 2*') of Dutch mainstream primary schools, except for one child who was tested at the end of the first year of kindergarten ('*groep 1*') (16 boys, 4 girls, mean age 5;11). The children were selected on an increased risk of developmental dyslexia due to their familial background. At least one first-degree family member had to be developmentally dyslexic, in order for a child to be included in the group². All children were native speakers of Dutch and had no known neurological or visual and auditory perceptual deficits. All children demonstrated normal progress in kindergarten as observed by the teacher.

*Control group*

Twelve normally developing children participated as control children who were matched on the age of the at-risk children (6 boys, 6 girls, mean age 6;01). All children were in their second year of kindergarten during testing, apart from one child who was at the end of the first year of kindergarten. Criteria for inclusion in this group were no self-reported history of reading problems of first-degree family members and normal progress during kindergarten of the child. Furthermore, children were screened on the absence of neurological deficits and visual or auditory perceptual problems.

The control children were enrolled in the same schools as the at-risk children.

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² Children were either recruited via schools, or via families that participate in a prospective study on precursors of developmental dyslexia that takes place in Groningen (see Koster et al., 2003).
4.5.2 Materials

4.5.2.1 Phonological abilities

Three tasks were presented that assess phonological abilities: rapid naming, phonological awareness (using a phoneme identification task) and passive and active letter knowledge. These tasks were selected from a test battery used by De Jong & Van der Leij (1999) in their longitudinal study of early reading acquisition.

**Rapid Automated Naming**
This test requires the speeded naming of a series of pictures depicting 5 different objects: a knife, an eye, a book, a door and a jacket. Two cards were presented containing 32 and 28 pictures in a random order. The child was asked to name the pictures as quickly as possible but also as accurately as possible. A practice card was used to practise the procedure and to ensure that the child knew the object names. For each test card the time needed to complete the card was noted together with the number of pictures that were named wrongly.

The total number of seconds that were needed to name the pictures on the two sets of card was scored. The number of correctly named objects per second was computed for each card separately and these figures were added so that the mean number of objects named per second for the two cards was computed.

**Phoneme identification task**
The child is presented with a card containing five pictures. The examiner names all pictures and asks the child to name the last sound of one depicted word. Then, the examiner asks the child which other picture also ends with that sound. The tasks consist of ten items, which have been included in Appendix I.

Each correct answer was awarded with one credit; the maximum score was 10.

**Passive and active letter knowledge**
Sixteen letters were presented one after another to the child who was asked to sound them out (active letter knowledge). Both the sound and the name of the sound were marked as correctly. To assess passive knowledge, two cards with ten
letters each were presented to the child, see Appendix II for the items. The examiner named a sound and asked the child to point to the matching letter.

Each correctly identified/named letter was awarded with one credit. The maximum score was 16 per subtask.

4.5.2.2 Sensitivity to subject-verb agreement

A grammaticality judgement task was used to assess sensitivity to subject-verb agreement. Grammatical and ungrammatical sentences were presented auditorily from a laptop computer (Toshiba Satellite). The child was asked whether this sentence was a ‘good’ sentence. The task consisted of the following three conditions:

**Type 1**. The verb was inflected for 1st person singular (also the verb stem) rather than the 3rd person singular:

*De leuke clown maak* een grapje (n=10) versus *de leuke clown maakt* een grapje (n=5)

Lit. *the funny clown make a joke versus the funny clown makes a joke

**Type 2**. The verb was inflected for the plural form (also the infinitive) rather than the 3rd person singular:

*De leuke clown maken* een grapje (n=10) vs *de leuke clown maakt* een grapje (n=5)

Lit. *the funny clown make a joke versus the funny clown makes a joke

**Type 3**. The verb was inflected for the 3rd person singular rather than for the plural form:

*De leuke clowns maakt* een grapje (n=10) vs *de leuke clowns maken* een grapje (n=5)

Lit. *the funny clowns makes a joke versus the funny clowns make a joke

In total, 45 items were presented to the children, see Appendix III for a list of the sentences. The grammatical sentences matching type 1 and 2 subject-verb agreement violations are the same type of sentences (the verb inflected for 3rd person singular) and were therefore taken together in the analysis.
The sentences were read aloud by a female speaker at a normal speaking rate and were recorded on a PC. The sentences were all of approximately the same length (4000ms). All lexical items in the sentences were selected from the word list of Kohnstamm et al. (1981) representing the average vocabulary of 6 year old children. The determiners of the nouns of the third sentence type were all de-words and all nouns were marked for plural with /s/. All words following the verb in the type 1 ungrammatical condition and the type 1/2 grammatical sentences start with a phoneme other than a /t/ to prevent from co-articulation influences. In this way, acoustical overlap between the verb inflection and the onset of the next word is avoided (for example: *het meisje slaapt tussen haar ouders in*; *the girl sleeps in between her parents*). The sentences were pseudo-randomised and divided over three blocks of 15 sentences each.

