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The impact of bilingualism on dyslexia: a comparative study of Welsh and English University students using Wordchains.

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Abstract

In this article, 2 studies are presented comparing English and bilingual Welsh speaking university students', including those who experience dyslexia on their speed and accuracy of segmenting Wordchains. In the pilot study, a Welsh translation of the standardised assessment, Wordchains, was evaluated with a group of students. The results indicated that this version was more difficult than the English version because of the longer length of the Welsh words. For the main study, the stimulus was adjusted for length and a comparison made of the performance on Welsh and English forms. The results indicated that the Welsh test was more difficult overall with the poorest performance from Welsh speaking dyslexics followed by Welsh speaking controls than the English test equivalent. The results have implications for countries across the world where bilingualism is common.

Keywords: Bilingualism, processing speed, dyslexia, Welsh, Higher Education

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INTRODUCTION

Bilingualism is extremely common world-wide, with 55 countries identified as bilingual, and 67 countries using English as one of their official languages [Wikipedia, 2022f], which makes this an important issue for research, with impact for many participants internationally. Bilingualism is known as 'simultaneous' when children are learning the language at home as well as in the educational context, and consequential or sequential when only adopted in education or work. English itself can be a major challenge for many people from a variety of backgrounds because of the irregularity and complexity of the English language. In the UK, issues related to bilingualism are becoming ever more relevant with growing numbers of bilingual and EAL (English as an Additional Language) children in school (Strand et al., 2015) with children potentially at a disadvantage in the UK system. In their review of 29 controlled interventions, vocabulary was shown to be key to success for these children, as well as improving listening comprehension, with growing numbers of children with poor language backgrounds of all types increasingly at risk for failure. This may well be a key issue for a number of Asian countries, such as Singapore, where although the language of instruction is English, native languages include Chinese (Mandarin), Malay and Tamil.

The question therefore arises, what is the impact of bilingualism in dyslexia? In this article, this issue will be explored further with 2 studies undertaken and presented here: firstly, a pilot study to evaluate a Welsh version of the Wordchains test (Miller-Guron, 1999) compiled by experts in the field. Secondly, a more comprehensive study using modified Welsh Wordchains stimuli, adapted to match the English stimuli for word length, in comparison between Welsh and English speakers, including participants who experience dyslexia and those who do not.

Costs and Benefits of Bilingualism

For many years there has been controversy over the impact of bilingualism on literacy, because it seems that initially children who are learning to speak in more than one language are delayed. It has even been suggested that this can lead to failure, but conversely research from Kuhl (2004) has argued that children who are learning in more than one alphabetic language will retain their ability to benefit from a wider variety of inputs over a longer period of time than monolingual speakers. The impact of this means that this initial delay (Garcia- Sierra et al., 2011) endows these children with a naturally enriched system of neural networks. This in turn will endow them with greater advantages in executive function, including memory and attention which have themselves been shown to be key to early learning. The impact of this enriched environment is known to increase metalinguistic awareness and competence, which underpin language learning. More theoretically, for example, learning a novel second language such as Hebrew or Chinese will lead to increases in statistical learning, which underpin the framework for learning to read (Frost et al., 2013). Interestingly, there have been suggestions (Lallier

and Carreiras, 2018) that theoretically early bilingualism modulates reading development, with the specific impact linked to the grain size hypothesis triggered by different orthographic depth (Zeigler and Goswami, 2005). This suggests that greater complexity of the language leads to greater difficulty in acquisition, with some languages appearing more compatible than others in terms of both accuracy and fluency, and English the most complex of them all.

Dyslexia and Bilingualism

In order to understand dyslexia in the context of bilingualism, it is necessary to understand how this might impact on literacy and how dyslexia can impact on language learning (Cline, 2000). For example, the orthographic complexity of a language determines how quickly it can be learned (Caravolas, 2005; Ziegler & Goswami, 2005). In a recent report, (Mortimore et al., 2012), a number of issues were highlighted, including the possible masking of dyslexia by difficulties in acquiring a 2nd language in their study of 125 schools with higher than average bilingualism. Strand et al, (2015) identified special educational needs as a major factor in escalating risk levels for bilingual children, but in their study, there was no attempt to differentiate dyslexia from other learning difficulties. A notable exception to this trend, the study by Kelly (2002) found 95% of a group of 200 Bengali children showed automaticity deficits in balance that have been linked to dyslexia, and moreover, that these linked to impaired phonology, in a longitudinal study of 7-8 year-old Punjabi children.

