English Literacy in Dutch Twice-Exceptional Children and Children with Dyslexia

Master's thesis - Utrecht University - Master Pedagogical Sciences – Master programme Orthopedagogy - Academic Year 2013-2014

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Date: 25-05-2014

Foreword

Over the course of the 2013-2014 academic year, I was involved in a research project on twice-exceptionality by the University of Utrecht. Together with other master students, we obtained a sample of 165 Dutch 7th and 8th grade children. Within the research project, I personally focused on the difference in English literacy performance of intellectually gifted and averagely intelligent children with dyslexia, and investigated the predictive role of working memory. I individually wrote this master's thesis and consequently designed the research questions, found corresponding literature, obtained and analysed the data for the analysis, and connected results to previous research in the discussion myself.

Working on the thesis has been an academic and social learning process in which I have had contact with many different people that I would like to thank. First of all I have met a lot of great and different children that I would all like to thank for taking part in the study. They often gave up their free afternoons for scientific purposes. I would also like to thank their parents for inviting me at their homes and making me feel welcome. Furthermore I would like to thank Sylvia van der Wild for bringing me into contact with Pirka Bool of the Dalton College. Pirka Bool provided contact information of children, whose mentors and teachers thought were good candidates for the research project. She also arranged spaces in which I could test eligible students. In addition, a thank you to Sietske van Viersen for answering my questions and her supervision, guidance, and assistance in writing my thesis.

Vera Lagendijk,
May 2014

Abstract

Deze studie onderzocht Engelse geletterdheid als tweede taal, en heeft keek naar de voorspellende waarde van werkgeheugen (WG) voor het niveau van Engelse geletterdheid. De totale onderzoeksgroep bestond uit 165 Nederlandse kinderen uit de eerste en tweede klas, bestaande uit vier groepen; dyslexie, hoogbegaafd/dyslexie, normaal ontwikkelend, en hoogbegaafd. Dyslexie en hoogbegaafd/dyslexie werden gebruikt voor de analyses. Een uitgebreide testbatterij werd gebruikt voor indeling in onderzoeksgroepen, en om Engelse geletterdheid (woord lezen/orthografie/spelling) en WG (verbaal werkgeheugen [VWG], verbaal korte termijn geheugen [VKTG], visueel-ruimtelijk korte termijn geheugen [VRKTG] , en visueel-ruimtelijk werkgeheugen [VRWG]) te meten. De hypothese dat hoogbegaafde kinderen met dyslexie beter zouden presteren op Engelse geletterdheid dan kinderen met dyslexie, werd aangenomen. Tevens werd verwacht dat WG componenten Engelse geletterdheid zou voorspellen. Voor hoogbegaafde kinderen met dyslexie bleek respectievelijk VWG voor woord lezen, en VKTG voor orthografie positieve voorspellers te zijn. Geen van de WG componenten waren significante voorspellers voor kinderen met dyslexie.

Trefwoorden: hoogbegaafdheid, dyslexie, tweemaal-uitzonderlijk, werkgeheugen, tweede taal verwerving

Abstract

This study investigated achievement in English literacy as a second language and examined the predictive value of working memory (WM) for English literacy levels. The total sample consisted of 165 Dutch children from 7th and 8th grade, covering four groups: dyslexia, gifted/dyslexia, typically developing, and gifted. Two groups, dyslexia and gifted/dyslexia were used for the analyses. An extensive assessment battery was used for classification into research groups, and to measure English literacy (word reading/orthography/spelling) and WM (verbal working memory [VWM], verbal short-term memory [VSTM], visuospatial short-term memory [VSSTM], and visuospatial working memory [VSWM]). The hypothesis that gifted children with dyslexia would outperform children with dyslexia on English literacy tasks, was accepted. Additionally, it was expected that WM components would predict English literacy performance. For gifted children with dyslexia, VWM and VSTM showed to be positive predictors for English word reading and orthography, respectively. None of the WM components were significant predictors in children with dyslexia.

Keywords: giftedness, dyslexia, twice-exceptionality, working memory, second language acquisition

English Literacy in Dutch Twice-Exceptional Children and Children with Dyslexia

Learning disabilities (LD) are a widespread phenomenon in modern societies in which reading, writing, and arithmetic are necessary skills in everyday life. Students with LD cover an estimated 4–7% of school-aged children (Geary, 2006; Hasselhorn & Schuchardt, 2006; Mercer & Pullen, 2005). Issues surrounding LD are subject to a large body of research in educational science, psychology, sociology, medicine, and other disciplines. The present study focuses on students with the specific learning disability dyslexia, a learning disability characterized by severe reading and/or spelling difficulties (Vellutino, Fletcher, Snowling, & Scanlon, 2004). Little research is devoted to dyslexia and foreign language literacy. At the same time, cross cultural communication is becoming increasingly important, demanding spoken and written mastery of the world's dominant languages, and especially of English. Also, within the field of LD, there is increasing interest in understanding twice-exceptionality; this is the occurrence of both giftedness and a LD within an individual (Assouline, Nicpon, & Whiteman, 2010; Brody & Mills, 1997). LD's can remain unrecognized for most of these students educational lives. As school becomes more challenging, academic difficulties may increase causing them to fall behind, and the suspicion of a LD arises. Learning a new language such as English may cause these children to fall behind because English is thought to be particularly difficult for people with dyslexia, mainly because English is characterised by an opaque orthography with inconsistent spelling (Seymour, Aro, & Erskine, 2003).

