The impact of dyslexia in higher education

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CHAPTER 5

The L1 and L2 spelling and writing skills of Dutch higher education students with dyslexia

Abstract

Academic writing can be challenging, especially for students with dyslexia. In this study, we investigated the L1 (Dutch) and L2 (English) word spelling and writing skills of higher education students with and without dyslexia. Participants were tested on two word dictation tests, one in Dutch and one in English, and were asked to write a short summary in both L1 and L2 after reading a text. The written summaries were evaluated on content quality, number of spelling errors, summary and sentence length and writing time. Additionally, we assessed a number of control variables that can be involved in spelling and writing, such as working memory, phonological awareness, print exposure, self-reported writing skills and high-school grades. The results demonstrated that students with dyslexia performed worse on word spelling in both languages. This was not only demonstrated in the word dictation tests but also more spelling errors were reported in both written summaries. Phonological awareness seemed to be the strongest predictor for spelling. For summary writing it was reported that students with dyslexia write summaries of poorer quality in both Dutch and English, even though the summaries were of similar length and spelling errors had not an effect on the content score of the summary. Strongest predictors for summary writing score were working memory, self-reported writing skills and grades in high school. All in all, the results showed that students with dyslexia have a disadvantage not only in word spelling but also in summary writing and this in their native language as well as in their L2. This will most likely also result in a disadvantage in higher education when students are confronted with summary type evaluations, such as essays and research reports.

Keywords: Dyslexia, Higher Education, Spelling, Summary Writing, Phonological Awareness, Working Memory, Questionnaire

5.1 Introduction

Writing can broadly be defined as the translation of ideas into text (Tops et al., 2014). It is a complex skill that continues to develop across the life span (Bazerman et al., 2018; MacCullagh et al., 2016; Tops et al., 2014). Writing is also one of the most important skills for academic success in higher education, because written texts form the basis for note taking, article writing, and many evaluations (Onwuegbuzie & Collins, 2002; Farmer et al., 2002). This can be especially problematic for students with dyslexia, for whom spelling and writing difficulties often have been reported (Tops et al., 2014).

5.1.1 Spelling

One of the main issues with writing for higher education students with dyslexia is knowing how to write words correctly (Bogdanowicz et al., 2014; Callens et al., 2012; Coleman et al., 2009; Galbraith et al., 2012; Kemp et al., 2009; Moojen et al., 2020; Sumner & Connelly, 2020). It is demonstrated by many studies across different languages that higher education students with dyslexia make significantly more errors in spelling than peers without dyslexia (Callens et al., 2012; Coleman et al. 2009; Galbraith et al., 2012; Moojen et al., 2020; Tops et al., 2014). Coleman et al. (2009) additionally reported that students with dyslexia have underdeveloped phonological, morphological and visual-orthographic awareness, resulting in these poorer spelling skills in English. Comparable results were reported by Tops and colleagues (2014) for Dutch. They showed that Dutch speaking students with dyslexia – both in word and sentence dictation - make approximately twice as many spelling errors as matched control students without dyslexia. The highest proportion of spelling errors was reported in the phonological domain (e.g., errors in letter to sound mappings), followed by those in the morphological domain (e.g., capitalization errors). Additionally, students with dyslexia also make more memory-based errors (i.e., words that have to be memorized such as loan words) than control students in absolute numbers, but this difference with the control group was percentage wise smaller than for the other two error types.

Although spelling problems seem to be present in writers with dyslexia of different languages, their frequency seems language dependent. Spelling errors appear to be (much) more frequent in writers with dyslexia of deep orthographies (e.g., English), than in languages with transparent, (e.g., Finnish and Spanish), or relatively transparent orthographies (e.g., Dutch), because the consistency between letter-to-sound mappings is lower (Afonso et al., 2015; Angelelli et al., 2010; Ziegler & Goswami, 2005). As such, it is more difficult to rely strictly on phonological spelling strategies in deep orthographies. Consequently, different approaches to learn the irregularities in deep orthographies in comparison to transparent orthographies are needed, like learning via analogies.

In Dutch higher education, students are quite regularly confronted with writing texts in both Dutch, their native language (L1), as well as in English, their second language (L2). An additional disadvantage in spelling can thus be expected for L2 learners with dyslexia, especially when the L2's orthography is deeper than the L1's orthography, which is the case for Dutch higher education students learning English. As a consequence, more spelling errors and other inconsistencies are expected in the written L2 texts, because it is more difficult

to rely on the phonological spelling strategies in English. It is likely that this impacts the readability of the text and thus negatively influences its assessment during for example an evaluation.

5.1.2 Writing

Successful writing in higher education is more than knowing how to write words correctly. Writing involves different 'higher-order' linguistic processes, such as planning and writing ideas, and reviewing text (Hayes & Flower, 1980). It should be noted that these so-called higher order linguistic processes are generally not considered to be *primary* deficits of dyslexia, but are rather seen as *secondary* challenges for individuals with dyslexia (Lyon et al., 2003). Writing also involves non-linguistic processes such as working memory, long-term memory and background knowledge (Hayes & Flower, 1980; Tops, et al., 2014). Besides difficulties with the higher-order linguistic processes, there is evidence that also these non-linguistic processes can be hampered in students with dyslexia, especially working memory (Li & Roshan, 2019; Miller et al., 2006).