Dyslexia in Higher Education

Academic learning is inevitably considered to be synonymous with reading and writing (Mateos et al., 2007). In reading text, comprehension is related to not only word decoding accuracy (which itself is related to spelling accuracy), but also to phonemic awareness and fluency, (Jackson, 2005) which has implications for dyslexic students in HE (Higher Education), who may continue to struggle in these areas. This is because they will require more time reading for their research before starting a written assignment, and more time at the writing stage than their non-dyslexic peers. It is important to note that the difficulties adults with dyslexia experience can only increase when they are "in situations that place great emphasis on written language skills" (Gauntlett, 1990). University is one such an environment and as stress exacerbates dyslexic difficulties, this may "result in a student with mild dyslexia exhibiting the symptoms of severe dyslexia." (Pavey et al., 2010). Gilroy (2004)has noted the extreme impact of ongoing stress on university students with dyslexia.

Students on degree courses are mainly assessed through written work, but planning and structuring a written assignment can be difficult because students with dyslexia find it hard to put their thoughts into logical, sequential sentences and they can take 10 or 20 times longer than their peers to produce a piece of coursework which may still not be a

true reflection of their ability, (Smith-Spark et al., 2004). Dyslexic individuals may have difficulties with any or all of the following: poor spelling, symbol confusion, omission of words, and difficulty in proofreading. These make for obvious difficulty in academic writing, especially as critical thinking, use of language, structuring and argument are core skills for academic writing, (Elander et al., 2006).

It may be that dyslexic students tend to select courses that demand less writing, for example creative art/design or practical-based mathematics courses such as engineering, biological or physical sciences. Often students with dyslexia excel in presentations where they can talk about their knowledge but they may have difficulty reading their own slides, mispronounce words and make spoonerisms which can result in being an object of fun (Cogan, 2000). Dyslexic students are more likely to be awarded a lower-class degree (lower second or third) and are more likely to withdraw after their first year of study (Richardson and Wydell, 2003 in Mortimore and Crozier, 2006).

In addition, some students with dyslexia may experience visual distortions when reading, such as the letters and words appearing to move on the page; text can form dark patterns on a white background for example, similar to rivulets down the page, or there may just be too much 'glare' from the white page, (Wilkins, 2003). A student with severe visual distortion who reads for more than twenty minutes usually develops itchy and sore eyes, and severe headaches or migraines. Although the cause of this condition has not yet been established, it can be helped by the use of a coloured overlay or coloured lenses, (Evans, 2001).

Not surprisingly, the situation when assessing the literacy skills of adults with dyslexia is even more complex, given the natural overlay of compensatory skills in those students who have managed to progress through to university. Cavalli et al, (2016), for example have shown that University students who experience dyslexia show vocabulary skills equivalent to chronological age controls, and these skills play a major role in comprehension at this level, and these findings are supported by many other studies in the literature. It seems that the defining feature for many adult dyslexics, particularly those who reach university, is the speed factor which means that their performance in reading simple one syllable words, whether regular, irregular or nonwords, may be nearly 3 times slower than their non-dyslexic peers (Nicolson et al., 2010). An important tool that can be used in these contexts would be the Wordchain group reading test (Miller Guron, 1999) which measures the speed and accuracy of segmentation of three and four syllable words. Interestingly, it is clear that the task itself captures the well-researched difficulties that dyslexics suffer in segmenting language efficiently. This test has been designed to evaluate silent reading speed in ages 7 to 18 and therefore is one of the few tests that is suitable for the adult age range in FE (Further Education) and HE. Originally normed for Swedish readers, a series of studies have translated the Wordchains stimuli, to compare reading speed in different orthographies, including English and Swedish, where comparisons were made with primary school children (Miller

Guron and Lundberg, 2004), as well as dyslexic children reading in English as a foreign language in Swedish schools (Miller, Guron and Lundberg, 2000). It has been successfully used in evaluating the cognitive linguistic profiles of multilingual dyslexic University students suspected of dyslexia (Lindgren and Laine, 2010) reading in both Swedish and Finnish, based on normative data and translation (Lindgren and Laine, 2007). More recently, Wordchains was adapted into Arabic and used to evaluate the incidence of dyslexia among young offenders in Kuwait (Elbeheri, Everatt and Al Malki, 2008).

Aspects of the Welsh Language

Welsh is a more orthographically transparent language than English and this affects the rate of acquisition of a language. A transparent language has a regular grapheme (letter) to phoneme (sound) correspondence and rules of pronunciation. It has been suggested that in language acquisition different strategies are used depending on the orthographic depth of the language. A study by Ellis and Hooper (2001) of year 2 children showed the Welsh speaking children were able to read more accurately and fluently than English speaking children, because of the greater orthographic transparency of Welsh, and this meant that the Welsh speakers showed higher comprehension levels. Moreover, the majority of their errors related to word length in Welsh. Mayer et al., (2007) working with Welsh-English bilingual children found that in reading and writing phonological processing seemed to be used preferentially, that is, a reliance on recognising the sounds of syllables and words. Their research found that Welsh children rely on phonological processing when spelling whereas orthographic strategies are more useful when spelling in English where there is a more "complex relationship between graphemes and phonemes".