The task was scored in percentages correct. The responses were divided into 'hits' (responding ‘yes’ to a grammatical item), ‘false alarms’ (saying ‘yes’ to an ungrammatical item, ‘misses’ (saying ‘no’ to a grammatical item) and ‘correct rejections’ (saying ‘no’ to an ungrammatical item). When children are asked to accept or to reject sentences based on grammaticality, they may show a bias in accepting sentences (McDaniel et al., 1996). Such a bias influences the interpretation of the data as more errors will be made on the ungrammatical sentences (as children need to reject sentences in such cases). Following Rice, Wexler & Redmond (1999), an alternative measure of sensitivity was computed: A’ values. A’ values can be interpreted as scores on a two-alternative forced choice task: ‘which of these two sentences is grammatical?’ For example, an A’ value of 0.8 can be interpreted as a score of 80% correct when the child was asked to select one of two sentences on its grammaticality. The formula as described in Linebarger et al. (1983) was used to calculate these scores: $A' = 0.5 + \frac{(y-x)(1+y-x)}{4y(1-x)}$ where $y$ represents the correct judgements of grammatical sentences (‘hits’) and $x$ the incorrect judgements of ungrammatical sentences (‘false alarms’). If a child has a strong tendency to reject sentences, the A’ value will be approximately around 0. A tendency to accept sentences will result in an A’ value of around 0.5 and good discrimination between grammatical and ungrammatical sentences will result in an A’ value of approximately 1.0 (top score).

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3 In Dutch, the lexical form of determiners of singular nouns is either *de* or *het* (depending on gender), but the determiner of plural nouns is always *de*. Nouns can be marked for plural by either the suffix –en or –s.
Figure 1 presents an overview of the tasks.

![Table](image)

**Assessment** | **Domain**
--- | ---
Rapid naming | Phonological processing
Phoneme identification | Phonological awareness
Active/passive letter knowledge | Early literacy skills
Grammaticality judgements | Subject-verb agreement

Figure 1. An overview of the tasks.

### 4.5.3 Procedure and data analysis

Children were tested individually in a quiet room at their school or in a room at the university. The tasks were presented with breaks in between. The complete session lasted about 45 minutes per child.

To compare performances between the at-risk group and the control group, T-tests were used (two-tailed, level of significance set at 0.05). To analyse the factor ‘sentence type’ in the grammaticality judgement task, repeated measures analyses were used. Due to time restrictions (see 4.6.3), it was not possible to follow all children in their reading development. Non-parametric tests (as the sample size of children with known reading outcomes was relatively small) were used to investigate whether performance at kindergarten age in poorly reading children was different to that of children with normal reading development.

### 4.6 Results

#### 4.6.1 Phonological abilities

Table 1 provides an overview of the scores obtained on the phonological tasks. T-tests show that the at-risk children scored significantly lower on the passive letter
knowledge task and on the phoneme identification task, but that performances on the active letter knowledge task and the rapid naming task were similar between the two groups.

As can be seen from the standard deviations, there was considerable performance variability within the two groups. The range of scores indicates that some of the children did not have much letter knowledge or phonological awareness, scoring 1 or 2 correctly, whereas others had top scores. This is expected for the at-risk group, as this group comprises children with and without developmental dyslexia. However, also in the control group, there was quite some variation in the task performances. This was especially true for the rapid naming task, which displayed a wide range of scores (see Figure 2).

Table 1: Range, means and standard deviations (SD) on the phonological tasks.

<table>
<thead>
<tr>
<th>Measure</th>
<th>At-risk group</th>
<th>Control group</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range  Mean</td>
<td>Range  Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rapid Automatised Naming a</strong></td>
<td>1.2-2.2 1.61</td>
<td>1.15-2.5 1.71</td>
<td>0.67</td>
<td>0.51</td>
</tr>
<tr>
<td><strong>Active letter knowledge (max 16)</strong></td>
<td>1-16  7.9</td>
<td>3-16  10.3</td>
<td>1.35</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>Passive letter knowledge (max 16)</strong></td>
<td>2-16  7.9</td>
<td>4-16  11.8</td>
<td>2.28</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Phoneme identification (max 10)</strong></td>
<td>1-10  6.4</td>
<td>7-10  8.6</td>
<td>2.89</td>
<td>0.007</td>
</tr>
</tbody>
</table>

a: The score represents the mean number of objects named per second for the two cards.

