

Validation of a Screening Tool for Dyslexia in English among Arabic-Speaking University Students in the Gulf Area

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Abstract: When teaching English for Academic Purposes (EAP) in an English as a Foreign Language (EFL) context, at times, dyslexic students may confound instructors at the lack of improvement in their English language ability. Such students may not have the specialist diagnostic assessment to access support services. A simple but inexpensive measure to screen for dyslexia would facilitate a more inclusive and equitable educational environment. This study examined whether an Arabic-translated version of a widely-used English L1 (first language) dyslexia checklist could identify Arabic L1 students who exhibited difficulties in English. Participants were 734 female EFL undergraduates studying EAP in one gulf university. The participants completed Arabic versions of the checklist. Using prescribed cut off scores, participants were divided into three groups: non-dyslexic, mildly dyslexic, and dyslexic. To validate the checklist, a subsample of 110 students were randomly selected for further assessment of dyslexia using the following indicators: word reading, pseudoword reading, spelling ability, phonological awareness, and rapid automatized naming skills. Results showed significant differences among the three groups for nearly all measures, suggesting that the Arabic translated checklist can be an easily administered, useful screening tool to identify Arabic L1 students who are at-risk of dyslexia in EFL.

Keywords: dyslexia, dyslexia among Arabic EFL students, dyslexia among Arabic-speaking EFL university students, dyslexia screening, screening for dyslexia among Arabic EFL students

1 Introduction

Dyslexia in a first language (L1) affects about 10% of the population, depending on the orthographic system of the language (Nergård-Nilssen and Hulme 2014). However, its incidence can differ among those in higher education (HE). In the United States, Henderson (2001) estimated that the proportion of HE students with dyslexia was approximately 4%. However, Singleton (2004) notes that approximately 40% of dyslexic students are only identified when they enter HE; hence, the percentage of dyslexic learners at university may well be higher. In terms of incidence of dyslexia in a second/additional language, research is limited (Almaazmi 2013). One study in 2007/2008 in the gulf region, where the current study is located, found that 17.6% of female Emirati students entering HE displayed indicators of dyslexia in Arabic and English (Aboudan, Eapen, Bayshak, Al-Mansouri and Al-Shamsi 2011).

Part of the responsibility of tertiary organizations includes needs analysis and support for dyslexic students. However, in such settings, academic staff have been identified as having both a lack of knowledge and understanding of dyslexia (Hanafin, Shevlin, Kenny and McNeela 2007; Cameron and Nunkoosing 2012). Dyslexia diagnosis typically requires expert clinical administration of a complex battery of assessments. This comes at considerable cost, which may act as a barrier to diagnosis and eventual learning support.

The problem is further compounded for second language students as dyslexia can manifest in one or more languages (Smythe, Salter and Everatt 2004; Moore, Lai, Quinonez-Beltran, Wijekumar and Joshi 2023). For instance, Arabic-speaking students learning English as a Foreign Language (EFL) may show signs of dyslexia in English but not in Arabic. This has significance as many non-English L1 countries, including some in the gulf region, educate their students in their L1 up to pre-university but switch to English as the medium of instruction in HE. Hence, students may not encounter difficulties with dyslexia until they enter HE. Moreover, research points to a tendency for instructors to misidentify dyslexic EFL students as having deficits in language competency (Solari, Petscher and Folsom 2014). Geva and Xi (2016) noted that the two can only be differentiated after students have been learning English for five to seven years. In many Arabic-speaking countries, students typically start learning EFL in their first year of formal schooling; hence, by the time they enter HE, they have had at least 12 years of English language study. Therefore, differentiation between dyslexia and deficiency in a foreign language is possible at HE.

At present, we are not aware of formal, systematic screening for dyslexia in EFL available within educational systems in the gulf area. With the incidence of dyslexia affecting a significant proportion of HE students and the noted unpreparedness of academic staff in identifying dyslexia, there is a need for a reliable screening tool as a first response to the issue.