Welsh may have transparent spelling but it does not have a transparent grammar. Grammatical gender is more complex in Welsh and Welsh speaking children generally do not achieve this skill until they are 10 years old, (Gathercole and Thomas, 2005). Welsh has a system of mutations of initial letters which can make it difficult to look words up in dictionaries, for example Cymru = Wales but Welcome to Wales = Croeso i Gymru. There is also a difference between written and spoken vowel mutation in Welsh (Cartmill, 1976). Possessive Pronouns cause mutations, for example, Cath = Cat

Table 1. Welsh grammar

fy nghath = my cat	ein cath = our cat
dy gath = your cat (informal)	eich cath =your cat
ei chatth = her cat ei gath = his cat	eu cath = their cat

As Welsh has a transparent orthography, children learning to read through the medium of Welsh are more successful at phoneme tasks than children from the same area of

Wales learning to read through the medium of English (McDougall and de Mornay Davies, 2010). Spencer and Hanley, 2003, found that 5 to 6 year-old children were more skilled in real and nonsense words and phonemic awareness, when reading in Welsh than English, although by age 10 this advantage had diminished. A study from Mayer et al., (2007) indicated a differential involvement of phonology in spelling, elicited by a concurrent vocalisation task, which impacted more severely on Welsh spelling, but only impacted on comprehension for the younger Welsh readers in the age group 7-8. Evidence has also been found to indicate that different grain sizes are applied during sentence reading dependent on the languages involved, with bilingual Welsh university students employing different strategies when reading in words embedded in sentences in Welsh or English, including more fixations in Welsh which represent the more consistent orthography (Egan et al., 2019) in response to words rather than pseudo-words. By contrast, the same subjects showed equivalent eye movements to monolinguals when reading English sentences.

Welsh Language and Dyslexia

The implication for Welsh children with dyslexia is that Welsh will be easier to learn than English initially but their difficulties will be more readily seen in English than in Welsh so detection in Welsh may be masked and consequently no support put in place. If children are not identified until much later in their education, for example, at university they can develop low self-esteem and less readily achieve their potential. However, until recently, there has been a shortage of screening tests and standardised instruments for measuring achievement for Welsh speaking dyslexics. Moreover, there has been a profound shortage of studies targeting Welsh speaking dyslexics, and the only study from Thomas and Lloyd, (2008), found that this group had greater difficulty than their peers in reading spelling and copying tasks.

Interestingly, a pattern showing the impact of home language was identified in children from English speaking homes in norm collection for a standardised Welsh screening test (WDT-J, Jones and Fawcett, 2013) 400 children, with 267 from English speaking homes, 180 from Welsh speaking homes, and 34 mixed were screened for risk of dyslexia, between ages 7 and 11. The results in table 2 below indicate that 29% risk level was found overall, with 14.4% risk in Welsh speakers, and 3% of this strong risk (Fawcett, 2000).

Table 2. Incidence of risk in Welsh and English speaking children

Home Language	Mild Risk	Strong Risk
English	34	65
Mixed	5	6
Welsh/English		
Welsh	17	9

One of the most striking aspects here was the impact of Welsh word length on completion time in the Rapid naming task, which meant that naming speed was significantly longer at the lowest level, although speed of single word reading was faster.

Welsh Students Who Experience Dyslexia

A key factor for Welsh students with dyslexia may be that they remain slower reading English than Welsh, because many of them need to translate words from Welsh into English in order to understand the text. In order to help students to read more efficiently strategies such as planning when they are more alert during the day, reading in short bursts, skimming for an overview, deciding on keywords and scanning for them, and using a ladder read can be helpful. If students usually think in Welsh, composition in English may be slower because they are having to translate. This has implications for written assignments and examinations and students may get left behind if copying from a board or taking notes in lectures or seminars particularly as there may be a problem with spelling.

When first language Welsh speaking students are writing in English there can be an over reliance on phonetic spelling and an over use of the definite article and as Welsh syntax is different from English a literal translation from the Welsh might be confusing. A Welsh dyslexic student may need more specific help in developing proofreading skills (Meehan, 2011). Supporting students in Higher Education requires adapting or creating new strategies tailored to the individual student but in terms of proofreading may include noting down the main difficulties the student experiences in English and finding a 'key' to help the student find the correct word and/or spelling. Assistive technology can be used and modified to the individual student. Indeed, the recent increased use of Virtual Learning at all educational levels due to the pandemic may help dyslexic students because they can review recorded lectures at their own pace. For businesses, the Welsh Government has a bilingual technology toolkit (https://gov.wales/bilingual-technology-toolkit-good-user-experience) and in the voluntary sector, the Welsh Language Commissioner offers a free bilingual proofreading service for text up to 1000 words.

In summary, bilingual students may need more time to read, write and proof read their work. Note-taking and copying from the board may be more difficult and they may fall behind in their coursework and find they have incomplete notes when they start to revise for examinations. These students may be slower in writing answers during examinations in both written English and in calculations if they translate from Welsh into English and then write their answer.

