L1 and L2 reading skills in Dutch adolescents with a familial risk of dyslexia

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Background. The present study investigated differences in reading and spelling outcomes in Dutch and English as a second language (ESL) in adolescents with a high familial risk of dyslexia, of whom some have developed dyslexia (HRDys) while others have not (HRnonDys), in comparison to a low familial risk control group without dyslexia (LRnonDys). This allowed us to investigate the persistence of dyslexia in the first language (L1) and the effect of dyslexia on the second language (L2), which has, in this case, a lower orthographic transparency. Furthermore the inclusion of the HRnonDys group allowed us to investigate the continuity of the familial risk of dyslexia, as previous studies observed that the HRnonDys group often scores in between the HRDys and LRnonDys group, and whether these readers without reading deficits in Dutch, have more reading difficulties in ESL.

Methods. The data of three groups of adolescents were analyzed; 27 LRnonDys, 25 HRdys 25 HRnonDys. The mean age was 14;1 years; months, and 37 were male. All were native speakers of Dutch, attended regular secondary education (grade 7-10), and were non-native speakers of English. Using MANOVA the groups were compared on Dutch and English word reading fluency (WRF), spelling and vocabulary, Dutch pseudoword and loanword reading fluency, phonological awareness (PA), rapid automatized naming (RAN), and verbal short term and working memory. A repeated measures ANOVA was used to compare English and Dutch WRF, spelling and vocabulary directly within the three groups.

Results. The analyses revealed that the HRDys group had a deficit in both reading and spelling in Dutch and ESL. They also performed poorer than the LRnonDys group on all other measures. Effect sizes were especially large for pseudoword reading and the reaction times during the PA task. The HRnonDys group scored generally poorer than the LRnonDys group but this difference was only significant for Dutch pseudoword reading, PA reaction times and verbal short term memory. In general the HRDys and HRnonDys group scored similar in Dutch and English, except for English WRF where the HRDys group scored slightly better than expected based on their Dutch WRF.

Discussion. There was a high persistence of dyslexia. Adolescents with dyslexia had large impairments in reading and spelling, and reading related measures, both in Dutch and ESL. Despite high inter-individual differences, an overall three-step pattern was observed. Adolescents in the HRnonDys group scored in between the HRDys and LRnonDys group, supporting the polygenetic origin of dyslexia and the continuity of the familial risk of dyslexia. The lower orthographic transparency did not have a negative effect on L2 reading, spelling and vocabulary, both in the HRnonDys and HRDys group. The latter group

performed slightly better than expected in L2, which may be a result of the massive exposure to English and high motivation to use English by adolescents.

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25   **Abstract**

26   **Background.**The present study investigated differences in reading and spelling outcomes

27   in Dutch and English as a second language (ESL) in adolescents with a high familial risk of

28   dyslexia, of whom some have developed dyslexia (HRDys) while others have not (HRnonDys),

29   in comparison to a low familial risk control group without dyslexia (LRnonDys). This allowed us

30   to investigate the persistence of dyslexia in the first language (L1) and the effect of dyslexia on

31   the second language (L2), which has, in this case, a lower orthographic transparency.

32   Furthermore the inclusion of the HRnonDys group allowed us to investigate the continuity of the

33   familial risk of dyslexia, as previous studies observed that the HRnonDys group often scores in

34   between the HRDys and LRnonDys group, and whether these readers without reading deficits in

35   Dutch, have more reading difficulties in ESL.

36   **Methods.** The data of three groups of adolescents were analyzed; 27 LRnonDys, 25

37   HRdys 25 HRnonDys. The mean age was 14;1 years; months, and 37 were male. All were native

38   speakers of Dutch, attended regular secondary education (grade 7-10), and were non-native

39   speakers of English. Using MANOVA the groups were compared on Dutch and English word

40   reading fluency (WRF), spelling and vocabulary, Dutch pseudoword and loanword reading

41   fluency, phonological awareness (PA), rapid automatized naming (RAN), and verbal short term

42   and working memory. A repeated measures ANOVA was used to compare English and Dutch

43   WRF, spelling and vocabulary directly within the three groups.

44   **Results.** The analyses revealed that the HRDys group had a deficit in both reading and

45   spelling in Dutch and ESL. They also performed poorer than the LRnonDys group on all other

46   measures. Effect sizes were especially large for pseudoword reading and the reaction times

47   during the PA task. The HRnonDys group scored generally poorer than the LRnonDys group but

48   this difference was only significant for Dutch pseudoword reading, PA reaction times and verbal

49   short term memory. In general the HRDys and HRnonDys group scored similar in Dutch and

50   English, except for English WRF where the HRDys group scored slightly better than expected

51   based on their Dutch WRF.

52   **Discussion.** There was a high persistence of dyslexia. Adolescents with dyslexia had

53   large impairments in reading and spelling, and reading related measures, both in Dutch and ESL.

54   Despite high inter-individual differences, an overall three-step pattern was observed. Adolescents

55   in the HRnonDys group scored in between the HRDys and LRnonDys group, supporting the

56   polygenetic origin of dyslexia and the continuity of the familial risk of dyslexia. The lower

57   orthographic transparency did not have a negative effect on L2 reading, spelling and vocabulary,

58   both in the HRnonDys and HRDys group. The latter group performed slightly better than

59   expected in L2, which may be a result of the massive exposure to English and high motivation to

60   use English by adolescents.

61   **L1 and L2 Reading Skills in Dutch Adolescents with a Familial Risk of Dyslexia**

62   Dyslexia is a specific learning disorder characterized by problems with accurate and/or

63 fluent word recognition, poor decoding, and poor spelling abilities at the word level (American

64 Psychiatric Association, 2013, p. 67), but it can have consequences for higher level reading

65 comprehension skills and writing skills as well (Tops, Callens, Cauwenberghe, Adriaens, &

66 Brysbaert, 2013). Dyslexia is not a discrete disorder, there is no natural cut-off point that

67 separates the reading skills of people with and without dyslexia (Shaywitz, Escobar, Shaywitz,

68 Fletcher, & Makuch, 1992). Furthermore, dyslexia is a heterogeneous disorder, as research has

69 found that there are multiple genes and cognitive deficits that may affect the reading skills of

70 people with dyslexia (Carrion-Castillo et al., 2017; Carrion-Castillo, Franke, & Fisher, 2013;

71 Pennington, 2006; Pennington et al., 2012). While a phonological processing deficit, especially a

72 deficit in phonological awareness (PA), is often seen as the core problem of dyslexia (e.g. Ramus

73 et al., 2003; van der Leij & Morfidi, 2006), it is neither necessary nor sufficient to explain all

74 cases of dyslexia at the individual level (Pennington et al., 2012). Other cognitive deficits linked

75 to reading problems include deficits in rapid automatized naming (RAN; e.g. Kirby, Georgiou,

76 Martinussen, & Parrila, 2010; Norton & Wolf, 2012; Papadopoulos, Spanoudis, & Georgiou,

77 2016), verbal working and short-term memory (VST/WM; e.g. de Jong, 1998; Pennington &