Not only the higher-order linguistic and non-linguistic processes, and the transparency of the language can make L1 and L2 writing extra difficult for students with dyslexia. Successful writing also requires good language comprehension and a good understanding of the grammar and the different written words (i.e., vocabulary). These components can hamper or boost the writing outcome for students with dyslexia, meaning that poorer language proficiency skills can cause a disadvantage in writing and good language proficiency skills can help in writing (Carson et al., 1990). This claim also seems to hold for L2 writing, as someone with good language proficiency skills and good L1 writing skills, can rely on this in L2 writing as proposed by the Linguistic Coding Differences Hypothesis (LCDH; Ganschow et al., 1991.). The LCDH states, among other things, that the more proficient someone is in the L1, for example in writing, the more proficient that person will be in the L2 (Carson et al., 1990; Ganschow et al., 1991).

All in all, it is to be expected that Dutch students with dyslexia in higher education continue to have writing problems in L1 and L2 as is the case for similar samples of higher education students (Coleman et al., 2009; Farmer et al., 2002; Hatcher et al., 2002; MacCullagh et al. 2016; Sterling et al., 1997; Sumner & Connelly, 2020). It has been shown that students with dyslexia write shorter texts (Coleman et al., 2009), need more time to write texts (Farmer et al. 2002; Sterling et al., 1997), show less variety in the use of vocabulary (Sterling et al., 1997) and make more errors in spelling (Coleman et al., 2009; Sumner & Connelly, 2020; Tops et al., 2014).

Additionally, Hatcher et al. (2002) studied the overall quality of summaries written by students with dyslexia. A group of students with dyslexia and a control group were asked to write a summary of a newspaper article they just read. The authors demonstrated that the written summaries of the students with dyslexia were of overall lower quality, which was mainly caused by the lack of a clear text structure and because of the use of poorer language, such as less variation in words and sentences. This ultimately resulted in a lower readability of the summaries of the students with dyslexia in comparison to control students without dyslexia. Similar results were found in a recent study by Sumner and Connelly (2020). These authors

also reported overall lower quality of written texts, including more spelling errors for students with dyslexia than for peers without a learning disability. However, no differences were found between the two groups as for writing time, other temporal analyses (e.g., handwriting, pause times and execution) and text length. Comparable results were also reported by Tops et al. (2014) for Dutch higher education students with dyslexia. Students with dyslexia and control students were asked to write a summary after silently reading an informal text. The authors demonstrated that students with dyslexia received lower marks on their summaries compared to the matched control group, mostly due to the fact that the summaries were less coherent and less structured, as was also the case in the study by Hatcher et al. (2002). Additionally, the texts of students with dyslexia also contained more spelling errors than the texts of students without dyslexia, which is in line with the results of Coleman et al. (2009).

5.1.3 Present study

Spelling and writing problems are likely to hamper the progress of higher education students with dyslexia, since they make more spelling errors and write texts of poorer quality compared to peers without dyslexia. However, research on writing in Dutch students with dyslexia is scarce, and even more scarce concerning writing in the L2. The aim of the present study is to examine the Dutch (L1) and English (L2) spelling and writing skills of Dutch higher education students with dyslexia. Performance on spelling and writing was compared to typically developing students matched on age, gender and field of study. Spelling skills were assessed using Dutch and English one-word dictation tasks. The writing process was targeted with Dutch and English summary writing tests (Vander Beken & Brysbaert, 2017).

Since it is also reported that students with dyslexia have difficulties with phonological awareness and working memory (Coleman et al., 2009; Li & Roshan, 2019, Miller et al., 2006), these potentially relevant cognitive predictors for spelling and writing were also included in our design. Lastly, students were also asked to fill in a questionnaire including some background information about print exposure, self-reported writing skills and grades in high-school, and these were added as possible linguistic control variables. Altogether, we came to the following research questions:

1. Do diagnosis and language (L1 versus L2) have an effect on the outcome of the spelling measures, while controlling for cognitive variables, *phonological awareness* and *working memory*, and linguistic variables, *print exposure, self-reported writing skills* and *high-school grades*?

2. Do diagnosis and language (L1 versus L2) have an effect on the outcome of summary writing, while controlling for spelling, cognitive variables, *phonological awareness* and *working memory*, and linguistic variables, *print exposure, self-reported writing skills* and *high-school grades*?

Based on the available literature, it is hypothesized that both diagnosis and language have an effect on the outcome on word spelling. It is expected that students with dyslexia make more spelling errors in word dictation and in summary writing than their matched peers without dyslexia, even to a higher extent in English, because of lower transparency and the

fact that it is their L2 (Coleman et al. 2009; Galbraith et al., 2012; Moojen et al., 2020; Tops et al., 2014). Previous studies have also shown a strong relation between phonological awareness and spelling, so out of the control variables, it is predicted that phonological awareness will show the strongest relation with L1 and L2 spelling (Coleman et al., 2009).

With respect to the second research question, it is hypothesized that diagnosis and language have an effect on the quality of the written summaries. We expect students with dyslexia to write summaries of overall lower quality based on previous studies of Hatcher et al., 2002; Sumner & Connelly, 2020; Tops et al., 2014). No differences are however expected on summary length and sentence length as suggested by Sumner and Connelly (2020), but we expect students with dyslexia to need more time to write a summary (Coleman et al., 2009). Lastly, it is hypothesized that spelling outcome, working memory and print-exposure will have an effect on the quality of the summary (Tops et al., 2014), with even larger effects for working memory on L2 summary writing, because of a higher cognitive demand (Miller et al., 2006; Galbraith et al., 2012).

5.2 Methods

5.2.1 Participants

The same sixty students with dyslexia and sixty control students without dyslexia as in the previous two chapters participated in this study (see for a complete demographic overview of the participants, Table 3.1 in Chapter 3). The criteria for the participants with dyslexia were met if (1) a participant could show an official dyslexia report and (2) a participant with dyslexia received (sub) clinical scores (< pc 10) on the word reading test (LEMs; Tops et al., 2019) and/or the pseudo word reading test (Klepel-R; Van den Bos et al., 1994; 2019) and/or the word spelling test used in our study (Depessemier & Andries, 2009; SDN, 2016).