These findings provided the motivation for the current study, which aimed to evaluate the speed and accuracy of performance on the Wordchain test of silent reading in Welsh speaking dyslexic university students in comparison with control students reading in both Welsh and English. It was predicted, based on evidence from earlier studies that the

Welsh speaking dyslexic students would be slower in their performance, and the results would provide confirmation of whether or not their speed issues relate to the need to translate into English, or whether there are specific underlying difficulties with efficiency in Welsh language tasks.

METHOD

Measures

The Wordchains test (Miller Guron, 1999) is a test of silent reading speed based on segmentation of words presented in clusters of 3 or 4 without spaces. The task demands that the participants complete the segmentation using pencil and paper to place a slash between each word e.g. sandcoffeeblue - sand/coffee/blue or in Welsh tywodcoffiglas tywod/coffi/glas. An expert evaluated the original word base, and translated the words directly from English to Welsh. To give an example:

the chain saladnursebakerdaisy should be segmented as salad/nurse/baker/daisy with the Welsh equivalent saladnyrspobyddllygadydydd segmented as salad/nyrs/pobydd/llygadydydd
The word daisy = llygad y dydd, and is notably longer than the English word.

The Questionnaire

This was developed in order to evaluate the level of Welsh contribution to each participant, including the home language and the time frame within which Welsh had been spoken. See Appendix 1 for the full questionnaire.

The Pilot Study

18 pilot study participants self-identified from a list of HE students who had agreed, in principle, to take part in research into dyslexia during their studies. All students undertook a Wordchains test in English or Welsh depending on the language spoken. In addition, 3 Welsh students took the Wordchains test in English.

16 students completed the questionnaire after the test: 8 dyslexic and 8 non-dyslexic students. 12 students were in the 18-21 age range and 4 were mature students.

Only students who were English speakers or bilingual Welsh and English speakers were accepted as participants in the study. All dyslexic students had a formal diagnosis of dyslexia by an Educational Psychologist or a Qualified Specialist Teacher in line with the guidelines for the Disabled Students Allowance. 8 were bilingual Welsh and English speakers and 8 were English speakers only. Of the 8 dyslexic students, 3 were bilingual Welsh and English speakers and 5 were English speakers. Of the non-dyslexic students,

5 were bilingual Welsh and English speakers and 3 were English speakers. 9 students identified themselves as female and 7 as male.

One participant was interviewed.

Conclusions of the Pilot Study

The results of the Pilot Study indicated that Welsh speaking students were slower at completing the Wordshains test in Welsh. This may have been due to the increased number of characters in the Welsh version of the test which was directly translated from the English corresponding to a greater difference in the length of the Wordchains.

Dyslexic Welsh speaking students were particularly slow completing the English Wordchains compared to English speaking Dyslexic students. English speaking non-dyslexic students and Welsh speaking non-dyslexic students all scored comparably on the English Wordchains test.

Gender Differences in Welsh Wordchains Mirrored those in English Wordchains

Aled, a Welsh speaking bilingual student, who was interviewed, described himself as "immersed in Welsh". Spelling and punctuation were difficult for him in both Welsh and English. He said that Welsh had no hidden letters and it was pronounced the way it was spelled, but in English there are silent 'k's and 'e's etc, so English was difficult for him. Aled was concerned that there are few tests (for dyslexia) in Welsh and for children this is important whereas he considered being tested as adult in English is acceptable. He felt that if his daughter, who attends a Welsh-language school, was tested for dyslexia in English it would be unfair, but not if she was tested in Welsh.

Modifications of the Pilot Study

Based on the results of the pilot study, it was decided to aim for a minimum of 20 students in each of the four groups: Welsh speaking Dyslexic and Non-Dyslexic students, and English speaking Dyslexic and Non-Dyslexic students. The students involved in the pilot study did not participate in the main study and the participants self-identified in the same way as in the pilot study. Again, only students who were mono-lingual English or bilingual Welsh/English were invited to take part. Only dyslexic students with a formal dyslexia diagnosis were admitted to participate in the study. All controls completed the Adult Checklist screener and those non-dyslexic students who were 'at risk' were not invited to participate in the study.

The initial part of the Wordchains test, Letterchains was changed to include Welsh letters. In addition, the Welsh Wordchains test was modified to have parity of character length between Welsh and English versions of the test.

Study 1. Bilingualism and Dyslexia: Evaluation using a Revised Wordchains Matched for Length.

A revised Welsh Wordchains test, with stimuli matched for overall word length with the English test was administered to bilingual Welsh speaking students in Higher education, A questionnaire was also administered to all participants, designed to elicit any differences experienced in processing in Welsh and English (see Appendix 1 for this questionnaire). This would provide both qualitative and quantitative support for the relative speed and difficulty of performance in Welsh and English. All Welsh speaking bilingual students were asked if they would be interviewed and one participant agreed in order to provide the case study below.