The present study will elaborate upon previous research, aiming to gain more knowledge and understanding about to what extent twice-exceptional children (giftedness and dyslexia) and children with dyslexia differ in their level of English literacy. Also, the role of working memory (WM), a proposed cognitive strength in gifted children, will be investigated regarding English literacy. These insights may provide better understanding of second language learning for (gifted) children with dyslexia. To develop a better understanding of the co-occurrence of both dyslexia and giftedness, both concepts as well as twice-exceptionality, will be explained and defined. Furthermore second language acquisition and literacy in English and Dutch will be discussed.

Dyslexia

Dyslexia manifests itself in children by pronounced problems with acquiring and using literacy, despite overall levels of intellectual functioning that are at or above average of the population. It is a specific language based disorder that is characterized by difficulties with different forms of written language, often including problems with acquiring literacy in reading, writing, and spelling (Miles, 1995). The cause of these problems may be due to difficulties in decoding words, usually reflecting insufficient phonological processing abilities (Snowling, 2000). The above definition of dyslexia indicates that literacy is a major problem for individuals with dyslexia, it is characterized by severe and persistent difficulties with reading and/or spelling, and it places phonological processing difficulties as one of its main underlying cognitive deficits (Goswami, 2002; Snowling, 2000; Vellutino et al., 2004). Theories about literacy development emphasize the fundamental importance of phonological skills. These phonological skills are necessary for successful literacy acquisition, and consist of three components; phonological awareness (PA), verbal short-term memory (VSTM), and rapid automatized naming (RAN; Snowling, 2000). Developmental dyslexia affects around 7% of children and can be found in all studied writing systems so far (Ziegler, Perry, Ma-Wyatt, Ladner, & Schulte-Korne, 2003).

Giftedness

Conceptions of giftedness can be defined in terms of multiple qualities, such as exceptional analytic abilities, high levels of creativity, ability to think of divergent ideas and solutions, specific aptitude (artistic, musical, or mechanical), or high intelligence (Ruban & Reis, 2005). In this study giftedness is defined as high intelligence as McCoach, Kehle, Bray and Siegle (2001) stated that "gifted/learning disabled students are students of superior intellectual ability who exhibit a significant discrepancy in their level of performance in a particular academic area" (p. 405). No universally agreed upon definition of intellectual giftedness exists (Davis & Rimm, 2004). For gifted identification, a minimum IQ score is typically classified between 130 and 140 (Lovett & Lewandowski, 2006) or above 130 (Winner, 1997). Intellectually gifted children are linked with strengths in working memory (WM; Conway, Cowan, Bunting, Therriault, & Minkoff, 2002), vocabulary and grammar (Hoh, 2005), giving them better than average literacy skills in comparison to the general population (see Van Viersen, Kroesbergen, Slot, & De Bree, 2014).

Giftedness and dyslexia

Twice-exceptional students are students who simultaneously meet the definition for giftedness and for LD. Intellectually gifted individuals can have dyslexia, however they are often unidentified. Parents or teachers may fail to notice the co-occurrence of both giftedness and dyslexia because the dyslexia may mask the giftedness or the giftedness may mask the dyslexia. Gifted children with dyslexia could be easily missed if professionals rely on achievement and response to intervention alone in their identification (Berninger & Abbott, 2013). Contrary to children with dyslexia, the literacy skills of gifted children with dyslexia may be average, as they may not positively or negatively stand out compared to the general population (Nielsen, 2002). Their average scores can indicate a discrepancy between ability and achievement. Explaining these average scores, gifted children with dyslexia are expected to have specific cognitive-related strengths that can explain their average reading and spelling performance (Assouline & Whiteman, 2011). A more efficient WM may be one possible underlying cognitive strength (Conway et al., 2002). Van Viersen and colleagues (2014) found a unique cognitive profile that was characterized by deficits related to dyslexia (i.e., phonology) and strengths associated with giftedness (i.e., WM and language skills) in gifted children with dyslexia. With these children, weaknesses in phonology seemed to be moderated by strengths in WM, leading to a discrepancy between ability and achievement for reading and spelling levels that do not always reach the diagnostic threshold for dyslexia.