Figure 2. The distribution of scores on the rapid naming task (objects per second) of the at-risk and the control children.
4.6.2 Grammaticality judgement task

The mean percentages correct of the children are presented in Figure 3. To protect the data against a possible bias of accepting sentences as grammatical, the A’ values will be used to interpret the data, see Table 2. The average A’ value across the three conditions was significantly lower ($t(30)=1.97$, $p=0.027$) for the at-risk children compared to the control children.

Figure 4 displays the distribution of the mean A’ values across the three conditions. As can be seen, the range of A’ values, indicating discrimination ability, is considerably large in the at-risk group, with values from 0.18 (indicating a tendency to reject all sentences) to 0.98, reflecting normal sensitivity to subject-verb agreement. This wide range of scores may again well reflect the fact that the at-risk group consists of dyslexic and non-dyslexic children.

![Figure 3. The mean percentages correct on the grammaticality judgement task. The percentages correct for the grammatical conditions are ‘hits’, the percentages correct for the ungrammatical conditions are ‘correct rejections’. Gramm 1 / 2, 3: the grammatical sentences of sentence types 1, 2 and 3; ungram. 1, 2, 3: the ungrammatical sentences of sentence type 1, 2 and 3.](image-url)
Table 2. Mean A’ values and standard deviations (SD) on the grammaticality judgement task.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A’ values type 1</em></td>
<td>At-risk</td>
<td>0.77</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>0.88</td>
<td>0.09</td>
</tr>
<tr>
<td><em>A’ values type 2</em></td>
<td>At-risk</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>0.87</td>
<td>0.11</td>
</tr>
<tr>
<td><em>A’ values type 3</em></td>
<td>At-risk</td>
<td>0.63</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>0.80</td>
<td>0.14</td>
</tr>
<tr>
<td><em>Mean all</em></td>
<td>At-risk</td>
<td>0.72</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>0.85</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Figure 4. The distribution of the A’ values across the three sentence types of the at-risk and the control children.
4.6.2.1 Effect of violation

To investigate whether there was an effect of the type of violation, repeated measures analyses were used. Indeed, such an effect was found \((F(2,60)=7.49, p<0.001)\), reflecting that the type 3 violations elicited more errors in comparison with the other two violation types. This did not prove to be specific for the at-risk group, as no interaction was found between group and sentence type \((F(2,60)=0.44, p>0.5)\). The main effect of group was marginally significant \((F(1,30)=3.89, p=0.06)\).

4.6.3 The results reinterpreted a year later….

Reading abilities of 13 children of the 20 at-risk children were assessed with an AVI-test after they had received one year of formal reading instruction\(^4\). The AVI-test is a reading test that measures the speed and accuracy with which children read aloud text (Van den Berg, 1991). Based on these scores, the at-risk group was divided in two groups: children who showed normal reading progress (AVI-level 2-3, \(n=6\)), and a group of children who did not progress normally (AVI-level 0-1, \(n=7\)), called poor readers.

Table 3 displays the mean scores of the tasks administered while the subjects were in kindergarten. Mann-Whitney tests show that the poor readers scored significantly lower than the normal readers (combined group of controls and normally reading children of the initial at-risk group, \(n=18\)) on the grammaticality judgement task, on both active and passive letter knowledge and phoneme identification, see Table 3.

The \(A'\) values, indicating the ability to discriminate between grammatical and ungrammatical sentences, of the poorly reading children were significantly lower than those of the children who showed normal reading progress. Of the seven poorly reading children, two scored below chance-level (an average \(A'\) value of less than 0.28), three scored around chance-level (average \(A'\) values of around

\(^4\) The majority of the children was tested towards the end of their second year in kindergarten, so that one year later their reading abilities could be assessed. However, when the participants were recruited, some families applied whose children were at that time in their first year of kindergarten. Therefore, they were tested a year later than the other children. This meant however, that for this analysis a first indication of their reading progress is not available.
0.65) and two children scored above-chance level (average A’ values of around 0.8). In contrast, only one child that demonstrated normal reading progress scored around chance-level (an average A’ value of 0.48) and the other children all scored higher than at least 0.71.