Participants

The sample consisted of 14 Welsh speaking Dyslexic students, 25 Welsh speaking Non-Dyslexic students, 24 English speaking Dyslexic students and 25 English speaking Non-Dyslexic students giving a total of N=88.

Results

64 female students took part in the study and 24 male students. 38 dyslexic students and 50 non-dyslexics, see Table 3.

Table 3. Male/female participants in the dyslexic and control groups

Count	Gender		Total
	Female	Male	
Dyslexic	28	10	38
Non-Dyslexic	36	14	50
	64	24	88

77 participants took the English Wordchains test, 56 female and 21 male. There was no significant difference between the mean scores obtained by female or male students, see Figure 2.

Figure 1 shows that non-dyslexic students had higher scores in the English Wordchains than the dyslexic students, of the latter, the English- speaking dyslexic students performed better than the Welsh students.

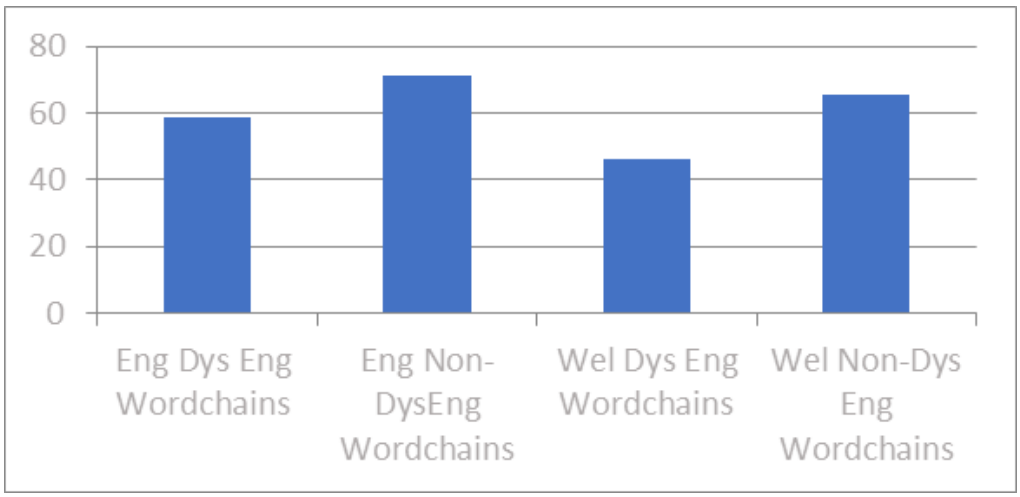

Figure 1. Mean scores of students taking the English Wordchains test against language and dyslexia

It is interesting to note that Welsh speaking non-dyslexic students achieved comparable scores to those of English dyslexic students. However, there was tremendous variability in the scores as seen in Table 4. This could be due to a basic difficulty with reading but Figure 2 shows that Welsh speakers whether dyslexic or not show the greatest difficulty.

Table 4. The Range of Raw Scores achieved by students undertaking the English and Welsh Wordchains, mean scores and standard deviations.

Language v Dyslexia	Range of Raw Scores	Mean	N	Standard Deviation
English Wordchains				
English Dyslexic Students	25-90	58.92	25	14.28
Welsh Dyslexic Students	22-65	46.07	14	15.79
English Non-Dyslexic Students	40-89	70.91	22	11.88
Welsh Non-Dyslexic Students	54-83	66.88	17	11.54
Welsh Wordchains				
Welsh Dyslexic Students	14-32	22.71	14	5.4
Welsh Non-Dyslexic Students	15-50	34.92	25	9.18