78 Lefly, 2001; Snowling, Gallagher, & Frith, 2003) and orthographic processing (e.g. Georgiou,

79 Papadopoulos, Zarouna, & Parrila, 2012; Rothe, Cornell, Ise, & Schulte-Körne, 2015).

80   Dyslexia has a prevalence of 5 to 10 percent in the normal population, depending on the

81 criteria used (Miles, 2004). However, as dyslexia has a partially genetic origin (e.g. Carrion-

82 Castillo et al., 2013) children with a parent with dyslexia have a much higher risk to develop

83 dyslexia, on average 45 percent (Snowling & Melby-Lervåg, 2016) . Because we can reliably

84 predict, before formal reading instruction starts, that a large proportion of children with a (high)

85 familial risk of dyslexia (FR) will develop dyslexia, they constitute an interesting population for

86 prospective longitudinal research. The participants of the present study have all participated in

87 such a study in the Netherlands, the Dutch Dyslexia Program (DDP; See e.g. van Bergen, de

88 Jong, Plakas, Maassen, & van der Leij, 2012; van der Leij et al., 2013). In the DDP study, a

89 group of children, of whom approximately two-third has a high FR and half of the children with

90 a high FR has eventually developed dyslexia, has been followed from birth. The present study

91 focused on a selection of these children at the age when they were advanced readers. More

92 specifically, we investigated how (a family risk of) dyslexia influences the word level reading

93 and spelling skills in early adolescence. As English is a mandatory subject in schools in the

94 Netherlands, and is increasingly used in everyday life, we did not only examine reading and

95 spelling in the participants' first language (L1) Dutch, but also reading and spelling in English,

96 their second language (L2). To our knowledge this is the first large-scale study that involves

97 adolescents with a high FR that has looked at L2 reading and spelling. Before we describe our

98 research questions and hypotheses in more detail, we will first discuss general differences that

99 have been found between (advanced) readers with and without (a familial risk of) dyslexia, the

100 position of English in the Netherlands, and learning to read in English as a second language

101 (ESL) with dyslexia.

102 **Readers with a Familial Risk of Dyslexia**

103   As dyslexia is not a discrete disorder, the degree at which parents are affected by dyslexia

104 also varies. Hence, the familial risk for dyslexia is continuous as well. Some of the cognitive and

105 reading impairments typically associated with dyslexia have also been found, usually in a milder

106 form, in children with a high FR who do not have dyslexia (HRnonDys). In family risk studies

107   they often score in between the group with a high FR with dyslexia (HRDys) and children with a

108   low FR without dyslexia (LRnonDys) in family risk studies (e.g. Elbro, Borstrøm, & Petersen,

109   1998; Pennington & Lefly, 2001; Snowling et al., 2003; van Bergen et al., 2012). This three-step

110   pattern is in line with a polygenetic inheritance and multifactorial origin of dyslexia, as the

111   HRnonDys group probably has inherited or has been exposed to some risk factors associated

112   with reading disability causing mild reading problems (see van Bergen, van der Leij, & de Jong,

113   2014 for a more in-depth discussion).

114   For advanced readers, results regarding this three-step pattern are somewhat mixed.

115   Snowling, Mutter and Carrol (2007) found significant differences in exception word reading, text

116   reading accuracy, and timed measures of nonsense passages, sight-word and decoding efficiency,

117   text reading rate, and spelling, between HRnonDys adolescents and a control group of

118   adolescents with a low familial risk without dyslexia (LRnonDys) at the age of 12-13. On the

119   other hand, Dandache, Wouters and Ghesquière (2014) found only a difference for Word

120   Reading Fluency (WRF) in Dutch readers in Grade 6, and Eklund, Torppa, Aro, Leppänen and

121   Lyytinen (2014) did not find significant difference between the HRnonDys group and the

122   LRnonDys group in Finnish readers in Grade 8. However, in all studies the scores of the

123   HRnonDys group were generally lower than the scores of the LRnonDys group, and higher than

124   the scores of the HRDys group. In all studies the HRDys group also scored significantly lower

125   than the LRnonDys control group. These effects were usually large, supporting the view that

126   dyslexia persists into adolescence, as has also been found by others (Ferrer et al., 2015; Shaywitz

127   et al., 1999).

128   **Position of English in the Netherlands**

129   Although Dutch is the dominant language in the Netherlands, English has a very

130   important position (See for a more elaborate discussion of the position of English in the

131   Netherlands also: Gerritsen, Van Meurs, Planken, & Korzilius, 2016). According to McArthur

132   (1996) the high level of bilingualism between English and Dutch in the Netherlands justifies the

133   view that English is a strong second language, rather than a foreign language. In the Netherlands,

134   children learn to read and write in their first language Dutch when they are 6 years old and enter

135   grade 1. Explicit English L2 instruction is mandatory from grade 5 onwards and remains

136   obligatory in almost all curricula until the end of secondary education and even in a wide range

137   of fields of study in higher education. However, some schools already start English as early as

138   Kindergarten, and the hours of English per week vary (Thijs, Trimbos, Tuin, Bodde, & de

139   Graaff, 2011). Dutch children come into contact with English almost daily via television and

140   multimedia, like internet and games. According to Di Carlo (1994) contact with multimedia,

141   where verbal messages are accompanied by visual images, has an impact on language learning.

142   Moreover, it has been shown that watching subtitled programs and films in a foreign language

143   causes (incidental) language learning, even in young children (d'Ydewalle & Poel, 1999)

144   because both languages are then simultaneously present.

145   **Reading in English (as a Second Language) with Dyslexia**

146   While English and Dutch both stem from Germanic origins, and share a relatively high

147   syllabic complexity, they differ in the transparency of their letter-to-sound conversions. Dutch

148   orthography has 40 phonemes that can be written in 76 ways, in contrast to English that has 44

149   phonemes that can be written in 561 ways (Dewey, 1971). Dutch orthography is therefore

150   considered more transparent than English. In transparent orthographies, firm and accurate

151   phonological representations are installed in the early stages of reading acquisition. Therefore

152   phonological awareness and reading development are faster in transparent than in deeper

153   orthographies (Seymour, Aro, & Erskine, 2003). This explains why a large proportion of Dutch

154   children can read accurately after one year of reading instruction, whereas English children need

155   on average four years to obtain the same reading level (Seymour et al., 2003).

156   According to the Linguistic Coding Differences Hypothesis (LCDH; Ganschow, Sparks,

157   Javorsky, Pohlman, & Bishop-Marbury, 1991) individuals who encounter difficulties with L1

158   acquisition, will also have problems in L2 because there is a link in L1 and L2 learning,

159   particularly in learning to read. Ganshow et al. (1991) emphasized the importance of

160   orthographic, syntactic and semantic, and especially phonological skills to transition from L1 to

161   L2. Although the relation between phonological awareness and reading decreases with age,

162   phonological processing still plays a role in the reading skills of individuals with dyslexia at a

163   later age (Bekebrede, van der Leij, & Share, 2009). For most typically developing children,

164   transition from L1 to L2 learning runs smoothly, whereas for children with dyslexia, L2 learning

165   is particularly challenging (Helland & Kaasa, 2005). In transparent orthographies, children with

166   dyslexia encounter difficulties with reading speed. In deeper orthographies, such as English,

167   children with dyslexia experience difficulties with reading accuracy as well (Hagtvet & Lyster,

168   2003).