Control students were as much as possible matched to the students with dyslexia on age, gender and field of study. All participants were native speakers of Dutch and attended higher education in the Netherlands, most of them in Groningen, a province in the Northern part of the Netherlands. Our study was approved by the Faculty of Arts of the University of Groningen.

5.2.2 Spelling and writing materials

Spelling

Dutch word spelling was measured with the word spelling task of GL&SCHR (Depessemier & Andries, 2009). Participants were asked to write down thirty dictated words. Fifteen of those words followed the Dutch spelling rules. The other fifteen words were considered exception words, including loan words or words involving unpredictable sound-letter mappings that require memorizing. Each correctly spelled word was rewarded with 1 point, with a maximum score of 30 points. Additionally, participants were asked to rate how certain they felt about their spellings (i.e., certain, almost certain, uncertain), which resulted in a weighted word spelling score. This led to a 5-points scoring system from certainly correct (5 points) to certainly incorrect (0 points), with a total maximum score of 150 points.

English word spelling was measured with the adapted version of the WRAT-III English Word Dictation task (Tops et al., 2015). Participants were asked to write down twenty-two dictated words increasing in level of difficulty. Correctly written words were rewarded with 1 point.

Writing

For the summary writing tests (see Appendix B. for the texts and scoring forms), one short L1 text and one short L2 text were used from a study by Roediger and Karpicke (2006). Both texts covered a topic in the field of natural sciences: the sun (L1) and sea otters (L2). The L1 text was translated and adapted by Vander Beken and Brysbaert (2017), matching the original L2 text as closely as possible. The L2 text received some minor changes by Vander Beken and Brysbaert (2017), altering some words from the imperial to the metric system (e.g., pounds into kilograms).

The L1 text was 249 words long and the L2 text was 279 words long. Both texts were presented on paper in Times New Roman 12 and line spacing 1.5 (Roediger & Karpicke, 2006; Vander Beken & Brysbaert, 2017). Participants were given four minutes to read and study either the L1 or the L2 text. All participants read both texts, but were asked to write a summary for either L1 or L2. For the other text they were asked to answer true/false questions as reported in Chapter 3. Control students received the same version as their matched peer with dyslexia.

The summary writing test was based on the same principle as Roediger and Karpicke (2006) and Vander Beken and Brysbaert (2017). Participants received the following instruction: "Write a summary of the text you just read. Give as much details as possible." No time restrictions were given during writing, but writing times were recorded.

The written summaries were reviewed according to the guidelines by Roediger and Karpicke (2006) and by Vander Beken and Brysbaert (2017): the text was split up in 30 ideas and each idea that was remembered accurately was awarded with the maximum score of 1. When an idea was almost accurate, a score of 0.5 was awarded. For example, the statement "the sun is going to be a red dwarf star" is a correct statement and is given 1 point, however, the statement "the sun is going to be a red star", is awarded with 0.5 point. The written summaries were all examined by the first author of this paper. Additionally, all summaries were analysed by a trained student assistant. The scores of the two different assessors per written summary were collected and the average score was calculated. The inter-rater reliability for the L1-summaries was .90 and the inter-rater reliability for the L2-summaries was .96. In addition, the number of spelling errors was counted.

5.2.3 Cognitive tests and print exposure

Phonological awareness

Phonological awareness skills were tested with a spoonerisms task and a reversals task of the GL&SCHR (Depessemier & Andries, 2009). For the spoonerisms task, the first sounds of two orally presented words must be switched by the participant, e.g., Harry Potter – Parry Hotter. In the reversals test, participants were asked to judge if two spoken words were reversals from

each other or not, e.g., lak-kal (correct) or lets-sel (incorrect). Both accuracy (maximum of 20 points per test) and time were measured.

Working memory

Working memory skills were tested with the WAIS-IV Digits and Letters Recall Task (Wechsler, 2012). The participants were asked to recall different sets of digits and letters and to put them in the correct order. Participants were asked to first reproduce the digits from low to high followed by the letters in alphabetical order (e.g., 9-L-E-3 becomes 3-9-E-L). Maximum number of points was 30 and participants were cut-off if three items of the same level of difficulty were reproduced incorrectly.

L1/L2 print exposure

Print exposure is the amount of time someone spends on writing and reading. Prior to the tests, participants were asked to fill in an online questionnaire including multiple choice questions about print exposure for L1 and L2 (e.g., how often do you read the newspaper, do you use subtitles when watching television, how many hours do you study per week in L1/L2), with a 5 points-scale per question. For L1, four questions were asked with a possible maximum score of 20 and for L2, five questions were asked with a possible maximum score of 25.

Personal writing assessment

Additionally, participants were asked to report their final grades for the courses Dutch and English at their final year in high school, and were asked to provide information about how they would judge their own writing skills in both L1 and L2 on a 5-point Likert scale.

5.2.4 Procedure

Participants were tested individually and all tests were part of a larger test protocol. All participants gave written permission to use their data for research. Participants received the online questionnaire before testing, which took approximately 10 to 15 minutes. Testing took place in a quiet room at the University of Groningen and lasted for 2.5 to 3 hours for the total protocol. Participants were provided with a break halfway testing of about 15 to 30 minutes.

Half of the participants started with the L1 tests and half of the participants started with the L2 tests, which was randomized. To minimize the chance on interference between the languages, L1 and L2 tests were presented in different blocks. Participants were provided with general instructions in the beginning and prior to every task.