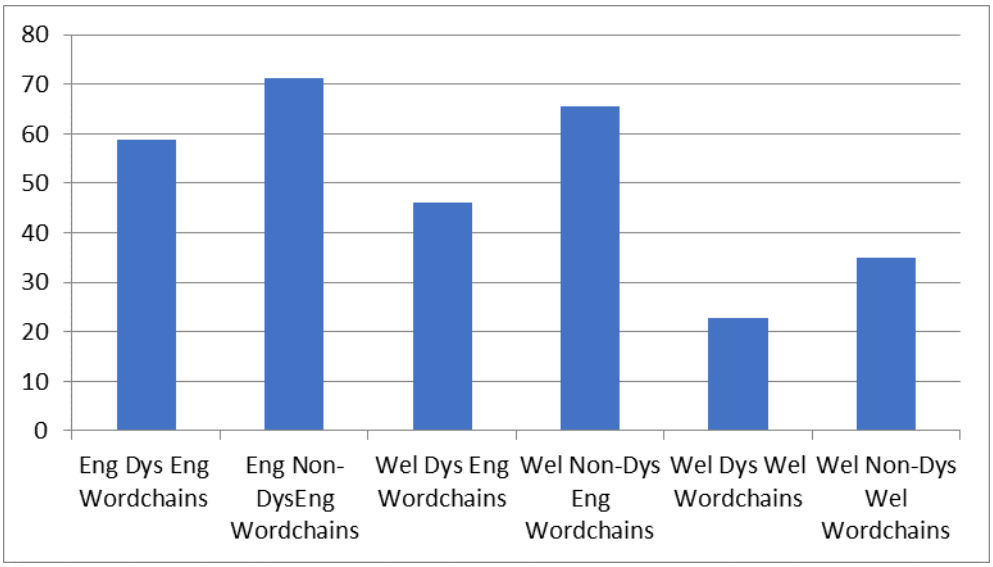

Figure 2. Raw Scores of English and Welsh Wordchains

The number of Wordchains correctly scored form the dependent variable and the independent variables are language (monolingual English or Welsh Bilingual) and Dyslexic or Non-dyslexic

An analysis of variance (ANOVA) test was undertaken on the English Wordchains scores indicating that there was a significant difference between the groups F=11.06 p <.001; see Table 5

Table 5. Comparison of scores for the impact of language and dyslexia

English Wordchains (means in groups)	
Language v Dyslexia	**Significance**
English Dyslexics v Welsh Dyslexics	0.048*
English Dyslexics v English Non-Dyslexics	0.030*
English Dyslexics v Welsh Non-Dyslexics	0.317
Welsh Dyslexics v English Non-Dyslexics	0.000**
Welsh Dyslexics v Welsh Non-Dyslexics	0.001**

*Values at 0.05 and 0.001 significance

At this level of significance (>.001) there would be a less than 1% chance of the difference between the variables occurring by chance.

Analysis of the Questionnaire.

The results of the questionnaire were tabulated and a series of chi square tests performed in order to identify any significant differences between the dyslexics and the non-dyslexics. The following results indicate the impact that dyslexia and bilingualism can continue to have on students in HE.

I. Is Reading Tiring?

The answer was yes if you are dyslexic, with a significant difference between the dyslexics and controls.

Table 6. A crosstabulation of Dyslexia against 'Is Reading Tiring?'

		Is Reading Tiring?		Total
		Yes	**No**	
Dyslexia	**Dyslexic**	27	11	38
	Non-Dyslexic	12	38	50
Total		**39**	**49**	**88**

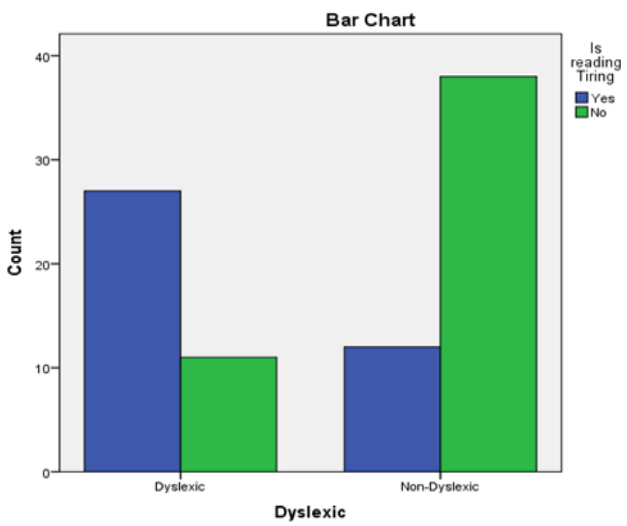

Figure 3. Bar chart of dyslexic and control responses to is reading tiring?

A chi square test indicated that this result was significant, n=88,df 1, X^2

19.37, p = <.001. Thus, suggesting that dyslexic students found reading significantly more tiring than non-dyslexic students.

II. Is Writing Easy?

A chi square test indicated that this result was significant, n88, df 1, X^2 13.7 p<.001, see Table 7

Table 7. A crosstabulation of Dyslexia against 'Is Writing Easy?'

		Is Writing Easy?		Total
		Yes	No	
Dyslexia	**Dyslexic**	14	24	38
	Non-Dyslexic	38	12	50
Total		**52**	**36**	**88**

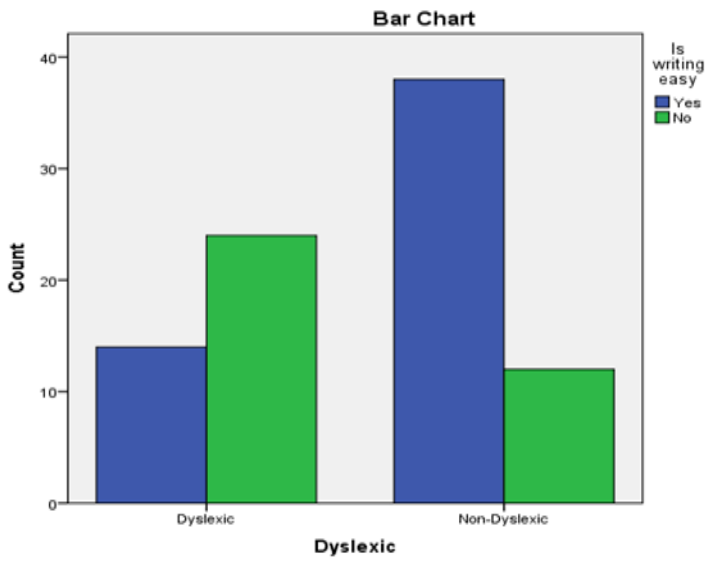

Figure 4. Is writing easy?