1.1 Dyslexia screening tools

At one gulf university, the forementioned research by Aboudan et al. (2011) involved a pilot study in an attempt to develop an Emirates Dyslexia Indicator Test as a screening instrument in the Arabic and English languages. The Arabic and English language versions of the test each included five indicators, which were letter/word/pseudoword identification, number identification, sequencing memory, mathematical ability and directionality identification. The figure of 17.6% of the participants as dyslexics was based on students who were identified by at least three of these indicators. However, as this was an online screening measure with no follow-up investigations of potentially dyslexic students, the result may have been skewed.

Two commonly used screening tools for dyslexia in English L1 are the Bangor Dyslexic Test (Miles 1997), and the Dyslexia Adult Screening Test (Nicolson and Fawcett 1998) with reliabilities of .72 (Reynolds and Caravolas 2016) and .92, respectively. However, both these measures require administering by

trained assessors, therefore making their large-scale application prohibitive in terms of cost and time.

To counter these limitations of cost and time, this study uses a survey developed by the British Dyslexia Association (BDA) (Smythe and Everatt 2002). This survey is freely available and can be administered easily online. This checklist and adapted versions of it have been used as a dyslexia screening tool in a number of studies for English L1 speakers (Pothos and Kirk 2004; Jones, Brannigan and Kelly 2008; Patel, Magnusson, Lush, Gomez and Fransson 2010; MacFarlane, Albrair, Marshall and Buchanan 2012; Snowling, Dawes, Nash and Hulme 2012) and also for other languages (Hategan, Anamaria, Alas and Moşneag 2015; Stampoltzis, Tsitsou, Plesti and Kalouri 2017).

In Jones et al.'s (2008) study, t-test results showed a significant difference ($p < 0.01$) between dyslexic and non-dyslexic English L1 groups on scores for the BDA checklist, with a large effect size ($d = 2.94$). When translated into Greek, BDA checklist scores were also found to show a significant difference ($p = .001$) between dyslexic and non-dyslexic groups of Greek L1 students (Stampoltzis et al. 2017). However, there is little research in the use of the BDA translated into another language to screen for dyslexia among EFL students and specifically for Arabic L1 EFL students. As mentioned, this represents a significant number of students in HE, where a reliable, easily-administered and cost-effective screening tool for dyslexia in English could be beneficial. Hence, the BDA translated into Arabic and evaluated against key indicators of dyslexia in English formed the basis of our study.

1.2 Dyslexia definition and indicators

In defining dyslexia, we build on Gough and Tunmer's (1986) simple view of reading, in which mastering reading involves decoding and language comprehension. Dymock and Nicholson (2012) explain dyslexia as impacting on decoding. It is characterised by severe and persistent difficulties in word reading, pseudoword reading and spelling (Snowling 2000; Norton, Beach and Gabrieli 2013).

Several underlying deficits appear to be associated with decoding in dyslexia. Of these, the most frequently cited is the phonological deficit hypothesis (Bishop and Snowling 2004). In this theory, decoding and recoding problems manifest in the retrieval and processing of phonemes in words and mapping letters to speech sounds. Measures of phonological awareness (PA) (e.g., pseudoword reading) are the best predictors of reading success (Genesee, Geva, Dressler and Kamil 2006), and a reliable predictor of second language (L2) reading difficulty (Geva and Yaghoub-Zadeh 2006). PA assessment can involve a hierarchy of tasks, requiring differing degrees of awareness (Tremain and Zukowski 1996). For instance, syllable counting is considered a lower-order awareness task because it is easier to manipulate larger separate syllable units than smaller phoneme units, which may also be more arbitrary and not always clearly audible (Anthony, Lonigan, Driscoll, Phillips and Burgess 2003; Anthony and Francis 2005). Additionally, initial and final phonemes in words may be more easily manipulated than those in the middle (Padeliadu, Kotoulas and Botsas 1998).