Table 3. Percentages correct and the A’ values of children who do not show normal reading progress after one year of formal reading instruction (poor readers) and of children with normal reading progress (normally reading at-risk children and control children).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Poor readers</th>
<th>Normal readers</th>
<th>Z-score</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range Mean SD</td>
<td>Range Mean SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid Automated naming</td>
<td>1.4-2.03 1.6 0.2</td>
<td>1.2-2.5 1.7 0.4</td>
<td>0.67</td>
<td>0.51</td>
</tr>
<tr>
<td>Active letter knowledge</td>
<td>1-13 5.4 4.7</td>
<td>3-16 10.7 4.5</td>
<td>2.3</td>
<td>0.025</td>
</tr>
<tr>
<td>Passive letter knowledge</td>
<td>2-14 6 4.9</td>
<td>4-16 11.9 4.1</td>
<td>2.2</td>
<td>0.028</td>
</tr>
<tr>
<td>Phoneme identification</td>
<td>1-8 6.2 3.3</td>
<td>4-10 7.9 1.8</td>
<td>0.94</td>
<td>0.04</td>
</tr>
<tr>
<td>A’ type 1</td>
<td>0.3-0.9 0.6 0.2</td>
<td>0.4-1 0.9 0.09</td>
<td>2.5</td>
<td>0.01</td>
</tr>
<tr>
<td>A’ type 2</td>
<td>0.0-0.9 0.5 0.3</td>
<td>0.65-1 0.9 0.11</td>
<td>2.93</td>
<td>0.003</td>
</tr>
<tr>
<td>A’ type 3</td>
<td>0.0-0.8 0.4 0.3</td>
<td>0.4-1 0.7 0.16</td>
<td>1.99</td>
<td>0.05</td>
</tr>
</tbody>
</table>

4.6.3.1 Relations between predictors of reading success

To assess the interrelationships between the various forms of phonological processing, early literacy skills and sensitivity to agreement, correlations were computed. Table 4 presents the correlations between the variables. As passive and active letter knowledge correlated highly (0.93), the mean of the two scores was computed and was used in this analysis.

Moderate to strong correlations were found between the measures of agreement, phonological awareness and letter knowledge. In contrast, rapid naming did not correlate with any of the variables.
Table 4. Correlations between the variables phonological awareness (Phon.), rapid naming (RAN), Agreement types 1, 2, & 3 (AGR type 1,2,3) and the mean score of active and passive letter knowledge (Letter).

<table>
<thead>
<tr>
<th></th>
<th>RAN</th>
<th>AGR1</th>
<th>AGR 2</th>
<th>AGR 3</th>
<th>Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phon.</td>
<td>.16</td>
<td>.45*</td>
<td>.58**</td>
<td>.45*</td>
<td>.57**</td>
</tr>
<tr>
<td>RAN</td>
<td>.08</td>
<td>.24</td>
<td>.14</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td>AGR Type 1</td>
<td>.85**</td>
<td>.71**</td>
<td>.58**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGR Type 2</td>
<td>.66**</td>
<td>.54*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGR Type 3</td>
<td></td>
<td>.45*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05 (two-tailed)
** p < 0.001 (two-tailed)

4.7 Discussion

This experiment was undertaken to address two research questions that have been outlined above and that will now be returned to.

The research questions were:

(1) Can children at risk for developmental dyslexia at pre-reading age be differentiated from control subjects on the basis of phonological awareness, letter knowledge, rapid naming and sensitivity to subject-verb agreement?

(2) Are results on the tasks tapping phonological awareness, letter knowledge, rapid naming and sensitivity to subject-verb agreement administered at kindergarten age related to reading achievement after a year of formal reading instruction?

The results showed that a group of at-risk children differed at kindergarten age from non-risk children on a measure of sensitivity to subject-verb agreement, phonological awareness and on passive letter knowledge.
It is estimated that children with a familial risk for dyslexia have around 40% chance of developing dyslexia, meaning that around 5 children of the participants with known reading progress after one year is expected to be dyslexic. As it turned out, 7 children matched the profile of dyslexic readers: their progress with reading after one year of formal reading instruction was below that of expected. These children were still on the lowest level of an index of reading progress, whereas the other children had moved up two or three levels. It is acknowledged here that one year of reading instruction is too little to base the classification ‘dyslexia’ on. Furthermore, in order to make such a classification, additional testing of different factors need to be done, among one is a measure of IQ. However, reading progress in Grade 1 gives a first indication whether a child is at-risk for developing reading problems or not.