Thus the results suggest that dyslexic students found that writing was significantly more difficult than non-dyslexic students.

Participants were also asked in which language they made more errors and whether they translated from Welsh to English while writing. Neither of these questions produced significant results.

Case Study of a Welsh Dyslexic Student

One Welsh speaking dyslexic student agreed to be interviewed.

Daffyd was a first language Welsh speaking bilingual student reading science. Both his parents spoke Welsh in the home until he was in primary school when his father changed jobs and then tended to speak English. English Television and radio were watched and listened to but Daffyd was educated through the medium of Welsh from nursery school until he reached university. He spoke Welsh to the teachers and in formal situations at school but English to his friends. He used and still uses English for speaking on the mobile phone or texting except to his Mother. In his university flat, he speaks mainly English but his flatmates are bilingual and he can speak fluently in either language.

He was taught mathematics through the medium of Welsh until university although he had an English mathematics tutor for the latter part of his A Level to help him revise. He did not feel that he had difficulty learning English or Welsh although the mutations were difficult to learn in Welsh and it was hard to spell and use correctly the 'easy' words in English, for example, 'were' and 'where'. He studied Welsh and English GCSE (Language and literature).

Until A level he approached mathematics through the medium of Welsh, but his English mathematics tutor helped him to learn some of the language of mathematics in English. In the first semester at university, he struggled with the English terms in mathematics, for example, 'differentiation'.

Daffyd was first assessed for Dyslexia at 18 years although as a child, his parents suspected he had a Specific Learning Difficulty. In the first semester at university work was nearer to A Level, and so it was easier for him to connect terms in lectures, but when new topics started to be introduced it became a steeper learning curve. When answering assignment questions, he needs to Google definitions but can "get lost in the question... He cannot get the context of the question." He stated that "I think in Welsh but when following the procedure [in mathematics] I think in English which is probably the influence of the English mathematics tutor". If there are multiple terms he does not know, he will struggle with the question.

When revising he spent time trying to understand the language of as many past papers as possible. He found it easier to decipher a complicated word in English because "I can break it down more easily than a complicated word in Welsh". In exams, Daffyd reported that, "I can skim over words because I'm dyslexic, and I can miss a word like 'not' and then I'll have to cross work out and redo it, and I struggle with punctuation."

He also reported that, "When speaking Welsh, I think through the medium of English and I'll think of my sentences in English, so it takes time to translate." When completing the

Welsh Wordchains test he stated that, "if he didn't know the words because of the dialect or how the mutations were applied, it was easier to work from the end of the chain forwards to find a break". This implies that Daffyd was using a process of logic rather than an automatic reading process to identify the individual words in a chain.

DISCUSSION

The results of this study indicated that even when words were matched for word length, the Wordchains test was more difficult in Welsh for both Dyslexic and Non-dyslexic students. Welsh speaking bilingual dyslexic students achieved the poorest scores followed by Welsh speaking controls in comparison to the results for the English test equivalent overall in agreement with Spencer and Hanley (2003) that any advantage learning Welsh as a first language may confer is lost after the age of 10 years when Welsh grammar becomes more complex. The questionnaire study also provided further evidence that dyslexic students still found reading tiring, and that writing was not easy for them. The difficulties encountered were reinforced by a rich case study that provided further evidence of the confusion that can arise when a dyslexic student, even one of high ability, learns in one language and uses another language in Higher Education. This is particularly true when the subject studied includes a range of terms that may not be familiar in the 2nd language.

In terms of teaching Welsh as a subject more widely within Wales, it is clear that Welsh itself can be a challenge for all students, but more specifically for dyslexic students. Nevertheless, it could also be argued that the benefits of bi-lingualism, whether in Welsh or other languages, impact on the refinement of executive function and provide some protection into old age instead Alzheimer's disease (Bialystok et al., 2012). However, more recently, this finding has been challenged by a metanalysis from Lehtonen and colleagues (Lehtonen et al., 2018), which found no statistically significant evidence for this view. However, it seems self-evident that a rich language background such as that encountered in many bilingual households, should lead to enhanced skills in language. Whether or not this holds true for students with dyslexia is not yet clear.