169   In addition to phonological processing, orthographic processing is also necessary for

170   fluent reading. There is much evidence for differences in orthographic knowledge between

171   typical and dyslexic readers (Bekebrede et al., 2009). However, there is also evidence that a

172   subgroup of readers with dyslexia read better in English L2 than in their more transparent L1.

173   Miller-Guron and Lundberg (2000) found that a group of dyslexic adult students that had a self-

174   reported preference for English (L2) over Swedish (L1), indeed read better in English than in

175 Swedish. Furthermore, the dyslexic students with a preference for English also performed better

176 on English spelling and free-writing tasks, compared to dyslexic students without a preference

177 for English. Miller-Guron and Lundberg (2000) have suggested that the dyslexic participants

178 with a preference for English could perhaps make use of frequently occurring spelling patterns or

179 orthographic structures that they learned from frequent exposure to English. According to the

180 authors, irregular grapheme-to-phoneme conversion rules in English dissuade readers from using

181 the decoding-route and favor the use of whole-word strategies. Additionally, van der Leij and

182 Morfidi (2006) found that a subgroup of Dutch (L1) poor readers in grade 7 and 8 were better at

183 English (L2) reading than at Dutch reading, and had a higher verbal competence in English than

184 they had in their mother tongue. This group was shown to have superior orthographic

185 competence, as measured with an orthographic choice task in both Dutch and English, compared

186 to a group of dyslexic readers who failed to show an advantage in L2 English.

187 **The Present Study**

188 The present study focused on Dutch and ESL literacy skills in Dutch adolescents with a

189 familial risk of dyslexia. As dyslexia is a problem at the word level we compared the three main

190 groups, HRDys, HRnonDys and LRnonDys, on word level reading and spelling, in Dutch and

191 English, as well as on word-level reading related skills: RAN, PA, vocabulary and VST/WM.

192 Based on previous studies we expected large differences between the HRDys group and the

193 LRnonDys group on all tests, as dyslexia is a persistent problem. In line with previous studies we

194 expected that the HRnonDys group will perform in between the HRDys and LRnonDys group,

195 but that these differences may not always be significant. As L1 reading skills are highly

196 predictive for L2 reading skills according to the LCDH we expected that reading and spelling in

197 ESL is also highly problematic for the HRDys group. To investigate if the effects are similar

198 across languages, we directly compared Dutch and English reading, spelling and vocabulary

199 skills between the groups. The lower orthographic transparency may make reading in English

200 more difficult, but a preference for reading in ESL has also been observed among some dyslexic

201 readers. Moreover, the inclusion of a HRnonDys group allowed us to investigate if this group,

202 which by definition has no reading problems in Dutch, does have reading difficulties in English

203 which is orthographically more complex than Dutch.

Method

205 **Participants** Eighty-one adolescents were included in the present study, 39 were male

206 and 42 were female. They attended year 1 to 4 of Dutch secondary school, corresponding to

207 grades 7-10 (mostly Grade 8), and the mean age was 14;1 years; months (SD = 7 months). They

208 all participated in the Dutch Dyslexia Program (DDP) in Groningen or Amsterdam, the

209 Netherlands. Seventy-eight percent of the children from Amsterdam and Groningen who

210 participated in the previous DDP measurement in Grade 6, participated in the present study. All

211 participants were native speakers of Dutch and spoke mainly Dutch in school, but a few

212 participants in the Northern region also spoke Frisian at home. None of the participants had lived

213 abroad in an English speaking country other than during a holiday.

214 Based on parental reading scores participants were divided into a high FR and low FR

215 control group. Parents were tested with WRF and pseudoword reading fluency (PWRF) tasks,

216 the same tasks that were used in this study and are described later. If the reading scores of at least

217 one parent belonged to the lowest 20 percent on one test and to the lowest 40 percent on the

218 other test, using the norms by Kuijpers et al. (2003), and if they reported a family history of

219 dyslexia, participants were categorized in the high FR group. For the low FR control participants,

220 reading scores of both parents did not meet these criteria, nor was there a self-reported family

221   history of dyslexia. Dyslexia status was based on the participants' reading scores during previous

222   DDP measurements. The adolescents were categorized in the group with dyslexia if they met the

223   following criteria: participation in at least two out of three measurements in grades 2, 3, and 6,

224   two scores in the lowest 10% range on either WRF or PWRF (again measured with the same

225   tests), and at least below average on the other test during that measurement. If they had

226   participated only twice and met the criteria once they were excluded because we aimed to

227   include only participants with persistent reading problems (one participant was excluded). By

228   combining the risk and dyslexia categorizations, four groups were created: 27 participants with a

229   low FR without dyslexia (LRnonDys), 25 participants with a high FR without dyslexia

230   (HRnonDys), 25 participants with a high FR with dyslexia (HRDys) and 4 participants with a

231   low FR with dyslexia (LRDys). While the latter group is too small for group comparisons, these

232   adolescents were included in the standardization of the test measures, which was based on the

233   whole low FR group, to have a more accurate estimation of the typical population. Participant

234   characteristics can be found in Table 1. Because of the longitudinal design groups could not be

235   matched on factors like age and gender. As age did not differ significantly between the three

236   main groups (F (2, 74) = 2.085, p = .132), we did not further consider age in the analyses.

237   Exclusion criteria were an IQ below 80 as measured during previous assessments, severe

238   medical or psychiatric problems, or the attendance of a secondary school where the language of

239   instruction for other subjects than English was English. For the latter reason four participants

240   (two in each non-dyslexic group) were excluded from the study. Since the other exclusion

241   criteria were already applied during previous DDP assessments no participants were excluded for

242   these reasons. Participants with comorbid developmental disorders, such as Attention Deficit

243   Hyperactivity Disorder (ADHD), Attention Deficit Disorder (ADD) or Autism Spectrum

244   Disorder (ASD) were included in the study as comorbidity is common between dyslexia and

245   other (neuro)-developmental problems (e.g. Germanò, Gagliano, & Curatolo, 2010; Kaplan,

246   Wilson, Dewey, & Crawford, 1998; Mayes & Calhoun, 2006; Willcutt & Pennington, 2000), and

247   excluding these participants would lead to an unrepresentative sample. Parents reported three

248   cases of comorbid disorders in the LRnonDys group (one with ASD and two with ADD), two in

249   the HRnonDys group (one with ASD and one with ADD), and four in the HRDys group (one

250   with ASD, two with ADHD, and one with ADD). Parents reported that one participant in the

251   LRDys group showed signs of both ADD and ASD, but it was unclear whether this participant

252   had an official diagnosis. From questionnaires conducted in Grade 6 we know that about 11

253   percent of the children in the LRnonDys group, 14 percent of the children in the HRnonDys

254   group, and 75 percent of the children in the HRDys group received extra help in school.

255   **Materials**

256   **Reading Fluency.** Four tests of reading fluency, measuring both reading accuracy and

257   speed, were included in the study: Dutch WRF ("Een minuut Test", one minute test, Brus &

258   Voeten, 1973), Dutch PWRF ("Klepel", van den Bos, Lutje Spelberg, Scheepstra, & de Vries,

259   1994), English WRF (Kleijnen, Steenbeek-Planting, & Verhoeven, 2008), and loan word reading

260   fluency, using loanwords from English that are incorporated in the Dutch language (Schijf,

261   2009). The participants had to read aloud word lists, with words of increasing difficulty, as fast

262   and accurately as possible. The score is the number of words read correctly within the allotted

263   time, which was one minute for all tests, except for PWRF where it was two minutes. The

264   English WRF test had 108 words and the Loan word test 116 words; for each test the words were

265   presented in four columns. For the Dutch WRF and PWRF the A-version was used, but the last

266   column of the B-version was added, such that there were 145 words spread over 5 columns, to

267   ensure that participants would not finish reading all words within the allotted time.