5.2.5 Statistical analyses

Data were analyzed using R (R Core Team, 2013). Different statistical approaches were used to study our research objectives. First, we analyzed the descriptive statistics of the cognitive predictors (i.e., phonological awareness (PA) and working memory (WM) scores

of our students), followed by the descriptive statistics of the questionnaire responses (i.e., linguistic variables, such as print exposure (PE), self-report writing (SR writing) and final high school grades). Next, the cognitive and linguistic variables were examined statistically with a One-Way ANOVA, with Diagnosis as the independent variable and PA, WM and questionnaire responses as the dependent variables, to report on the differences between students with dyslexia and students without dyslexia.

To answer our first research question, that is: Do diagnosis and language have an effect on the outcome of the spelling measures, while controlling for cognitive and linguistic variables, we determined the differences between students with and without dyslexia on the L1 and L2 word dictation tests. The spelling scores were transformed into standard scores to allow for an equal comparison, and the between-group differences were measured with a One-way ANOVA, with Diagnosis as the independent variable and spelling outcomes as dependent variables for L1 and L2. Additionally, the cognitive predictor variables (i.e., PA and WM), and the linguistic control variables, (i.e., PE, SR and final grades), were added to the model to test our prediction that these variables influence the outcome on spelling. This was done with a Multiple Regression Analysis, which was done as a separate analysis because we first wanted to explore the isolated between-group results before analysing the influence of the cognitive variables and linguistic control variables.

The between-group differences on the different summary writing measures were also analysed to answer our second research question, that is: Do diagnosis and language influence have an effect on the outcome of summary writing, while additionally controlling for spelling, cognitive variables and linguistic variables. Summary writing scores, number of spelling errors, summary length, sentence length and writing time were all evaluated with separate Two-way ANOVAs, with the different summary scores as the dependent variables and Diagnosis and Language (L1/L2) as the independent variables.

The last step was adding the word dictation outcome, the cognitive predictor variables (i.e., PA and WM), and the linguistic control variables (i.e., PE, SR writing and final grades), to the summary writing model to test our prediction that these variables influence the outcome on summary writing, which was done with a Multiple Regression Analysis. Again, this was done as a separate analysis because we first wanted to explore the isolated between-group results before analysing the effect of the cognitive and linguistic control variables.

5.3 Results

The goal of this study is to report on the outcomes of students with and without dyslexia on spelling and writing, and the cognitive and linguistic variables influencing this outcome. First, the cognitive and linguistic control variables are reported, to give an overview of how students perform on these variables, followed by the results on L1 and L2 spelling, and the influence of the control variables on spelling. Lastly, we report the group results on L1 and L2 summary writing followed by the effects of spelling and the control variables on summary writing.

5.3.1 PA and WM

Participants' PA and WM skills were assessed to explore possible between-group differences (see Table 5.1), and to add them as predictor variables for spelling and writing to answer our research questions. No participants were excluded from the analysis.

Table 5.1: Phonological awareness and working memory outcomes

	(Dys n = 60)		**(NonDys n = 60)**			
	M	**SD**	**M**	**SD**	***p***	***d***
Phonological awareness						
Spoonerisms	17.4	2.1	19.2	1.1	<.001*	1.07
Spoonerisms time	172	64.9	107	28.8	<.001*	1.29
Reversals	15.9	2.2	17.8	1.8	<.001*	.95
Reversals time	122	46.3	85	24.6	<.001*	.99
Working memory						
Span test	18.2	2.2	20.4	2.4	< .001*	.96

Note. Phonological awareness = scores on PA tests; Spoonerisms/Reversals = accuracy score on spoonerisms or reversals [Max. = 20 per test], Spoonerisms/Reversals time = total number of seconds; Working memory = score on the span test [Max. = 30]; Dys = dyslexia group; NonDys = control group; *p < .001; d = Cohen's d.

As expected, students with dyslexia perform significantly worse on spoonerisms$_{accuracy}$, $F(1, 117) = 34.810$, $p < .001$, and spoonerisms$_{speed}$, $F(1, 117) = 50.350$, $p < .001$, showing large effect sizes for both accuracy, 1.07, and speed, 1.29. Similar results were found for the reversals task. Control students outperform students with dyslexia on reversals accuracy, $F(1, 117) = 38.84$, $p < .001$, with a large effect size of .95, and reversals speed, $F(1, 117) = 29.830$, $p < .001$, demonstrating a large effect size of .99.

As also anticipated, a significant difference between the two groups is also demonstrated for WM. Students with dyslexia perform worse on WM than their non-dyslexic peers, $F(1, 118) = 27.900$, $p < .001$, with a large effect size of .96.

5.3.2 Questionnaire responses

Similar to PA and WM, participants' questionnaire scores were assessed to demonstrate the differences between the groups and to include them as control variables for the final analysis for Spelling and Writing (see Table 5.2). No participants were excluded from the analysis.

Table 5.2: Language proficiency and questionnaire results

	(Dys n = 60)		(NonDys n = 60)			
	M	**SD**	**M**	**SD**	***p***	***d***
Print Exposure						
L1 Print Exposure	11.6	4.0	11.1	3.0	.437	-.14
L2 Print Exposure	12.3	3.6	12.4	3.7	.823	.03
Grades						
L1 grade	3.0	0.8	3.4	0.7	<.001*	.53
L2 grade	3.1	1.0	3.7	0.9	<.001*	.63
Self-rated writing skills						
L1 self-rated	3.1	0.8	4.2	0.6	<.001*	1.56
L2 self-rated	2.7	0.9	3.5	0.9	<.001*	.89

Note. L1 Print Exposure = total score on L1 print exposure [Max = 20]; L2 Print Exposure = total score on L2 print exposure [Max. = 25]; L1/L2 Grade = final grade at last year of high school [Max. = 5], L1/L2 self-report = judgement of own writing skills in L1/L2 [Max. = 5]; *p < .001; Dys = dyslexia group; NonDys = control group; d = Cohen's d.