Another key indicator of dyslexia is rapid automatized naming (RAN) speed (Araújo, Inacio, Francisco, Faisca, Petersson and Reis 2011; Norton and Wolf 2012; Gharaibeh, Sartawi, Dodeen and Alzyoudi 2019). The RAN distinguishes dyslexics from ‘garden variety’ poor readers or readers with other learning disabilities (Wolf and Bowers 1999; Araújo, Reis, Petersson and Faisca 2015) and has been utilised among dyslexics across languages (Kishchak, Ewert, Halczak, Kleka and Szczeciński 2023). RAN deficits have been found among dyslexics in HE (Vukovic, Wilson and Nash 2004; Lindgrén and Laine 2011; Beidas, Khateb and Breznitz 2013). The RAN test involves the rapid naming of a string of familiar visual stimuli (typically letters, numbers, objects and/or colors). Reading and RAN have been theorised to both rely on cognitive processes that are intrinsically related, including attention to visual stimuli, visually recognising and differentiating stimuli information, and accessing and retrieving phonological and orthographic codes (Manis, Seidenberg and Doi 1999; Wolf and Bowers 1999). A meta-analysis of 137 studies on RAN and reading performance by Araújo et al. (2015), found moderate to strong relationships between RAN and reading performance ($r = .43$). In terms of stimuli, RAN alphanumeric items (letters and numbers) had higher correlations with reading performance than non-alphanumeric items (colors and objects). Araújo et al. (2015) suggest that alphanumeric RAN speeds seemed better able to reflect the underlying processing abilities that contribute to word reading performance, including those of dyslexics. Donker, Kroesbergen, Slot, Van Viersen and De Bree (2016) explain that processing of alphanumeric RAN stimuli involves matching stimuli with easily-accessed verbal codes, so mostly rely on phonological processing. However, non-alphanumeric RAN stimuli first need to be processed conceptually for meaning and then associated with corresponding name codes before phonological processing drives an articulated response.

Accordingly, to validate an Arabic translated version of the BDA screening tool, the present study used the forementioned measures of PA, RAN of letters, digits, colors and objects, word and pseudoword reading, and spelling ability. It attempted to answer the research question of whether the BDA survey could reliably distinguish between non-dyslexic, mildly dyslexic and dyslexic Arabic L1 EFL students.

2 Method

2.1 Participants

Prior to the commencement of the study, ethics approval was sought from the university administration. This was followed by obtaining informed consent from the participants who were a cohort of freshman students enrolled in an English for Academic Purposes (EAP) course in one university in the gulf area.

It should be noted that the English entry requirement for this EAP course was a score on the International English Language Testing System (IELTS) exam of 5.0 or above. However, the majority of students entering the university scored an IELTS 5.0 grade. To control for the effects of variability in English language ability, only participants who had obtained an IELTS band 5.0 were included in the study.

This numbered 734 participants, all of whom were female Arabic L1 EFL students. The mean age for the study participants was 18 years and 9 months, ranging from 18 years to 23 years and 8 months.

2.2 Research design and procedure

The first part of the study was the administration of an Arabic-translated version of the BDA survey relating to students' experience of reading and writing in English on all 734 participants. Using scoring scales as specified by the BDA, students were then classified into three groups (non-dyslexic, mildly dyslexic and dyslexic groups). The BDA scoring scale was as follows: a score of less than 45 suggests no dyslexia, while scores above 60 indicate a likelihood of moderate to severe dyslexia (i.e., dyslexic). Scores between 45 and 60 point to a chance of mild dyslexia. See Table 1 for the distribution of participants within these ranges.

Table 1. Breakdown of BDA survey scores ($N = 734$)

BDA Score	N
< 45 (non-dyslexic)	635
45 – 60 (mildly dyslexic)	53
> 60 (dyslexic)	46

In the second part of the study, from each of the three groups, approximately 30 students were randomly selected for further in-depth testing of dyslexia indicators. Details of numbers in each group, corresponding mean age and years of English study are shown in Table 2. Participants in the 3 groups were assessed on dyslexia indicators of PA, RAN of letters and digits, word spelling, word and pseudoword reading ability.

As all participants had fulfilled English language requirements for the EAP course and only students with IELTS scores of band 5 were selected for the study, only factors of age and years of English study were examined to establish equivalence between groups. A one-way ANOVA compared the ages of each of the three groups. The analysis was found to be statistically non-significant, $F(2, 107) = 2.00$, $p = .14$. A similar analysis was conducted on the number of years of learning EFL and no significant differences were found, $F(2, 107) = 0.13$, $p = .88$.