268   **Spelling.** Dutch and English spelling was measured with a dictation test. First a whole

269   sentence was read, next the target word(s) were repeated. The participant had to write the target

270   words on an answer sheet where the rest of the sentence was already printed. The test was

271   executed at the participant's own pace and at request words were repeated more than once. For

272   Dutch the "PI-signalerings dictee" (Geelhoed & Reitsma, 2004) was used, which is a spelling

273   screening instrument for the first grade of secondary school. It consists of 38 sentences and has

274   90 target words. For Dutch learners of English there was no standardized spelling test available.

275   Therefore we created an English dictation test based on English textbooks for the lowest level of

276   the first two grades of Dutch secondary school (grades 7 and 8). This dictation consists of 20

277   sentences with 20 target words, and can be found in Appendix A .

278   **Vocabulary.** Dutch and English vocabulary knowledge were tested with an oral

279   vocabulary test. For Dutch this was the vocabulary task from the third edition of the Dutch

280   Wechsler Intelligence Scale for Children (WISC-III-NL, Wechsler, 2005). During this task

281   participants were asked to describe the meaning of words that increased in difficulty as the test

282   progressed, like for example "paraplu" (umbrella) and "onafhankelijk" (independent). There are

283   35 items and 2 points can be gained for a fully correct answer and 1 point for a partially correct

284   answer as determined by the test manual. After 4 incorrect answers the test is terminated. English

285   vocabulary knowledge was tested with the fourth edition of the Peabody Picture Vocabulary Test

286   (PPVT-IV, Dunn & Dunn, 2007). During this test the participants heard a word and had to

287   indicate which picture out of four pictures matches with the word. First a base set was

288   established, a set of 12 items where all answers were correct or only one mistake was made.

289   Thus, if more mistakes were made in the starting set, determined by the participant's age, a lower

290   set was chosen until the base set was reached. Next, the ceiling set was established, the set for

291   which eight or more mistakes were made, by moving up from the starting set. A total score is

292   obtained by subtracting the total number of errors from the item number of the last item of the

293   ceiling set. The maximum score for this test is 228.

294   **Phonological Awareness.** PA was measured with a Dutch spoonerism task (Depessemier

295   & Andries, 2009). The test was computerized and the items were recorded such that all

296   participants heard the items exactly the same way. The participants heard two words through

297   headphones and were instructed to switch the first sounds of the words such that the first sound

298   of the second became the first sound of the first word, and vice versa. This resulted mostly in

299   pseudowords, but sometimes also in other real words. For example "nieuwe wagen" (new

300   wagon) became "wieuwe nagen". If a word started with a consonant cluster, both the answer

301   where the whole cluster was reversed and the answers where a single phoneme was reversed

302   were considered correct. For example in the case of "grote boom" (big tree), both "brote goom"

303   and "bote groom" were considered correct. There were six practice items and 20 test items. For

304   the test items the participants were instructed to respond as fast and accurately as possible, but

305   only if they knew the complete answer, such that the researcher could record both reaction times

306   and accuracy. Reaction times were recorded manually when the participant started to utter the

307   first word. The reaction times scores were corrected for extreme outliers and wrong registrations

308   by removing reaction times shorter than 100 ms and longer than 3 standard deviations above the

309   mean reaction time per participant.

310   **Rapid Automatized Naming.** RAN was measured with a digit naming task (van den Bos

311   & Lutje Spelberg, 2007). The participant had to name 50 digits grouped in 5 rows as fast and

312   accurately as possible. Taking into account accuracy and the time needed to name all items the

313   number of items that could be named correctly within one minute was calculated.

314   **Verbal Short Term and Working Memory.** The Digit span task of the WISC-II-NL

315   (Wechsler, 2005) was used to measure VST/WM. During the forward task, where mainly short

316   term memory is involved, the participants heard a series of digits that had to be repeated in the

317   same order. During the backward task the participant had to repeat the series of digits in a

318   reversed order. Here working memory is also involved as the information does not only have to

319   be stored but also has to be manipulated. The length of the series increases during both digit span

320   tasks. If the participant failed to repeat two series of the same length, the test is terminated. The

321   score is the number of series reported correctly. The maximum score is 16 in the forward task

322   and 14 in the backward task.

323   **Procedure**

324   Participants were seated in a quiet test environment. Tests were conducted individually.

325   As they participated in the DDP before, participants were already familiar with this testing

326   situation. First, all Dutch tests were conducted, then the reading related subtests, and finally the

327   English tests, to not confuse the participants with the different languages. There was a break in

328   between the reading related tests and the English tests and participants were encouraged to take

329   more breaks if deemed necessary. Informed consent was obtained from the parents, and

330   adolescents gave their informed assent, as well. Travel costs were reimbursed and participants

331   received a gift voucher to thank them for their participation. The study was approved by the

332   Medical Ethical Committee of the University Medical Center Groningen (METc-nr: 2014/076,

333   ABR-nr: NL48140.042.14).

334   **Analyses**

335   To investigate whether data were missing completely at random, and whether we could

336   use expectation maximization to impute missing data, a missing value analysis was conducted

337   with Little's MCAR test in SPSS 23 (IBM Corp, Armonk, NY, USA). A Multivariate Analysis

338   of Variance (MANOVA) was conducted between the LRnonDys, HRnonDys and HRDys groups

339   to investigate first if there was a group difference over all measures together, and next to

340   investigate for which measures the groups differed from each other. Post-hoc pairwise

341   comparisons with the Least Square Difference Method were used to investigate which groups

342   differed from each other. Since we did overall tests first, and since we have separate hypotheses

343   for each contrast, namely that we would see a three-step pattern for each of the included reading

344   (related) test where the LRnonDys group would have the highest score and the HRDys group the

345   lowest, we did not further correct for multiple comparisons as this would strongly reduce power

346   and increase the Type-II error rate. Hedges' g was calculated as a measure of the effect sizes

347   based on the mean and standard deviations. This adaptation of the commonly reported Cohen's d

348   corrects for a bias due to small sample sizes (Hedges & Olkin, 1985). For Dutch and English

349   WRF, vocabulary and spelling, repeated measures ANOVAs with a 3x2 design were used to

350   investigate if the effect of Group (LRnonDys, HRDys, HRnonDys) was larger in a certain

351   Language (Dutch or English). All hypotheses were tested two-sided, but we also report

352   marginally significant effects ($p < .1$) that would be significant if we tested one-sided. If

353   variables were not normally distributed, and/or if the homogeneity of variance assumption was

354   violated we also ran non-parametric analyses, but since the conclusions based on the non-

355   parametric analyses were very similar we only report the results of the parametric analyses.