Against our expectations, print exposure for both groups of students does not show a difference for neither L1, $F(1, 118) = 0.640$, $p = .427$, nor L2, $F(1, 118) = .220$, $p = .646$. However, as expected, a significant difference was found between the two groups on the grade for L1, $F(1, 118) = 12.610$, $p < .001$, with a medium effect size of .53. Students with dyslexia received lower grades on Dutch at the end of high school. The same holds for L2, students without dyslexia received higher grades at the end of high school on English, $F(1, 118) = 15.820$, $p < .001$, with a large effect size of .63.

Similar results were found on the self-report writing in L1 and L2. Students with dyslexia give significant lower estimations of their L1, $F(1, 118) = 64.830$, $p < .001$, and L2, $F(1, 118) = 21.270$, $p < .001$, writing skills than non-dyslexic students, with large effect sizes for both L1, 1.56, and L2, .89.

5.3.3 Spelling

The mean scores, percentage of mean scores and standard deviations for L1 and L2 spelling can be found in Table 5.3.

As expected, results showed that there is a significant difference between students with and without dyslexia for L1 spelling, $F(1, 118) = 76.480$, $p < .001$, and L2 spelling, $F(1, 118) = 59.490$, $p < .001$, with large effect sizes of 2.02 and 2.03 respectively. In addition, students with dyslexia received a lower weighted score on the L1 Word Spelling test, $F(1, 118) = 118.700$, $p < .001$, with a large effect size of 2.03.

Table 5.3: Word spelling scores

	(Dys n = 60)		(NonDys n = 60)			
	M	**SD**	**M**	**SD**	***p***	***d***
Word spelling						
L1 accuracy	17.9 (60 %)	3.5	24.2 (79 %)	2.8	<.001*	2.02
L1 weighted score	96.9	13.7	120.6	9.6	<.001*	2.03
L2 accuracy	15.3 (69 %)	3.2	19.1 (87 %)	2.1	<.001*	1.40

Note. Word spelling = scores on the word spelling tests; accuracy = number of items correct on the L1 word spelling [Max. = 30]; L1 weighted score = weighted score on the L1 word spelling test [Max = 150]; L2 accuracy = number of items correct on L2 word spelling [Max. = 20]; Dys = dyslexia group; NonDys = control group; *p < .001; d = Cohen's d.

Influence of predictors on L1 and L2 spelling scores

A multiple regression analysis was run to predict L1 and L2 spelling scores from PA, WM and questionnaire variables (see Table 5.4 for more details). In the first regression model (Model 1), WM was introduced as cognitive predictor; in the second (Model 2) PA (accuracy and speed), and in the third (Model 3) also the linguistic control variables (i.e., SR writing, Grade and PE were included).

As expected, diagnosis, with a large effect of $n_p^2 = .142$, $\text{PA}_{accuracy}$, with a medium effect size of $n_p^2 = .067$, and self-report L1 writing, with a medium effect of $n_p^2 = .048$, significantly predicted the score on L1 word spelling, $F(7, 111) = 22.300$, $p < .001$, $R^2 = .584$. WM and other questionnaire variables did not significantly predict the outcome.

As expected, diagnosis, with a medium effect of $n_p^2 = .055$, PA_{speed}, with a large effect of $n_p^2 = .125$, and self-report L2 writing, with a medium effect of $n_p^2 = .046$, significantly predicted the outcome on L2 word spelling, $F(7, 111) = 18.030$, $p < .001$, $R^2 = .532$.

Table 5.4: Multiple regression outcomes spelling

	Model 1.			Model 2			Model 3		
	β	***p***	**se**	β	***p***	**se**	β	***p***	**se**
L1 Spelling									
Diagnosis	1.367	<.001*	.142	1.094	<.001*	.165	3.628	<.001*	.848
WM	.069	.336	.071	.002	.983	.073	-.074	.818	.321
PA acc.				.191	.015*	.077	.974	.006*	.344
Pa speed				-.115	.145	.078	-.489	.173	.357
SR L1							.864	.020*	.367
Grade L1							.291	.348	.309
PE L1							.033	.910	.290
L2 Spelling									
Diagnosis	3.379	<.001*	.548	.592	.001*	.180	1.556	.012*	.612
WM	.521	.061	.276	.055	.491	.795	-.014	.958	.267
PA acc.				.116	.128	.084	.494	.070	.270
Pa speed				.038	<.001*	.085	-1.099	<.001*	.276
SR L2							.694	.023*	.300
Grade L2							.049	.854	.267
PE L2							.341	.187	.257

Note. WM = working memory; PA acc./speed = Phonological awareness accuracy/speed; SR L1/L2 = self-report L1 or L2; Grade L1/L2 = final grade L1 or L2; PE L1/L2 = print exposure in L1 or L2; β = beta; *p < .05, se = standard error.

5.3.4 Summary writing

Mean scores, standard deviations and p-values for between-group differences in L1 and L2 summary writing can be found in Table 5.5.