When the variables were again tested for differences between groups, with now the group classification based on poor or normal reading, it turned out that the poorly reading children had scored lower than normally reading children on letter knowledge (both active and passive), phonological awareness and sensitivity to agreement (all sentence types).

These findings are in line with Elbro et al., (1998), Gallagher et al. (2000) and Catts et al. (1999) who found letter knowledge in kindergarten the strongest predictor of reading success. In addition, phonological awareness, measured with a phoneme identification task at kindergarten age differentiated the two groups. Again, this measure was found to be a predictor of reading success in the Elbro et al. (1998) study. Furthermore the earlier discussed association between letter knowledge and phonological awareness was confirmed in this study, with letter knowledge and phonological awareness strongly correlating (De Jong & Van der Leij, 1999).

In contrast to De Jong & Van der Leij (1999), rapid naming did not differentiate between poor and normal readers in this sample, even though the same task was used. No explanation is presently at hand for the discrepancy between the results of the two studies.

The data obtained in this experiment add to the findings of Scarborough (1990; 1991), Gallagher et al. (2000) and Lyttinen et al. (2001) who found that children at risk for, or with developmental dyslexia, experience syntactic delays at pre-reading age. It furthermore can be concluded that unlike the participants in
the study of Scarborough (1990; 1991), children in this study of around 5 to 6 years old had more problems with a task tapping morphosyntax than control subjects. Thus, it could well be that the choice of methodology accounted for the observed recovery of the delay of the participants in Scarborough’s study. In the next chapter, children with developmental dyslexia of around 8 years old will be assessed on their sensitivity to agreement, to examine whether in that age group problems with morphosyntax remain.

In chapter 2, three opposing views on the relationships between syntactic abilities and dyslexia have been discussed. The first one is that dyslexic children may experience delays in their acquisition of syntactic skills as a secondary consequence of impaired literacy skills. In this case, reading experience is expected to raise children’s awareness of linguistic principles and structures, and reduced exposure to print may therefore interfere with the development of syntactic rules (Bryant, 1995). Note that in this experiment, decreased sensitivity to agreement morphology cannot be regarded as a consequence of dyslexia, as none of the children (at-risk and control children) had received formal reading instruction when they participated in the experiment. Thus, the observed decreased sensitivity to agreement morphology in the at-risk children in this sample, relative to the controls cannot be the result of the difference in reading experience between the two groups.

An alternative view was that syntactic problems in dyslexia are related to the phonological problems those children may have. Both problems in segmental phonology and verbal working memory may produce (morpho-)syntactic problems (Smith et al., 1989; Crain & Shankweiler, 1990; Bar-Shalom et al., 1993; Joanisse et al., 2000). This experiment did not include measures of verbal working memory, but the data do show significant correlations between phonological awareness and sensitivity to agreement, demonstrating indeed a link between the two skills. Following the account of Joanisse et al. (1998; 2000), marking verbs for agreement is, to a certain extent, dependent on phonological abilities, as an inflected verb form consists of a verb stem and an agreement marking morpheme of which the realisation depends on the subject of the sentence. Children thus have to be able to segment off the verb stem from the agreement marking morpheme (which has different surface forms); a skill that requires sensitivity to
the phonological structure of a word. Therefore, decreased phonological awareness may affect the building of morphosyntactic paradigms.

The third view on the relation between syntactic and reading abilities is that syntactic problems are unrelated to phonological processing deficits in dyslexia, but that a delay in syntactic abilities may have a detrimental effect on the acquisition of reading as it prevents children from applying contextual facilitation when they have to decode words (Byrne, 1981; Gallagher et al., 2000; Waltzman & Cairns, 2000; Catts et al., 1999; 2002).

The subjects in this experiment who did not progress normally in reading, scored more poorly on the grammaticality judgement task than normally reading subjects, indicating that morphosyntactic difficulties precede reading difficulties. However, from these data it is not clear whether the decreased sensitivity to agreement is a by-product of phonological problems (Joanisse et al., 2000), or whether it reflects a delay of the morphosyntactic system that is independent of factors outside the syntactic system (such as phonology (Byrne, 1981)). However, the significant correlation between phonological awareness and agreement morphology does support the idea that these two are related skills. In the next chapter, more data on agreement, phonological processing and literacy will be presented in older children with developmental dyslexia and SLI to elucidate the relationships between agreement morphology, various forms of phonological processing and literacy skills.