356   **Results**

357   **Missing Data Analysis and Descriptive Statistics**

358   One case was missing for Dutch spelling, two cases were missing for RAN, and 4 cases

359   were missing for the spoonerism reaction time due to test administration errors, registration or

360   computer errors. Since the data were missing completely at random (χ^2 (35) = 26.510, p = .848),

361   and the number of missing cases was small, missing cases were imputed with the expectation

362   maximization method in SPSS. Normality within the groups was checked with the Kolmogorov-

363   Smirnov test. In Table 2 with descriptive statistics it is indicated when the distribution deviated

364   significantly from a normal distribution. The data of the Spoonerisms RT, which had a severe

365   positive skewness and kurtosis, was successfully transformed with a log transformation; for the

366   other variables that were not normally distributed transformations were not successful. There

367   was homogeneity of variance for most variables, except for Digit-span - Forward, Spoonerisms

368   Accuracy and RT, and Dutch spelling. To make the scales of the different reading and reading

369   related measures comparable, the data were standardized on the basis of the means and standard

370   deviation of the whole low familial risk group, including 4 participants with dyslexia. Therefore

371   the means and standard deviations of the LRnonDys group slightly deviate from zero and one,

372   respectively. Correlations between the different reading (related) measures can be found in Table

373   3. In table B1 in the appendix descriptive statistics and the minimum and maximum score can be

374   found for the unstandardized data for all groups and for the total sample.

375   **Group Comparison**

376   The MANOVA revealed a significant overall effect of Group (Pillai's Trace = .96, F (26,

377   13) = 4.43, p < .001, η_p^2 =.48). Pillai's Trace is reported because Box's test of equality of

378   covariance matrices was significant (M = 346.64, F (282, 14371.80) =1.42 p < .001). For all

379   measures the effect of Group was significant (p < .05). Pairwise comparisons with the Least

380   Significant Difference method were performed after the MANOVA; effect sizes and

381   significances can be found in Table 4. The HRDys group performed significantly worse than the

382   LRnonDys control group on all measures, and effect sizes were especially large for the reading

383   fluency and spelling measures. The HRDys group also performed significantly worse than the

384   HRnonDys group on most measures, except for the digit span forward task and Dutch

385   vocabulary, although the difference was marginally significant ($p = .07$) for the latter test.

386   Although the HRnonDys group always scored in between the HRDys and LRnonDys group,

387   their performance was in most cases not significantly different from the LRnonDys group.

388   Exceptions here are the Dutch pseudoword reading fluency, spoonerisms RT and the digit-span

389   Forward tasks where the HRnonDys group performed significantly worse than the LRnonDys

390   group. For English spelling there was a marginally significant difference between the two non-

391   dyslexic groups ($p = .09$).

392   **Comparison between English and Dutch Literacy Skills**

393   As can be seen from the correlations in Table 3, English and Dutch WRF and spelling

394   skills were overall strongly correlated, while there was only a small correlation between Dutch

395   and English vocabulary. To compare Dutch and English WRF, spelling and vocabulary between

396   groups, we performed a 2x3 repeated measures ANOVAs with Language (English vs. Dutch) as

397   within-subject factor, and Group (LRnonDys vs. HRDys vs. HRnonDys) as between subject

398   factor. For WRF there was a significant main effect of Group (F (2, 74) =35.09, p <.001,

399   η_p^2=.49), and a significant interaction between Language and Group (F (2, 74) =5.15, p =.01,

400   η_p^2=.12). There was no main effect of Language (F (1, 74) =.35, p =.56, η_p^2=.01). A main effect

401   of Language could not be expected in this analysis, since the data were normalized per subtest

402   and thus per language. Pairwise comparisons using the LSD method revealed that the HRDys

403   group overall performed poorer than the LRNonDys and HRNonDys groups ($p < .05$), but that

404   the nonDys groups did not differ from each other ($p > .05$). Further analyses of the interaction

405   showed that the difference between English and Dutch WRF (calculated by subtracting the

406   Dutch WRF score from the English WRF score) was larger for the HRDys group ($M = .44$, $SE =$

407   .14) compared to the LRnonDys group ($M = -.03$, $SE = .14$, $p = .04$) and HRnonDys group ($M = -$

408   .26, $SE = .18$, $p = .002$). Thus, the HRDys group performed relatively well on English compared

409   to Dutch WRF. In Figure 1, that shows the means and standard errors per group per language,

410   this interaction can also be observed. The difference between the LRnonDys and HRnonDys

411   groups was not significant ($p = .30$).

412   There also was a main effect of Group on spelling ($F_{(2, 74)} = 41.36$, $p > .001$, $\eta_p^2 = .53$)

413   and vocabulary ($F_{(2, 74)} = 6.34$, $p = .003$, $\eta_p^2 = .15$). Pairwise comparisons for both spelling and

414   vocabulary revealed that the HRDys group performed poorer than the LRNonDys and

415   HRNonDys groups ($p < .05$), but that both nonDys groups did not differ from each other ($p >$

416   .05). In contrast to WRF, there was no interaction between Language and Group for spelling (F

417    $_{(2, 74)} = 1.58$, $p = .21$, $\eta_p^2 = .04$) or vocabulary ($F_{(2, 74)} = .17$, $p = .84$, $\eta_p^2 = .005$). There was also

418   no main effect of Language on spelling ($F_{(1, 74)} = .1.48$, $p = .23$, $\eta_p^2 = .02$) or vocabulary (F (1,

419   74) $= .01$, $p = .91$, $\eta_p^2 > .000$), but again this was expected because the data were standardized per

420   subtest.

421   **Discussion**

422   **Reading Skills of Adolescents (with a Familial Risk of) Dyslexia**

423   The first aim of this study was to investigate how adolescents with a familial risk of

424   dyslexia perform at reading and spelling tasks in Dutch and ESL in comparison to a low familial

425   risk control group without dyslexia. Moreover, we compared these groups on several literacy

426   related measures: English and Dutch vocabulary, RAN, PA, and VST/WM. Large reading and

427   spelling deficits and mild vocabulary deficits were found in the HRDys group, both in Dutch and

428   in English. The HRDys group scored significantly lower than the LRnonDys Group on all other

429   reading-related tasks as well. The HRDys group also scored significantly worse than the

430   HRnonDys group on all measures with the exception of Dutch vocabulary, where there was a

431   marginally significant difference. These findings are in agreement with previous studies that also

432   found that dyslexia is persistent into adolescence (Ferrer et al., 2015; Shaywitz et al., 1999).

433   We observed a three-step pattern in the data as the scores of the HRnonDys group were in

434   between the scores of the LRnonDys group and the scores of the HRDys group, but the

435   difference between the two nonDys groups was only significant for Dutch pseudoword reading,

436   the Spoonerisms RTs measuring Dutch PA and the digit span-forward task measuring VSTM.

437   The results are in line with studies of adolescents with a familial risk where the HRnonDys group

438   generally performs poorer than the LRnonDys group, but only some of the differences were

439   significant (Dandache et al., 2014; Eklund et al., 2014; Snowling et al., 2007). These results

440   support a continuous view of (the familial risk of) dyslexia and a multifactorial origin of dyslexia

441   as described by among others Pennington et al. (2012) and van Bergen et al. (2014). It is likely

442   that adolescents in the HRnonDys group have been exposed to some of the same family risk

443   factors that affected the HRDys group. However, based on this study we cannot determine

444   whether these family influences are genetic, environmental, both, or an interaction between

445   genetics and the environment. This view of dyslexia is further supported by family-risk studies

446   where the reading skills of parents of high FR children who did develop dyslexia have been

447   found to be even lower than the reading skills of parents of high FR children who did not

448   develop dyslexia (Torppa, Eklund, van Bergen, & Lyytinen, 2011; van Bergen et al., 2011,

449   2012).