Literacy in Dutch and English

Van Hell (2004) stated that second language acquisition builds upon the foundations of the first language. Studies of children's reading progress in bilingual programs indicate that cognitive skills transfer across languages and that the cognitive, linguistic, and reading skills of the primary language predict progress in learning to read in a second language (e.g., Comeau, Cormier, Grandmaison, & Lacroix, 1999; Cisero & Royer, 1995; Durgunoğlu, Nagy, & Hancin-Bhatt, 1993; Gottardo, Yan, Siegel, & Wade-Woolley, 2001; Lindsey, Manis, & Bailey, 2003). These results support Ganschow, Sparks, Javorsky, Pohlman, and Bishop-Marbury (1991) original statement that the basic skills in the native language provide the foundation for learning a foreign language. For example, phonological processing, the efficient use of orthographic knowledge, and verbal memory capacity contribute to the transfer of reading related skills across languages (Geva & Siegel, 2000). However, the rate of acquisition of languages skills with comparable alphabetic principles varies with orthographic depth. Dutch and English are comparable in syllabic structure but differ in orthographic depth. Dutch orthography has a medium position on the scale between shallow and deep, whereas English orthography is an outlier on the far deep side. The results of Van der Leij, Bekebrede and Kotterink (2010) support these assumptions as they found that word reading fluency was easier to acquire in Dutch in comparison to English. They furthermore suggest that the effects are attributable to fundamental linguistic differences in syllabic complexity and orthographic depth.

The present study will test English word reading, orthography and spelling performance differences between gifted children with dyslexia and children with dyslexia to answer the question if gifted children with dyslexia differ from children with dyslexia on their English literacy levels. Based on previous research showing that gifted children with dyslexia score higher on every aspect of literacy compared to children with dyslexia in their own primary language, weaknesses in phonology seemed to be moderated by strengths in WM (van Viersen et al., 2014) and a strong WM being related to giftedness (Conway et al., 2002), it is expected that gifted children with dyslexia would score higher on English literacy tasks than children with dyslexia. The concept of WM will be further defined and explained to understand its function in language.

Working memory

WM is a multicomponent system in which a dissociation between verbal and visuospatial working memory can be made. It provides temporary storage of information for brief periods of time that can be used to support ongoing cognitive activities (Baddeley, 1986; Baddeley & Hitch, 1974). This multicomponent system encompasses four components; a central executive (CE), a phonological loop (PL), a visuospatial sketchpad (VSSP), and the episodic buffer (see Figure 1; Baddeley, 2000). The CE is supported by two unimodal storage systems of working memory, the PL and the VSSP (Baddeley & Hitch, 1974). It controls and monitors these 'slave systems' and it is in charge of the interactions of the PL and the VSSP (Ruijssenaars, Van Luit, & Van Lieshout 2004). The episodic buffer is the latest addition to the multi-component model of WM. It is a multimodal store capable and responsible of integrating and binding information across informational domains and memory subsystems into integrated chunks (Baddeley, 2000).

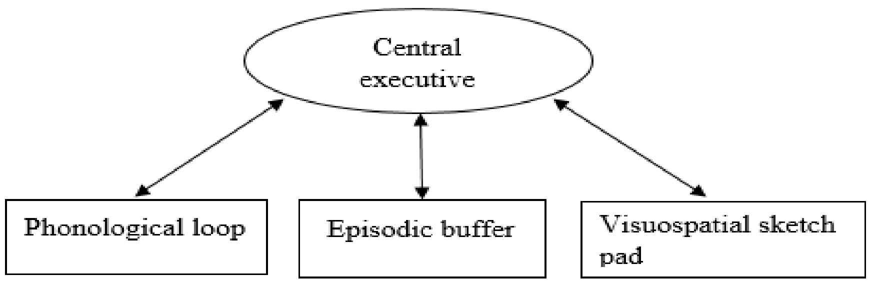

Figure 1. Baddeley's (2000) working memory model.

In WM, the CE is involved as a source of attentional control, enabling the focusing of attention, the division of attention between concurrent tasks and as one component of attentional switching (Repovš & Baddeley, 2006). The CE regulates the flow of information in working memory (Gathercole & Baddeley, 1993). It encodes information from the sensory memory, selects the important information to be stored in long term memory, and (if necessary) retains information back from long-term memory (Gazzaniga & Heatherton, 2003). The system has limited capacity (Gathercole, Pickering, Knight, & Stegmann, 2004). According to Alloway, Gathercole, Kirkwood and Elliot (2009), these initial assumptions of the CE proved to be robust and capable of explaining phenomena related to verbal working memory (VWM) and visuospatial working memory (VSWM). The PL comprises two components, a phonological store, which holds memory traces in acoustic or phonological form that fade in a few seconds, and an articulatory rehearsal process analogous to subvocal speech. The function of the articulatory rehearsal process is to retrieve and re-articulate the contents held in this phonological store, and in this way to refresh the memory trace (Baddeley, 1986). While the PL is specialized to hold verbal information, the VSSP is assumed to be capable of maintaining and manipulating visual and spatial information (Repovš & Baddeley, 2006). These initial assumptions of the PL and VSSP proved to be robust and capable of explaining phenomena related to verbal short-term memory (VSTM) and visuospatial short-term memory (VSSTM), respectively (Alloway et al., 2009).