In terms of Welsh speaking students, there is a clear need internationally to maintain minority languages that have been in danger of dying out. No-one would suggest that this is not a worthy consideration. However, it might well be argued that Welsh speaking students would benefit from extra time in their examinations when they are asked to process in English, whether or not they are dyslexic. There is of course, a compelling case for providing extra time for dyslexic students, in whichever language they process. The UK system is currently one of the best in providing recognition for dyslexia and other conditions that might impact on progress in examinations. A speed deficit, whatever the cause, has recently been recognised as justification for the provision of extra time in school examinations, with the school themselves able to provide evidence to this effect through specialist teachers.

Unfortunately, this allowance of extra time is not provided as a right in many countries across the world, and in Asia provision of support at this level is varied. Moreover, support throughout schooling can also be variable, with some outstanding exceptions. The findings from the case study are particularly important, because bilingual dyslexic students may well suffer from unexpected difficulties with vocabulary when processing in English, if they have previously studied in their native language. Furthermore, provision of support is still not a right, and can remain expensive and restricted in access in many countries.

LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH.

This study, although well designed and executed remains relatively small and there is no doubt that further research in this area is needed. A larger scale study would be useful, as well as a study of younger participants at secondary level, to see whether or not the same pattern of results pertains.

The Wordchains test, which is available for translation into a range of languages (with permission from the author) could be a key to progress across a range of studies of bilingualism.

CONCLUSIONS

A study of bilingual Welsh speaking students showed that Welsh students with dyslexia were particularly slow, even when stimuli were matched for word length. Interestingly, non-dyslexic Welsh speakers were also slow, although not as slow as their dyslexic counterparts. Moreover, despite the known speed deficits associated with dyslexia, the performance of the non-dyslexic Welsh speakers was equivalent overall to the dyslexic English speakers, suggesting a gradation in difficulty level with the Welsh dyslexic most severely affected, but even the non-dyslexic Welsh speakers showing mean speed levels that matched the English-speaking dyslexic. However, there was considerable variability within this pattern of results, with some English-speaking dyslexics showing more extreme results than others. Implications for bilingual students more generally were discussed and Wordchains recommended as a suitable vehicle for examining speed differences between languages.

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APPENDIX

Welsh, Dyslexia and Bilingualism Questionnaire			
This questionnaire is in two parts. Part I deals your experience of reading and writing, and Part II asks for some personal details. Please complete both parts			
Part 1			
1	Do you find reading tiring?	Yes	o
		No	o
2	Is writing easy for you?	Yes	o
		No	o
3a	Is Welsh your first language?	Yes	o
		No	o
b	Is English your first language?	Yes	o
		No	o
4	Is your level of spoken Welsh:		
	fluent?		o
	Intermediate?		o
	beginner?		o
	None of the above?		o
5a	Do you speak Welsh at home?	Yes	o
		No	o
b	Do you speak Welsh at college?	Yes	o
		No	o

6	Is your level of written Welsh:		
		fluent?	o
		Intermediate?	o
		beginner?	o
		None of the above?	o
7a	Do you think mainly in English?	Yes	o
		No	o
b	Do you think mainly in Welsh?	Yes	o
		No	o
8a	Do you dream mainly in Welsh?	Yes	o
		No	o
b	Do you dream mainly in English?	Yes	o
		No	o
9a	Do you take longer to read in English?	Yes	o
		No	o
b	Do you take longer to read in Welsh?	Yes	o
		No	o
10	Do you text/email in Welsh?	Yes	o
		No	o
11	When writing in English do you find yourself translating from Welsh?	Yes	o
		No	o
12a	Do you find you have more errors in your written Welsh?	Yes	o
		No	o
b	Do you find you have more errors in your written English?	Yes	o
		No	o

13a	What kind of errors do you make in written English?		
b	What kind of errors do you make in written Welsh?		
Part 2			
Please could you fill in some details about yourself.			
14	Your age: 20-30 O 31-40 O 41-50 O 51-60 O 61-70 O		
15	Are you: Male O Female O		
16	Which subject and qualification do you hope to gain, e.g. BA. Nursing, BEng (Civil) etc.		
17a	Do you have a qualification in Welsh, e.g. GCSE?	Yes	O
		No	O
	Which qualification?		
b	Do you have a qualification in English, e.g. GCSE?	Yes	O
		No	O
	Which qualification?		
18	Were you taught trough the medium of Welsh at:		
	Nursery		O
	Primary School		O
	Secondary School		O
	College/Further Education		O
	Higher Education		O
	None of the above		O
19	Do you have an assessment of dyslexia?	Yes	O
		No	O

20	When were you assessed	
	Primary School	o
	Secondary School	o
	College/Further Education	o
	Higher Education	o
21	Have you received support for dyslexia at:	
	Primary School	o
	Secondary School	o
	College/Further Education	o
	Higher Education	o
Thank you for taking the time to complete this questionnaire		