450   The effect sizes of the group differences were highly variable. For the dyslexic group

451   compared to the nondyslexic groups, effect sizes were especially large for reading and spelling

452   measures, as would be expected based on the definition of dyslexia. For the reading related

453   measures, effect sizes were especially large for Dutch PA, and in particular for the reaction

454   times. Also, the largest difference between the HRnonDys and LRnonDys group was on this PA

455   measure. These findings are in line with a phonological core deficit in dyslexia (Bekebrede et al.,

456   2009; van der Leij & Morfidi, 2006). Although it has been shown that phonological problems are

457   neither necessary nor sufficient to explain dyslexia (Pennington et al., 2012), many children with

458   dyslexia do have a severe phonological deficit. Our study suggests that also non-dyslexic

459   adolescents with a high FR have phonological problems, measured with Dutch PA, although

460   milder than students with dyslexia. While the HRnonDys group generally scored lower than the

461   LRnonDys group, their RAN, Verbal Working Memory (VWM) and both English and Dutch

462   vocabulary scores were very similar, as indicated by the small effect sizes. For the HRnonDys

463   group RAN, VWM and/or vocabulary knowledge may be protective factors or compensations for

464   their phonological deficit; further research is needed to investigate whether the good RAN,

465   VWM and vocabulary skills are a cause or consequence of their reading level, or whether they

466   are merely correlated. These results are in line with Moll, Loff and Snowling (2013) who found

467   that PA and VSTM were associated with family risk status as well as with dyslexia status. The

468   authors argued that phonological skills can be considered as a cognitive endophenotype of

469   dyslexia. In addition, RAN, word recall and morphological awareness were also in their study

470   only associated with dyslexia status, and were seen as additional risk factors for dyslexia. For

471   both HR groups effect sizes were largest for pseudoword reading in comparison to the other

472   reading and spelling tasks, probably because pseudoword reading relies mainly on letter-to-

473   phoneme decoding, in addition to the use of sub-lexical orthographic units, but word-based

474   orthographic strategies cannot be used to compensate for their phonological deficit.

475   **English Versus Dutch**

476   Our second aim was to make a direct comparison of reading, spelling and vocabulary

477   skills in Dutch and English. Overall Dutch and English reading, spelling and vocabulary skills

478   were significantly correlated; there were strong positive relationships between L1 and L2 reading

479   and spelling, and small positive relationship between L1 and L2 vocabulary. Thus, adolescents

480   with dyslexia had not only a literacy impairment in Dutch, but generally also in ESL. These

481   findings are in agreement with the LCDH (Ganschow et al., 1991) which states that L1 reading

482   skills are a strong predictor for L2 reading outcomes. Furthermore, previous studies have also

483   observed reading problems in L2 among readers with a reading deficit in L1 (e.g. Helland &

484   Kaasa, 2005; Helland & Morken, 2016; Łockiewicz & Jaskulska, 2016).

485   To our knowledge, our study was the first to make a direct comparison of Dutch and ESL

486   in a group of adolescents with a familial risk of dyslexia. This did not only allow us to study

487   whether deficits of the dyslexic group were similar across languages, but also whether the

488   HRnonDys group, which by definition has no reading deficit in L1, has literacy problems in L2.

489   We found that the HRDys group performed, relative to the LRnonDys control group, better on

490   WRF in English compared to Dutch, however, this interaction effect was small; for spelling and

491   vocabulary this effect was not found. The HRnonDys group did not show any significant

492   differences between Dutch and English reading, spelling and vocabulary, as compared to this

493   LRnonDys pattern. The relatively greater reading fluency in English than in Dutch in the HRDys

494   group may seem surprising as the lower orthographic transparency of English makes reading in

495   English more difficult, at least for beginning readers (Seymour et al., 2003). Moreover, the

496   adolescents in our study were unbalanced bilinguals who acquired English later than Dutch, and

497   who were generally more proficient in Dutch, therefore they may be less able to compensate

498   using semantics-based reading strategies.

499   However, other factors may be involved as well. Because our participants were not

500   beginning readers in Dutch, they had presumably already developed a whole-word based reading

501   strategy in Dutch, and perhaps they could already apply this strategy when they learned to read

502   in English. Because of the lower orthographic transparency, whole-word reading is more

503   successful than decoding in English. Perhaps the reading deficit of dyslexic readers in ESL was

504   therefore smaller than expected based on their Dutch reading. Furthermore, not all readers with

505   dyslexia have an orthographic processing deficit (van der Leij & Morfidi, 2006). In fact, an

506   earlier study by Siegel, Share and Geva (1995) found that English dyslexic readers had superior

507   orthographic skills compared to normal readers, which may suggest that they rely more on the

508   visual orthographic characteristics of a word than on its phonological characteristics. This result

509   has, however, not been replicated. It is unclear whether the dyslexics as a group show better

510   orthographic skills, or that it is a characteristic for a substantial subgroup, as is predicted by the

511   phonological-core variable-orthographic differences model (e.g. Bekebrede et a., 2009). To read

512   successfully in English, a reader needs to identify larger orthographic units than in Dutch.

513   Therefore having average to good orthographic skills is more beneficial for reading in English.

514   Some readers with dyslexia may have been able to use orthographic strategies to compensate for

515   their phonological deficit in ESL, like the readers with a preference for English in the study by

516   Miller-Guron and Lundberg (2000).

517   Another influencing factor responsible for the advantage of ESL for students with

518   dyslexia relates to the massive exposure to English that (young) people have nowadays. As the

519   use of English becomes more and more important for adolescents to participate in modern

520   society, the motivation to learn English may be high. Perhaps reading in English is also less

521   associated with the frustration individuals with reading difficulties experienced as beginning

522   readers in Dutch, because, when they learned ESL, they had already developed some

523   compensation strategies in Dutch. These hypotheses are still speculative and need further

524   investigation, but they seem to be supported by a few recent studies. In a Norwegian study by

525   Brevik, Olson and Hellekjaer (2016) it was found that 22 percent of the worst readers in

526   Norwegian L1 had good reading skills in ESL. Most of these poor L1 but good L2 readers were

527   boys in vocational education programs. A follow-up case study of five boys in vocational

528   programs with poor L1 Norwegian reading skills but good ESL reading skills showed that they

529   all played online games in English and also used English more than Norwegian for Facebook,

530   music, TV and films (Brevik, 2016). Also Sundqvist and Wikström (2015) found that frequent

531   online-gamers, who were again mostly boys, had the highest English grades, wrote better English

532   essays in which they used more advanced vocabulary, and had a larger L2 vocabulary size. High

533   exposure through multimedia and intrinsic motivation to learn English as a lingua franca in

534   modern society are two possible explanations for the slight advantage we found in English for

535   students with dyslexia compared to their mother tongue.