Although most WM research has focused on adults, Jarvis and Gathercole (2003) also found a dissociation between verbal and visuospatial working memory systems in 11- and 14-year-old children. Furthermore, Alloway, Gathercole and Pickering (2006) found that all described working memory components are in place by 4 years of age.

Working memory and language

WM skills are predictors of literacy outcomes (Alloway & Alloway, 2010). Also, Van der Leij (2003) shows a positive relationship between the level of WM development and the level of technical reading. That is, the CE shows to be important in reading, especially in early readers. As the language rules are not automated yet, they have to be activated in the long-term memory. Concurrently, phonological information has to be stored and processed. As described above, the CE regulates this range of tasks. Furthermore, the word knowledge of children during the early school years is strongly linked to the capacity of the phonological memory. Children with less skilled memory show to be slower in learning words (Gathercole & Baddeley, 1993).

In relation to language, WM and language learning are strongly linked (Gathercole, Alloway, Willis, & Adams, 2006; Gathercole & Baddeley, 1993). WM plays a crucial role in language learning (Van der Leij, 2003). To remember new words, a transition has to take place between the temporal representation of phonological information in the PL to a more permanent structure in the memory system. The level of available memory to support language processing and language storage in children varies. For instance, the extent to which the PL functions is a predictor in children's second language acquisition (Gathercole & Baddeley, 1993). Also, there seems to be a strong positive relationship between the capacity of the phonological memory and the acquisition of a second language (Papagno & Vallar, 1995).

The present study will test the predictive value of WM on English literacy to answer the question if WM is a predictor for the outcome of English literacy skills in gifted children with dyslexia and children with dyslexia. As previous research shows, especially VWM and VSTM seem to play an important role in literacy and second language acquisition (Alloway & Alloway, 2010; Gathercole & Baddeley, 1993; Papagno & Vallar, 1995; Van der Leij, 2003). It is expected that higher levels of VWM and VSTM will predict higher levels of English literacy. Because little research is devoted to visuospatial working memory (VSSTM and VSWM), they are included in the present study to examine their predictive value for literacy. However, spatial working memory measures are not expected to be highly associated with verbal skills. Evidence for this position is provided by Shah and Miyake (1996; see also Friedman & Miyake, 2000).

Method

Participants

The sample consisted of 165 Dutch 7th and 8th grade children, of which 83 boys (50.3%) and 82 girls (49.7%). Participants ranged from age 11 to 14 (M = 12.94, SD = 8.73) and came from various cities throughout The Netherlands. Different educational tracks were represented (i.e., vmbo -basis [1.2%], -basis -en kader [0.6%], -kader [1.2%], -theoretische leerweg [13.3%], vmbo-tl/havo [17.0%], havo [5.5%], havo/vwo [17.6%], vwo [14.5%], atheneum [6.7%], gymnasium [20.0%], bilingual vwo [2.4%]). The participants were divided into four groups: children with dyslexia (D), gifted children with dyslexia (GD), typically developing children (TD), and gifted children (G). The present study used two groups (i.e. D and GD). For both groups, the inclusion criteria were threefold. First, children had to show at maximum average scores on reading *and* spelling (standard score ≤ 12). Second, they had to show below average performance on reading *or* spelling (lowest 10-15% or standard score < 7). Third, children had to show below average scores on at least one of the cognitive factors proposed to underlie dyslexia (i.e., PA, RAN, and VSTM, standard score < 8; Snowling, 2000). Giftedness was defined as a high IQ-score on a validated intelligence test (see Lovett & Lewandowski, 2006). The cut-off value was >120 in case of a full IQ-score and in case of a short form the 95% reliability interval had to tap at least 130. Table 1 shows the group distribution, and division of age, intelligence and sex in the two groups.

Table 1

Sample Size, Percentage of Girls, and Means and Standard Deviations for Age and IQ-score per Group

			Age (months)		IQ (total)	
Group	*n*	*% Girls*	*M*	*SD*	*M*	*SD*
Dyslexia	37	54.1	156.05	8.38	104.65	9.89
Gifted + dyslexia	37	35.1	155.30	9.55	132.41	6.66

Instruments

Intelligence. A short form of the *Wechsler Intelligence Scale for Children - Third Edition- NL* (WISC-III-NL) was used to estimate the general cognitive abilities of the participants. The short form consisted of the verbal subtests similarities and vocabulary and the performance subtests picture completion and block design (WISC-III-NL; Kort et al., 2005). Estimated total IQ was used for the inclusion. The reliability and validity quotients are reported to be good (all above .83; Kaufman, Kaufman, Balgopal, & McLean, 1996).