Table 5.5: Summary writing scores

	Dys (n = 60)		NonDys (n = 60)			
	M	**SD**	**M**	**SD**	***p***	***d***
L1 FR						
Summary score	10.0 (33.3 %)	2.7	13.0 (43.3 %)	3.0	<.001*	1.05
Errors	6.5	5.0	3.3	4.2	.005*	.69
Summary length	101.4	28.7	112.9	22.8	.091	.76
Sentence length	14.3	3.4	14.3	4.3	.966	.00
Writing time	304	82.3	342	84.9	.080	.45
L2 FR						
Summary score	8.5 (28.3 %)	3.2	11.9 (39.6 %)	4.6	.002*	.8
Errors	8.4	6.0	3.3	2.8	<.001*	.51
Summary length	105.1	36.9	115.8	41.7	.304	.28
Sentence length	12.8	2.2	12.9	2.7	.872	.05
Writing time	403	158	382	166	.620	.13

Note. Content = content scores on summary writing [Max. = 30]; errors = number of errors on the summaries; summary length = length of the summary; sentence length = average length of the sentences; writing time = writing time in seconds; Dys = dyslexia group; NonDys = control group; *p < .001; d = Cohen's d.

Partially in line with our expectations, a main effect was found for Diagnosis $F(1, 112) = 19.855$, $p < .001$, but not for Language, although the total summary scores of the latter almost reached significance, $F(1, 112) = 3.622$, $p = .059$. There was no significant interaction (see Figure 5.1 for more details) between Language and Diagnosis, $F(1, 112) = .497$, $p = .496$.

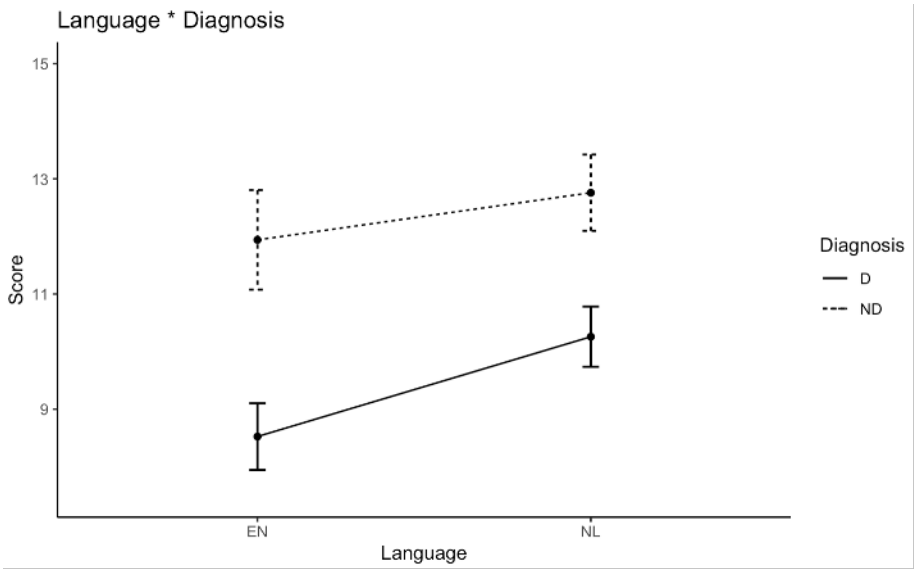

Figure 5.1: Interaction between Diagnosis and Language for summary writing content score

For number of Spelling Errors, only a main effect was found for Diagnosis (see Figure 5.2 for more details), $F(1, 112) = 24.236$, $p < .001$, but not for Language, $F(1, 112) = .347$, $p = .557$. No interaction was between Diagnosis and Language was found, $F(1, 112) = .320$, $p = .573$. No main effects or interactions were found for summary length, sentence length and writing time (see Table 5.5 for more details).

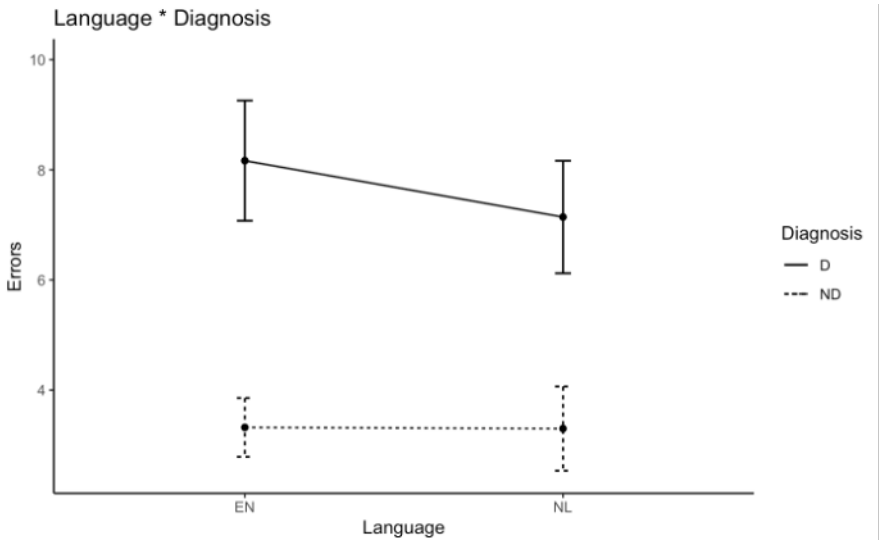

Figure 5.2: Interaction between Diagnosis and Language for summary writing errors

Influence of predictors on summary score and spelling errors

In addition, a multiple regression analysis was run to predict L1 and L2 summary scores and number of spelling errors in the summary from the word-spelling test the cognitive predictors (i.e., WM and PA), and the questionnaire variables (i.e., PE, SR and high-school grades; see Table 5.6 for more details). For L1 and L2 summary scores, a first regression analysis (Model 1) included Diagnosis and WM as possible predictors. In a second regression analysis (Model 2) also PA and spelling were added. Lastly, Model 3 also included the questionnaire variables.