536   **Limitations and Future Directions**

537   In the present study we have chosen to use a categorical approach towards dyslexia and

538   familial risk. We have done so because categorical diagnoses are still used for clinical practice

539   and for the comparability with other studies. However we do realize that both dyslexia and

540   familial risk are continuous constructs as we have explained in the introduction. Because of the

541   longitudinal design groups were not matched and we had no control over factors like the quantity

542   and quality of the remediation, instruction in and exposure to English, and had only limited

543   information available about these factors. Future cross-sectional studies could look further into

544   these factors as they could be relevant in the context of our research question. Since this study

545   was conducted at the end of a longitudinal design, it had a higher dropout rate than previous

546   waves of the DDP program, leaving the groups smaller than we had hoped for. This affected the

547   statistical power, and may be the reason why some of the small effects between the two non-

548   dyslexic groups were not significant. However, the present study indicates that the differences

549   between the HRnonDys and LRnonDys groups are not large. For the comparison of Dutch and

550   English vocabulary it would have been better if we used more similar tests. Because of time

551   concerns, we used the vocabulary test from the WISC-III-NL (Wechsler, 2005) for Dutch and the

552   more elaborate PPVT-IV (Dunn & Dunn, 2007) for English. This could at least partially explain

553   why the correlations between the English and Dutch vocabulary tests were small. Moreover, a

554   standardized spelling ESL test for Dutch learners was not available. So, we had to create a new

555   test. However, because of strong correlations with the Dutch spelling test and the English WRF,

556   we judged it sufficiently valid and reliable.

557   Including a larger sample would allow for the investigation of factors that contribute

558   stronger to reading in Dutch versus reading in English, and whether this is the same for groups

559   with a different risk and dyslexia status. Moreover, this would allow us to look at subgroups, or

560   even at the individual level to investigate the influence of exposure and motivation in more

561   detail. In the present study we did not look at orthographic processing, but it would be really

562   interesting to include this in future studies, and to also consider higher level reading skills such

563   as sentence and text comprehension, silent reading, and to measure reading related skills and

564   pseudoword reading also in L2. Future studies could also use neuro-imaging techniques to

565   investigate which brain networks are involved in reading in L1 and L2 in the different groups.

566   Such research could also help to identify compensation mechanisms used by the HRnonDys

567   group that allows them to read well despite the mild phonological processing difficulties that we

568   found in the present study using the Dutch PA task. Knowing more about what contributes to

569   reading success in ESL is not only important for theoretical purposes but could also be useful for

570   future interventions.

571   **Conclusions and Implications**

572   We found that dyslexia is persistent in adolescents with a high familial risk of dyslexia.

573   Although the reading deficit of the adolescents with dyslexia was slightly smaller in ESL than

574   expected based on their Dutch WRF skills, adolescents with dyslexia generally also have large

575   reading and spelling deficits in L2. Therefore it is important that they still receive help for this in

576   secondary education and are granted access to measures like extra time in exams and the use of

577   spellcheckers in L1 and L2. A phonological deficit was found in both groups with a familial risk,

578   however it was less severe in the HRnonDys group who may also have used their better RAN-

579   and VWM-abilities to compensate. Despite their subtle phonological deficit, and the low

580   orthographic transparency of English, the HRnonDys group did not have reading difficulties in

581   ESL. Thus, their familial risk seems to affect L1 and L2 in a similar way, and extra help in ESL

582   is probably not needed for most of these students.

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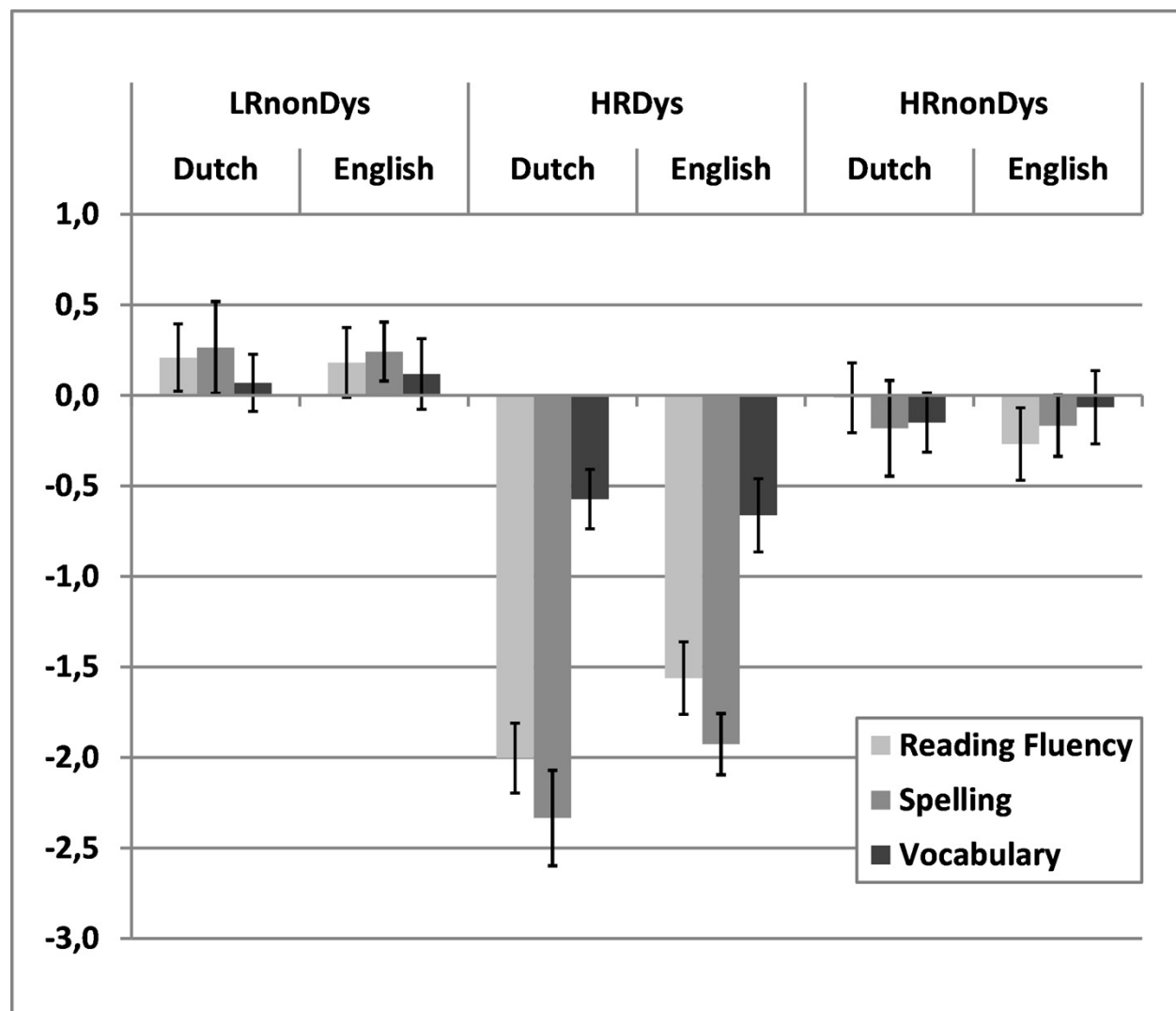
Figure 1.

Mean Standardized Scores on Dutch and English Word Reading Fluency, Spelling and Vocabulary for the Three Groups. Error Bars indicate Standard Errors. (LRnonDys = low familial risk without dyslexia, HRnonDys = high familial risk without dyslexia, HRDys = high familial risk with dyslexia)

Table 1.