Dutch literacy. Dutch literacy was measured using several reading and spelling tasks. Word reading fluency was measured using *Een-Minuut-Test* (EMT; Brus & Voeten, 1973), and decoding speed of nonwords was measured using *Klepel* (Van den Bos, Lutje Spelberg, Scheepstra, & De Vries, 1994). Participants were asked to read a maximum of 116 words of increasing length within respectively one and two minutes. Accuracy and speed were of importance. Normscores were used for the inclusion. Internal consistency is reported to be .90 for EMT and .92 for *Klepel* (Evers et al., 2009-2012). Parallel test and test–retest reliabilities are reported to be over .80 for EMT (Van den Bos et al., 1994).

Spelling was measured using the dictation '*The wondrous weather'*. This test measured spelling skills at sentence level. The dictation consisted of 10 sentences increasing in difficulty. The test score was the number of words spelled correct, and was used for the inclusion.

Phonology. PA was measured using the computerised *Fonemische Analyse Test* (FAT; Van den Bos, Lutje-Spelberg, & De Groot, 2011) to test the ability to analyze and manipulate phonemes. The first subtest targets phoneme deletion (e.g., *kraal* 'bead' without /k/ is *raal*), and the second subtest targets phoneme transposition (e.g., transposing onset phonemes of *Kees Bos* to *Bees Kos*). Raw response time and accuracy scores were transformed into a number correct per second ratio score for the inclusion. Internal consistency of the test is reported to be .93 (Evers et al., 2009-2012).

RAN was measured using multiple tasks of the *Continu Benoemen & Woorden Lezen* (CB&WL; Van den Bos & Lutje Spelberg, 2007). The test included four subtests (colours, digits, pictures, and letters) assessing the child's naming speed. Raw scores for the colours and pictures subtests and the digits and letters subtests were computed for the inclusion . Internal consistency of the test varies between .79 and .87 (Evers et al., 2009-2012).

VSTM was measured using multiple computerized tasks from the *Automated Working Memory Assessment* (AWMA; Alloway, Gathercole, & Pickering, 2004). After three incorrect answers, all WM subtests were discontinued. In the digit recall task, the child heard a sequence of digits and had to recall each sequence in the correct order. In the word and non-word recall task, the child heard a sequence of (non) words and had to recall each sequence in the correct order. Test–retest reliability is .84, .76, and .64 for digit recall, word recall, and nonword recall, respectively (Alloway et al., 2004). Raw scores of digit recall, word and non-word recall were used for the inclusion

English literacy. English literacy was measured using several reading and spelling tasks. Reading was measured using the English version of the EMT called *One Minute Test* (OMT; Fawcett & Nicolson, 1996). This word reading task gave an indication of the extent to which accurate and fast decoding of words has been developed (technical reading) in English language. Participants were asked to read words as quickly and well as possible within one minute. The test consisted of 108 words of increasing length. The pronunciation had to be correct English, using the Dutch grapheme-phoneme correspondence rules was not acceptable. The test score was the number of words read correctly and was used for the analyses. Fawcett and Nicolson (1996) reported a good test–retest reliability of .99.

Spelling was measured using an English dictation and an orthographic choice task. In the English dictation, 30 English sentences were presented. Participants were asked to write down the target word. The orthographic choice task was the original test of Olson, Forsberg, Wise and Rack (1994) evaluating orthographic knowledge in English. The test consisted of forty pairs of words (e.g., wurd-word, coat-cote). Participants were asked to choose the correctly spelled word in each pair. Internal consistency was found to be .76 (Bekebrede, Van der Leij, & Share, 2009). Raw accuracy scores for English dictation and the orthographic choice task were used in the analyses.

Working memory. Working memory was measured using multiple subtests of Alloway's (2007) AWMA. After three incorrect answers, all computerised WM tasks were discontinued. VWM, corresponding to the CE in the Baddeley WM model, was measured using the backward digit recall subtest. Participants were asked to recall increasing series of digits backwards. VSTM, corresponding to the PL in the Baddeley WM model, was measured using the earlier described digit recall subtest. VSSTM, corresponding to the VSSP in the Baddeley WM model, was measured using the dot matrix subtest. Participants were asked to recall the position of increasing series of red dots by tapping the squares on the computer screen. VSWM, corresponding to the CE in the Baddeley WM model, was measured using the odd-one-out subtest. Participants were asked to indicate in increasingly complex sequences which figure out of three is odd, and recall the odd figures in a matrix. Test–retest reliability is .86, .85 and .88 for backward digit recall, dot matrix and odd-one-out, respectively (Alloway et al., 2009). Raw scores were used for the analyses.