For L1 and L2 spelling errors, a first regression analysis (Model 1) included word spelling as a possible predictor. In Model 2, also PA and WM were added as possible cognitive predictors. Finally, Model 3 also included the linguistic questionnaire variables.

Table 5.6: Multiple regression outcomes summary writing

	Model 1.			Model 2			Model 3		
	β	***p***	**se**	β	***p***	**se**	β	***p***	**se**
L1 Score									
Diagnosis	1.049	.232	870	.158	.904	1.300	-.109	.457	1.457
WM	1.532	<.001*	.439	1.373	.005*	.465	1.309	.006*	.458
PA acc.				-.020	.955	.426	.165	705	.432
PA speed				-.606	.195	.462	-.981	.051	.490
Spelling				.245	.673	.578	-.308	.958	.585
SR L1							.800	.145	.538
Grade L1							.104	.794	.398
PE L1							.645	.102	.387
L2 Score									
Diagnosis	3.427	.009*	1.283	.400	1.506	2.322	1.556	.102	1.394
WM	-.027	.967	.637	-.357	.567	.634	-.774	.183	.573
PA acc.				.778	.211	.613	.471	.403	.559
PA speed				.349	.600	.660	.330	.563	.573
Spelling				.195	.004*	.651	1.251	.051	.626
SR L2							-.314	.632	.651
Grade L2							1.111	.042*	.532
PE L2							1.831	.001*	.538
L1 Errors									
Diagnosis	-3.067	.126	.197	-1.443	.523	2.243	-1.894	.463	2.560
Spelling	-.404	.694	1.023	-.216	.835	1.031	-.118	.860	1.062
PA acc.				.908	.225	.739	.989	.201	.764
PA speed				1.133	.164	.802	.689	.427	.861
WM				-1.190	.146	.806	-1.315	.110	.809
SR L2							-.091	.924	.944
Grade L2							.153	.828	.699
PE L2							1.143	.105	.693
L2 Errors									
Diagnosis	-2.297	.082	1.294	-1.945	.184	1.679	-1.762	.277	1.822
Spelling	-2.645	<.001*	.653	-.2464	.002*	.733	-2.665	.003*	.830
PA acc.				-.562	.466	.686	-.489	.548	.739
PA speed				.351	.628	.737	.383	.607	.753
WM				.732	.271	.726	.567	.428	.786
SR L2							.203	.822	.855
Grade L2							-.157	.825	.721
PE L2							.541	.463	.703

Note. PA Acc. = accuracy on phonological awareness, PA speed = speed on phonological awareness; WM = working memory; SR L1/L2 = self-report L1 or L2; Grade L1/L2 = final grade L1 or L2; PE L1/L2 = print exposure in L1 or L2; β = beta; *p < .05

Against our expectations, only WM (with a medium effect of $n_p^2 = .049$), significantly predicted the L1 summary score, $F(8, 51) = 4.536$, $p < .001$, $R^2 = .416$. PA_{speed} was a marginally significant predictor, however the effect size of $n_p^2 = .003$ was small. For L1 spelling errors, none of the predictors was significant.

Also against our expectations, L2 Grade, with a medium effect of $n_p^2 = .045$, and L2 print exposure, with a large effect of $n_p^2 = .156$, were significant predictors of the summary content score. L2 word spelling was a significant predictor in Model 2, however, it was marginally

significant in Model 3, with a medium effect of $n_p^2 = .045$. However, Model 3 gave the best overall model fit, $F(8, 49) = 6.085$, $p < .001$, $R^2 = .417$.

Lastly and as hypothesized, only the L2 word dictation test outcome, with a large effect of $n_p^2 = .233$, was found to be a significant predictor of the number of spelling errors in the L2 summary, $F(2, 54) = 18.780$, $p < .001$, $R^2 = .410$. Adding the questionnaire variables did not significantly improve the model.

5.4 Discussion

Academic writing can be challenging, especially for students with dyslexia, since spelling and writing impairments have often been reported for this group of students. In this study, the L1 (Dutch) and L2 (English) spelling and summary writing skills of Dutch higher education students with and without dyslexia were investigated. Our research questions involved the influence of diagnosis and language on spelling and writing outcome, while controlling for cognitive and linguistic variables.

5.4.1 Spelling

As hypothesized, students with dyslexia make more spelling errors in Dutch and English than matched control students in word dictation tests and in summary writing, which, therefore, directly answers our first research question. A main effect was found for diagnosis, but no interaction effects were found with language. Students with dyslexia scored 60 % correct on the Dutch word dictation test and 69 % on the English word dictation test. Control students, however, perform 79 % correct on the Dutch test and 87 % on the English test. It was furthermore reported that the L2 word dictation test seemed to discriminate slightly less between the two groups of students than the Dutch word dictation test, as the effect sizes were lower for English.

Our results are overall in line with previous research confirming that spelling problems are persistent and remain to exist in adulthood, even for high functioning adults in higher education (Coleman et al., 2009; Sumner & Connelly, 2020; Callens et al., 2012). This demonstrates that despite many years of education, students with dyslexia are not able to perform likewise on spelling to matched students without a learning disability in Dutch, their native language, and also in English, their L2.