Participant Characteristics

Group	*n*	*n* males	Age (Months)		School Grade	
			M	*SD*	*M*	*SD*
LRnonDys	27	11	166.9	5.3	8.1	.5
LRDys	4	2	163.5	4.4	7.8	.5
HRnonDys	25	12	170.0	9.0	8.1	.7
HRDys	25	14	170.7	6.8	8.1	.9

Note. LRnonDys = Low Risk without Dyslexia, LRDys = Low Risk with Dyslexia, HRnonDys = High Risk without Dyslexia, HRDys = High Risk with Dyslexia.

Table 2.

Descriptive Statistics of Standardized Scores per Group

	LRnonDys (n = 27)			HRnonDys (n = 25)			HRDys (n = 25)		
	M (SD)	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
Dutch Words RF	.21 (.78)	-.08	-1.10	-.01 (.96)	.11	.14	-2.00 (1.14)	-.76	.25
Pseudoword RF	.24 (.80)	.06	-.62	-.38 (.83)	-.37	.66	-1.75 (.67)	-.95	.71
Loanword RF	.21 (.85)	-.31	.35	-.21 (.84)	.37	1.34	-1.77 (1.52)	-.42	.18
English Word RF	.18 (.87)	.08	-.61	-.27 (.83)	.66	1.53	-1.56 (1.25)	.03	.06
Dutch Spelling	.26 (.74)	-.62	-.13	-.18 (.99)	-.58	-.35	-2.33 (1.94) [a]	-.39	-1.18
English Spelling	.24 (.79)	-1.19	1.99	-.17 (.77) [a]	-1.48	2.71	-1.93 (.97) [a]	.29	-.94
Dutch Vocabulary	.07 (1.03)	-2.22	7.33	-.15 (.62)	.36	-.23	-.57 (.73)	-.66	-.44
English Vocabulary	.12 (.98)	-.41	-.39	-.07 (.85)	-.69	.24	-.66 (1.17)	-.10	-.69
Spoonerisms - Acc	.16 (.59) [a]	-.71	-.67	-.55 (1.40) [a]	-1.19	.41	-2.79 (2.39)	-.59	.99
Spoonerisms - RT (Log)	-.27 (.67)	.73	.57	.66 (.88)	-.56	-.62	1.98 (.91)	.73	.74
RAN (Items / min)	.18 (.94)	.43	-.56	-.01 (.95) [a]	.75	2.19	-.58 (.60)	-.24	-.42
Digit Span - Forward	.11 (1.00) [a]	.15	-1.14	-.56 (.74) [a]	-.44	-.27	-.95 (.69)	.20	-.78
Digit Span - Backward	.15 (.98)	-.01	-.92	-.21 (1.09)	.26	.18	-.75 (.75) [a]	-.20	-1.10

Note. [a] the distribution of this variable within this group differed significantly from a normal distribution according to the Kolmogorov-Smirnov test for normality.

LRnonDys = Low Risk without Dyslexia, HRnonDys = High Risk without Dyslexia, HRDys = High Risk with Dyslexia, RF = Reading Fluency, Acc = Accuracy, RT = Reaction Time, RAN = Rapid Automatized Naming.

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Table 3.

Pearson Correlation between Dutch and English Reading and Reading Related Skills for Participants in the LRnonDys, HRnonDys and HRDys group.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Dutch Words RF	-												
2. Pseudoword RF	.88	-											
3. Loanword RF	.87	.81	-										
4. English Word RF	.81	.75	.89	-									
5. Dutch Spelling	.76	.71	.77	.70	-								
6. English Spelling	.80	.79	.80	.77	.84	-							
7. Dutch Vocabulary	.44	.37	.48	.52	.45	.55	-						
8. English Vocabulary	.43	.39	.59	.71	.43	.51	.36	-					
9. Spoonerisms - Accuracy	.62	.60	.68	.66	.65	.69	.30	.58	-				
10. Spoonerisms - RT (Log)	-.68	-.74	-.63	-.59	-.65	-.63	-.32	-.30	-.61	-			
11. RAN (Items / min)	.58	.60	.48	.38	.34	.38	.17	.19	.25	-.39	-		
12. Digit Span - Forward	.44	.43	.35	.36	.41	.44	.24	.26	.40	-.41	.25	-	
13. Digit Span - Backward	.46	.40	.34	.29	.50	.42	.25	.15	.28	-.32	.36	.59	-

Note. N = 77. LRnonDys = Low Risk without Dyslexia, HRnonDys = High Risk without Dyslexia, HRDys = High Risk with Dyslexia, RF = Reading Fluency, RT = Reaction Time, RAN = Rapid Automatized Naming. Correlations of .19 and larger are significant at .1 level (2-tailed), Correlations of .24 and larger are significant at the .05 level (2-tailed), and correlations of .30 and larger are significant at the .01 level (2-tailed)

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Table 4.

Effect Sizes and Confidence Intervals of Group Differences.

Measure	LRnonDys - HRDys			HRnonDys - HRDys			LRnonDys - HRnonDys		
		95% Confidence Interval			95% Confidence Interval			95% Confidence Interval	
	Hedges' *g*	Lower bound	Upper bound	Hedges' *g*	Lower bound	Upper bound	Hedges' *g*	Lower bound	Upper bound
Dutch Words RF	2.25***	1.55	2.94	1.86***	1.20	2.52	.25	-.30	.80
Pseudoword RF	2.65***	1.91	3.40	1.79***	1.13	2.44	.75***	.19	1.31
Loanword RF	1.59***	.97	2.22	1.25***	.64	1.86	.48	-.07	1.03
English Word RF	1.60***	.98	2.23	1.20***	.59	1.80	.52	-.03	1.07
Dutch Spelling	1.77***	1.12	2.41	1.37***	.76	1.99	.50	-.05	1.06
English Spelling	2.42***	1.71	3.14	1.98***	1.30	2.65	.52*	-.04	1.07
Dutch Vocabulary	.70***	.14	1.26	.61*	.04	1.18	.25	-.29	.80
English Vocabulary	.71***	.15	1.27	.57**	.01	1.14	.20	-.35	.74
Spoonerisms - Accuracy	1.70***	1.06	2.33	1.13***	.53	1.72	.66	.10	1.21
Spoonerisms - RT (Log)	-2.79***	-3.55	-2.02	-1.45***	-2.07	-.82	-1.18***	-1.76	-.59
RAN (Items / min)	.94***	.37	1.51	.70**	.13	1.28	.20	-.34	.75
Digit Span - Forward	1.20***	.61	1.79	.54	-.03	1.10	.74***	.18	1.31
Digit Span - Backward	1.02***	.44	1.59	.57**	.01	1.14	.34	-.21	.89

Note. The indicated statistical significance is based on pairwise comparisons using the Least Square Difference method in the MANOVA

* *p* < .01, ** *p* < .05, *** *p* < .1

LRnonDys = Low Risk without Dyslexia, HRDys = High Risk with Dyslexia, HRnonDys = High Risk without Dyslexia, RF = Reading Fluency, RT = Reaction Time, RAN = Rapid Automatized Naming, MANOVA = Multivariate Analysis of Variance.

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