Procedure

The study was part of a larger research project and followed up an earlier study that investigated achievement and cognitive characteristics of gifted children with dyslexia in primary education. Respondents were recruited through schools, website advertisement, educational psychologists, and personal family contacts. Parents were sent a registration form and extra information. Informed consent was obtained from all eligible participants and their parents. Supervised and trained graduate students conducted the tests. The duration of the test battery ranged from 2.5 hours to 4 hours depending on the pace and need for breaks of the child, and the availability of recent relevant test results. The test administrations took place at homes and schools. Afterwards, parents received a report including test scores and advice.

Analyses

Analyses were performed using Statistical Package for the Social Sciences (SPSS; SPSS, Inc., Chicago, Illinois, www.spss.com) version 22.0, with a $\alpha = .05$ significance level.

Data screening. Missing data analyses showed no missing data points. The data contained no univariate or multivariate outliers. Assumptions for multivariate and univariate analysis of variance, and multiple regression were tested. Except for normality, further data screening showed no violations of assumptions. Normality was violated for orthography and digit recall. Digit recall was transformed and used in the analyses. It was not possible to transform data for orthography to make it an approximate sample for a normal distribution. The non-normal distribution can be explained because the sample consists of participants with disorders. Because normality is robust to violation (Osborne & Waters, 2002), no further actions were taken.

Main analyses. The analyses comprised two steps. In the first step, multivariate analysis of variance (MANOVA) was conducted to investigate whether the GD group differed from the D group on English spelling and reading tasks. The hypothesis stated that gifted children with dyslexia would score higher on English literacy skills than children with dyslexia. Here, the independent variable was de group-variable and the dependent variables were English word reading fluency, orthography, and spelling scores. In the second and final step, multiple regression was performed. Previous research has found WM to be associated with and higher levels of literacy. Consequently, the multiple regression analyses aimed to examine whether WM skills predicted the level of English word reading fluency, orthography and spelling skills for gifted children with dyslexia and children with dyslexia. Here, the independent variables (predictors) were the scores on backward digit recall, digit recall, dot matrix and odd-one-out per group (GD and D). Dependent variables were word reading, orthography and spelling scores per group (GD and D).

Results

Literacy

For English literacy, the hypothesis stated that gifted children with dyslexia would perform better than children with dyslexia on English literacy. As expected, the multivariate analysis showed significant differences between the groups for the measures of English literacy overall. In addition, the univariate analyses showed significant differences between the groups on all three literacy tasks separately. Results indicate that gifted children with dyslexia scored higher than children with dyslexia on every aspect of literacy; word reading fluency, orthography, and spelling. Table 2 shows the means and standard deviations of the English literacy and WM tasks per research group, and results for literacy overall (multivariate) and each literacy skill separately (univariate).

Table 2

Means, SDs and main effects of the two groups on English Literacy and WM Tasks

	Dyslexia (*n* = 37)		Gifted + dyslexia (*n* = 37)					
Variable	*M*	*SD*	*M*	*SD*	Wilk's λ	*F* (3, 70)	*p*	η^2_p
Multivariate					.68	10.93	.00**	.32
Univariate								
WRF	49.57	9.68	60.62	11.47		20.07	.00**	.22
Orthography	32.30	3.73	35.08	3.98		9.66	.00*	.12
Spelling	12.24	3.40	17.22	4.58		28.13	.00**	.28
VWM	13.19	3.10	16.27	3.91				
VSTM	1.42	0.05	1.46	.06				
VSSTM	27.41	3.83	30.73	5.21				
VSWM	21.89	5.65	25.03	6.34				

Note. WRF = Word reading fluency; VWM = Verbal working memory; VSTM = Verbal short term memory; VSSTM = Visuospatial short term memory; VSWM = Visuospatial working memory.
Higher mean numbers indicate better performance on English Literacy and WM Tasks.
* *p* <.01. ** *p* <.001.

WM

For WM, the hypothesis stated that better WM was associated with higher levels of literacy and would predict the level of English word reading fluency, orthography and spelling skills for gifted children with dyslexia and children with dyslexia. Table 3 shows Pearsons' correlation coefficient between the literacy and WM tasks. Some tasks show a large relation, but there is enough support that the tasks measure separate functions of WM and literacy and were therefore not merged.