Besides being dyslexic or not, it was demonstrated that from the cognitive variables, PA was a significant predictor of spelling outcome in both L1 and L2. In fact, this effect occurs even over and above the effect of diagnosis, which demonstrates that PA remains to be a strong predictor of spelling outcome in adulthood. Moreover, it could potentially be argued that the effect of PA seems to be even more influential in a L2, since both PA accuracy and speed seem related to word spelling outcome in L2. This suggests that being less proficient in the L2 results in a stronger relation with PA, similar to the effect of PA for early-phase readers and spellers in the L1 (De Groot et al., 2019). However, this result could also be attributed to the fact that English is much more opaque than Dutch (Borleffs et al., 2017).

For the linguistic variables (i.e., print exposure, self-reported writing skills and high-school grades), it was demonstrated that only self-reported writing skills were related to spelling

outcome in both the L1 and the L2. This most likely means that students who felt quite confident about their own writing skills (e.g., students without dyslexia), which they were asked to indicate in the questionnaire, are more likely to perform well on L1 and L2 spelling, than those who did not feel so confident (e.g., students with dyslexia) and thus they appear to be aware of their strengths and weaknesses.

5.4.2 Writing

The findings reported above could have implications for the support and assessment of higher education students with dyslexia. To see to what extent these spelling difficulties also have an effect on the outcome on a writing assignment, students were also asked to write a summary about a short, informative text they just read. No time limits were given to the students when writing the summary, so students did not feel pressured by time. Participants had to write a summary about either the sun text in Dutch, or about otters in English. After reading the text, students were asked to reproduce what they remembered from the text. Students with dyslexia scored 33 % correct on L1 and 28 % correct on the L2 summary, meaning that from the 30 statements that could be reproduced, they reproduced 33 % of the statements correctly for Dutch and 28 % correctly for English. The matched control group received a score of 43 % on the L1 summary and 39 % on the L2 summary, demonstrating that control students significantly outperform the students with dyslexia.

With respect to summary length, sentence length and writing time, we did not find any significant differences between the two groups. This suggests that even if students with dyslexia do not get a strict time limit, are not judged by spelling errors by itself, and create equally long summaries, they still have a serious disadvantage in writing those summaries as content scores are lower. Studying the effect of the cognitive and linguistic predictors it was demonstrated that working memory had a significant effect on the summary writing score. However, it was also shown that students with dyslexia demonstrate a poorer performance on working memory, indicating that a poorer working memory could be one of the reasons why constructing a summary in a L1 is more difficult (Fischer & Glanzer, 1986; Li & Roshan, 2019; Miller et al. 2006). More specifically, this could potentially cause impairments in storing and manipulating information and consequently problems in making connections and inferences in the text (Li & Roshan, 2019; Miller et al., 2006). This could therefore be one of the explanations why students with dyslexia are not able to reproduce the text as well as the matched control students.

For summary writing in English (L2), it was demonstrated that word spelling, and high-school grades and self-reported writing performance, were predictors of the summary content score, demonstrating that spelling skills, past education and own feeling about writing performance seem very important in the process of writing. It is likely that students with dyslexia have less experience in writing than controls without a learning disability, and thus they might have an underdeveloped awareness of how to use written language, which was proposed by Sumner and Connelly (2020). Additionally, Torrance et al. (2016) suggested that the overall lower quality of written summaries of students with dyslexia may also be attributed to poorer knowledge of written language, as a result of less reading exposure over the years. We did not however find differences between the students with dyslexia and control

group on the print exposure measures and therefore no evidence could be given regarding the statement of Torrance et al. (2016).

Lastly, we believe that students with dyslexia experience a disadvantage in writing a summary in English because they have significantly poorer written language proficiency in English than matched control students as reported in Chapter 3 and 4. A significant relation was reported between L2 language proficiency and L2 summary writing performance. Likewise, writing a summary in a language that is not their native language, might cause extra difficulties.

5.4.3 Limitations and suggestions for future research

Limitations of the current study should be covered. The students with dyslexia in the current study are considered high-functioning, in comparison to the wider population of students with dyslexia or adults with dyslexia. Therefore, results cannot be generalized to this wider student population. Secondly, spelling errors were not investigated and classified within our study. It would however be valuable to investigate the type of errors made by the students with dyslexia in the Dutch and English in word dictation and in summary writing. Types of errors could be compared across languages and could be classified according to the different subtypes (i.e., phonological, morphological and memory-based errors), because, to our knowledge, no research has focused on this particular topic. On a final note, in this paper we have only examined the first stage of the writing process, which is the composition of a text and writing it down. However, reviewing your written product is also a major linguistic and meta-cognitive part of the process of writing in higher education. Therefore, future research could also focus on the review process of writing and see the possible differences between students with dyslexia and students without a learning disability and also check if students are able to find for example spelling errors and composition errors that could influence the quality of their written text.

5.4.4 Conclusions

In this study, evidence was found for the fact that writing difficulties of Dutch higher education students are not limited to spelling at the word level for both L1 and L2. In fact, spelling difficulties are also present in writing summary type texts in both Dutch, their L1, and English, their L2, as students with dyslexia make more spelling errors than matched students without a learning disability. Moreover, Dutch students with dyslexia also write summaries of lower quality in both their L1 and L2, causing potential disadvantages in higher education if students with dyslexia have to write summary type texts, such as essays and research reports.

The question that likely follows is: how to tackle these demonstrated difficulties on spelling and summary writing for higher education students with dyslexia? In most higher education programs, students with dyslexia are already getting extra time during exams and dispensation for errors they make during writing, which, seem effective compensatory methods. Also drawing from this study, we think in general that it is very important to invest more time in academic writing for students. Especially students with dyslexia can benefit from multi-dimensional remedial teaching programs focusing on multiple levels, such as word, sentence

and discourse level. However, the efficiency of such programs is, to our knowledge, not studied yet and thus this remains a topic for future research.

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