### 4.8 Conclusions

The aim of this chapter was to examine whether children at a familial risk for dyslexia at pre-reading age can be differentiated on several aspects of spoken language and early literacy skills from non-risk children. This proved to be the case. Children at risk for dyslexia performed more poorly on tasks tapping phonological awareness, letter knowledge and agreement morphology. When the results on the tasks were re-examined after one year of reading instruction it appeared that the children who did not show normal reading progress scored significantly lower on these tasks than the children with normal reading progress. No differences between the two groups on the rapid naming task were found.
These results support the earlier described predictive value of letter knowledge, phonological awareness and reveal that agreement morphology also differentiates between dyslexic and non-dyslexic children.

Several views have been articulated on why morphosyntactic skills are related to dyslexia. The significant correlation between agreement and phonological awareness is compatible with the idea that problems with agreement morphology are consequences of poor phonological skills. Furthermore, the finding that dyslexia is associated with weak morphosyntactic abilities also fits an interactive framework of reading in which not only phonological skills, but also syntactic (and semantic) skills play a role in early word decoding.
Appendix I: Phoneme identification task

1. **Boom**  
   - roos  
   - *raam*  
   - boot  
   - vis
2. **Slak**  
   - *bok*  
   - slang  
   - haas  
   - bel
3. **Maan**  
   - *trein*  
   - ster  
   - vaas  
   - kous
4. **Kam**  
   - kar  
   - huis  
   - *tram*  
   - baard
5. **Kin**  
   - wang  
   - kip  
   - *haan*  
   - tak
6. **Sok**  
   - deur  
   - schoen  
   - kop  
   - *boek*
7. **Hoed**  
   - hoef  
   - beer  
   - *paard*  
   - jas
8. **Haas**  
   - kok  
   - haak  
   - schaap  
   - *das*
9. **Boek**  
   - zaag  
   - pen  
   - *dak*  
   - boer
10. **Kat**  
    - *taart*  
    - kam  
    - raam  
    - vis
11. **Peer**  
    - appel  
    - *vuur*  
    - reep  
    - zon
12. **Knoop**  
    - boot  
    - jas  
    - duif  
    - *pop*

Appendix II: Letter identification

**Active and passive letter knowledge:**

1. a  
2. b  
3. c  
4. i  
5. j  
6. k  
7. m  
8. n  
9. o  
10. p  
11. r  
12. s  
13. t  
14. u  
15. v  
16. z
Appendix III: Grammaticality judgements

Subject-verb agreement violations type 1:

1. Minnie Mouse bak een appeltaart
2. Het stoute meisje volg een zwarte hond
3. Oom Dagobert zie een zak met geld
4. Het leuke meisje duw een man om
5. Het ondeugende zusje knoei een beetje
6. Het kleine jongetje graaf een diepe kuil
7. Pluto de hond begraaf een dik bot
8. Mickey Mouse vang een grote bal
9. De bruine hond blaf een keer
10. De dikke boef steel een ketting

Subject-verb agreement violations type 2:

11. De oude vrouw wassen een kopje
12. De snelle voetballer winnen een beker
13. De dikke man drinken een glas sinasappelsap
14. De meester knippen het papier af
15. De onhandige man breken een vaas
16. De rijke prins roken een sigaar
17. De grote timmerman zagen de plank door
18. De vrolijke man lachen om de clown
19. De lieve vrouw aaien het konijn
20. De dunne man tekenen een banaan

Grammatical sentences matching type 1/2:

21. De dikke kok maakt een taart
22. De snelle dief steelt een zak met geld
23. De brandweerman parkeert een brandweerauto
24. Mijn grote broer vangt een rode bal
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25. De oude oma aait het baby'tje
26. De aardige kapper knipt het haar af
27. De bruine hond ziet een lekker bot
28. De oude meester poetst zijn tanden
29. De aardige man bekijkt een schilderij
30. Het hertje Bambi loopt een eindje

Subject-verb agreement violations type 3:

31. De groene kikkers kwaakt in de vijver
32. De stoute jongens verstopt de bal
33. De bruine cavia’s eet een wortel
34. De wilde tijgers achtervolgt de jongens
35. De snelle panters rent door het oerwoud
36. De melkbekers valt op de grond
37. De vriendelijke kappers knipt mijn haren
38. De grote slagers werkt in een winkel
39. De langzame ezels drinkt uit een rivier
40. De lieve oppassers woont vlakbij ons

Grammatical sentences matching type 3:

41. De grote tijgers drinken het water
42. De tandenborstels liggen in de badkamer
43. De enge tovenaars kennen een heks
44. De groene knikkers vallen van de tafel af
45. De dappere ridders rijden op hun paarden