Table 3

Pearsons' Correlations Between Variables of the English Literacy and WM Tasks

Variable	WRF	Orthography	Spelling	VWM	VSTM	VSSTM	VSWM
WRF	1.00						
Orthography	.38*	1.00					
Spelling	.57**	.41*	1.00				
VWM	-.08	.28	.26	1.00			
VSTM	.02	-.17	.11	.34*	1.00		
VSSTM	-.21	.27	-.15	.18	.27	1.00	
VSWM	-.21	.05	-.07	.35*	.29	.44**	1.00

Note. Values of ±.1 represent a small effect, values of ±.3 represent a medium effect and values of ±.5 represent a large effect.
* *p* <.05. ** *p* <.01.

Three multiple regression analyses were conducted to examine whether VWM, VSTM, VSSTM and VSWM predicted word reading fluency, orthography, and spelling for (gifted) children with dyslexia (see Table 4). For the children with dyslexia, none of the four WM components predicted English word reading fluency, orthography, or spelling. The results for the children with dyslexia indicated that a higher displayed level of VWM, VSTM, VSSTM and VSWM were not predictors for better literacy skills. The results for the gifted children with dyslexia showed that VSTM, VSSTM and VSWM did not predict word reading fluency. Also, VWM, VSSTM and VSWM did not predict orthography. Furthermore, none of the four WM components predicted spelling. However, VWM did positively predict English word reading and VSTM did positively predict orthography. VWM explained 44.2% of the variance, and VSTM explained 39.0% of the variance, indicating a moderate effect. A higher displayed level of VWM predicted a higher displayed level of English word reading fluency and a higher displayed level of VSTM predicted a higher level of English orthography for children with giftedness and dyslexia.

Table 4

Variance in Predicting English Literacy Explained by WM

	Dyslexia (*n* = 37)					Gifted + dyslexia (*n* = 37)				
Model	*B*	SE	β	*t*	*p*	*B*	SE	β	*t*	*p*
WRF										
VWM	-.11	.59	-.04	-0.19	.85	1.30	.55	.44	2.36	.03
VSTM	24.39	37.51	.12	0.65	.52	11.49	33.49	.06	0.34	.73
VSSTM	-.43	.49	-.17	-0.89	.38	0.21	.42	.10	0.50	.62
VSWM	-.27	.35	-.16	-0.77	.45	-0.36	.36	-.20	-1.02	.31
Orthography										
VWM	.17	.22	.14	0.79	.43	-.02	.20	-.02	-0.09	.93
VSTM	-22.92	13.78	-.30	-1.66	.11	24.03	11.88	.39	2.05	.05
VSSTM	.35	.18	.36	1.97	.06	-.21	.25	-.27	-1.40	.17
VSWM	-.05	.13	-.08	-0.42	.68	.07	.13	.12	0.57	.57
Spelling										
VWM	.34	.20	.31	1.67	.10	.24	.23	.21	1.04	.31
VSTM	6.63	12.82	.09	0.52	.61	9.41	14.15	.13	0.67	.51
VSSTM	-.15	.17	-.17	-0.93	.36	.18	.18	.21	1.06	.30
VSWM	-.08	.12	-.13	-0.66	.52	-.17	.15	-.24	-1.16	.26

Note. WRF = Word reading fluency, VWM = Verbal working memory, VSTM = Verbal short term memory, VSSTM = Visuospatial short term memory, VSWM = Visuospatial working memory.
R^2 model 1 dyslexia = .07 Gifted + dyslexia = .21, model 2 dyslexia = .15 Gifted + dyslexia = .17, model 3 dyslexia = .12 Gifted + dyslexia = .11.

Discussion

The aim of the present study was to examine whether Dutch twice-exceptional children and children with dyslexia differed in their level of English literacy. Also, the role of WM as a cognitive predictor for English literacy outcomes was investigated.

English literacy

It was hypothesized that gifted children with dyslexia would show higher reading, orthography and spelling performance overall than children with dyslexia. Recent research by Van Viersen and colleagues (2014) indicated that gifted children with dyslexia outperform children with dyslexia on literacy skills in their primary language. Congruent with the study of Van Viersen and colleagues (2014) and as expected, twice-exceptional children displayed higher levels of literacy overall and on every aspect of literacy individually; word reading, orthographic knowledge, and spelling. Therefore, the hypothesis was accepted. These findings extend the results of van Viersen and colleagues (2014) in the sense that not only do twice-exceptional children showed higher literacy performances in their own language, they also displayed better literacy performances in English as a second language compared to children with dyslexia.

The difficulty of identifying twice-exceptional children is illustrated in the fact that twice-exceptional children, even though school becomes more challenging by learning a new language, still performed better than children with dyslexia that function intellectually at or at above average. As a consequence, gifted children with a dyslexia could still be easily missed because their English literacy skills may be better than children with dyslexia, or do not negatively stand out compared to the general population. Results indicate that, as twice-exceptional children perform better in their own and foreign languages, they probably do not (always) fulfil the same the diagnostic criteria as children with dyslexia.

Working memory

It was hypothesized that WM, and especially VWM and VSTM, were predictors of English literacy performance of the research groups. This hypothesis was supported at the reading level for VWM and orthography level for VSTM for twice-exceptional children. It was not supported at reading, orthography and spelling level for children with dyslexia. A higher displayed level of VWM predicted a higher displayed level of English word reading fluency, and a higher displayed level of VSTM predicted a higher level of English orthography for children with giftedness and dyslexia. Therefore, the hypothesis was partially accepted, but only for twice-exceptional children. These results confirm previous studies stating that the CE has showed to be important in reading (Van der Leij, 2003) and that the extent to which the PL functions is a predictor in children's second language acquisition (Gathercole & Baddeley, 1993). Also, as results were only found for twice-exceptional children, this may support findings that intellectually gifted children are linked with strengths in WM (Conway et al., 2002; Van Viersen et al., 2014).

It was not hypothesised that there would be a difference between WM as a predictor for twice-exceptional children and children with dyslexia. This decision was based on the absence of clear previous research. Consequently, a theoretically support hypothesis in regard to a difference between WM as a predictor for twice-exceptional children and children with dyslexia could not be made. As only the twice-exceptional children showed some significant results, the question what particular role WM plays for children with dyslexia gets more complicated. Helland (2007) found that equal, or similar, symptoms of dyslexia, may relate to different patterns at the cognitive level. So, even if current research groups showed little to no support for WM as a predictor for English literacy, possible different patterns at cognitive level may indicate that this outcome does not have to be a general outcome for all (gifted) children with dyslexia.

Limitations

Not all children were officially diagnosed with dyslexia or twice-exceptionality, but to assure sufficient quality of the dyslexia and the twice-exceptional group, only children who met all criteria for dyslexia and dyslexia and giftedness were included. However, these are not official diagnoses, and to ensure more accurate research groups, further research should try to include only children who have official diagnoses. Also, norms of the FAT and AWMA tasks are up to twelve year old. As participants age ranged from 11 to 14, test scores may not be fully accurate for some of the children. However, no other validated tests for children over twelve are available yet. Other additional WM tasks that are more age appropriate, such as WM tasks of the WISC-III and Dyslexia Screening Test, are suggested for future research that includes WM tasks and children above the age of twelve. Finally, different test environments could have had a potential effect on test administrations. Further research should take place in a more controlled setting, to minimize these potential effects.

Implications

As twice-exceptional children showed better literacy performance than children with dyslexia, raising awareness about the ways in which dyslexia might occur in gifted children is the main objective of the study. As this study supports, twice-exceptional children can “fall through the cracks” at school because they don’t perform as poorly as children with dyslexia or poorly enough on standardized testing to be identified as having a LD. Deriving new diagnostic criteria from these findings is excessive, but it can be stated that teachers and diagnosticians should be more conscious about gifted children who show signs of ability-achievement discrepancy or sudden deterioration in their school performance (especially when learning new languages) when going to 7th grade.

Because there is little predictive value of WM for English literacy performance and symptoms of dyslexia may relate to different patterns at the cognitive level, it is advisable to test more children to further explore what kind of patterns they display, and to further determine what role memory plays for children with dyslexia. Furthermore, previous studies had already concluded that WM affects learning a second language. In this study, the predictive value of working memory and literacy was partly found by using the Baddeley and Hitch's (1974) WM model. However, there are also other models for WM. It would be interesting to test the predictive value for literacy with other validated models such as an alternative account of WM capacity as provided by Miyake and colleagues, who have proposed that working memory capacity is supported by two separate pools of domain-specific resources for verbal and visuospatial information (Shah & Miyake, 1996), or Pascual-Leone's (1970) multimodal WM model that explained memory by considering it to be a causal factor of cognitive growth between domains (Kemps, De Rammelaere, & Desmet, 2000). Different results may be found as, for example, Baddeley and Hitch's model is very linguistic, while Pascual-Leone's model is not.

Conclusion

The present study supports statements that gifted children with dyslexia outperform children with dyslexia on second language literacy skills. A stronger WM may compensate literacy difficulties leading to better reading, orthography and spelling ability levels in second language, as earlier research found strengths in WM to be associated with giftedness. Consequently, twice-exceptional children may still be missed even though school becomes more challenging by learning a new language with a different orthography. As a result teachers and diagnosticians should be more conscious about gifted children who show signs of ability-achievement discrepancy or sudden deterioration in their school performance (especially when learning new languages). For the level of second language literacy skills WM has only found to be a predictor for twice-exceptional children, as VWM and VSTM showed to be positive predictors for reading and orthography, respectively. None of the WM components were predictors for children with dyslexia. To furthermore test the predictive value for WM on literacy, other validated WM models should be further explored.\

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