Table 2. Means and standard deviations of age and time spent learning English for the follow-up non-dyslexic, mildly dyslexic and dyslexic groups ($N = 110$)

Group	N	Mean Age (SD) in Years	Time Spent Learning English (SD) in Years
non-dyslexic	37	18.61 (0.60)	12.08 (0.64)
mildly dyslexic	41	18.45 (0.37)	12.07 (0.26)
dyslexic	32	18.84 (1.26)	12.13 (0.42)

2.3 BDA survey

The BDA survey (Smythe, Salter and Everatt 2002) comprises 15 questions exploring common effects of dyslexia in everyday life, such as difficulty understanding text, and confusing visually similar words like 'cat' and 'cot'. Survey respondents choose from a 4-point Likert scale of answers to indicate the impact of these in their lives, generating a score for each question. While all the questions are relevant to indicating likelihood of dyslexia, those that have been shown to have the greatest predictive power are allocated higher scores. The total possible score is 88 points. A score below 45 suggests no dyslexia, while scores above 60 indicate a likelihood of moderate to severe dyslexia. Scores between 45 and 60 point to a chance of mild dyslexia. To make this accessible to our Arabic L1, EFL participants, it was translated into Arabic. This was carried out by a teacher bilingual in Arabic and English. Arabic audio and written translations were produced so that participants would have the option of completing the survey in a delivery mode suited to them. Following this, the online survey was created with the Arabic written version as well as the Arabic audio version uploaded. To establish face validity, the survey was presented to 5 English language teachers (2 teachers who were English L1, Arabic L2 and 3 who were Arabic L1 and English L2) and 10 Arabic-speaking EFL students who were not part of the participant pool. Feedback was gathered in terms of whether they were able to understand the survey questions and if the original English and translated Arabic versions reflected the same content. The finalized Arabic translation of the BDA checklist was found to have reliability (Cronbach's alpha) of .83.

2.4 Follow-up literacy measures

These examined the key indicators of dyslexia including the constructs of PA skills, and RAN of letters, digits, colors and objects. Measures also included those that characterised dyslexia, including word reading and spelling, and pseudoword reading ability. These measures are explained in the following sections.

2.4.1 Test of phonological recoding skills

This test was adapted from the Sutherland Phonological Awareness Test (Neilson 2003), and it evaluated participants' ability to identify and manipulate sounds. The test, conducted orally, comprised six subtests, each comprising four items. The six subtests progressed in level of difficulty, following the hierarchy as specified by Treiman and Zukowski (1996). The first subtest, segmenting syllables, measured participants' ability to state the number of syllables contained within each word. The words ranged from three-syllable words, e.g., 'computer', to five-syllable words, e.g., 'university'. In the second subtest of phoneme blending, participants were read three phonemes separately in the correct consonant, vowel, consonant (CVC) order to make a word, and then asked to say the word they formed together. For example, /f/ - /a:/ - /m/ would make the word 'farm'. The third subtest of phoneme onset identification required participants to correctly identify the initial consonant of a word. These words were CVC pattern (e.g., fish) or CV pattern (e.g., no). Subtest four concerned counting the constituent phonemes in words.

Participants were presented with words containing three to five phonemes, such as 'date' and 'stand' and were asked to state the number of phonemes in each test item. The fifth subtest, phoneme onset deletion, measured participants' ability to delete the initial consonant of a CVC pattern word by pronouncing the word without the initial consonant. For example, the word 'tall' would become 'all'. A test of internal phoneme consonant deletion formed the final subtest. Participants were read CVC words (e.g., skin) or CVCCVC words (e.g., winter) and asked to say the word without a specified internal consonant. For instance, participants were asked to say 'winter' without the 't', which would be 'winner'. The Sutherland Phonological Awareness Test has been used in various research studies to measure PA skills among dyslexics (Eisenmajer, Ross and Pratt 2005; Claessen and Leita0 2012) and has a high reliability, Cronbach's $\alpha = .96$ (Neilson 1998). The maximum score for this test was 24.

2.4.2 RAN test

The Comprehensive Test of Phonological Processing (second edition) (Wagner, Torgesen, Rashotte and Pearson 1999) was used to measure RAN speeds to evaluate reading fluency. It is considered one of the best predictors of dyslexia across all known orthographies (Georgiou, Parrila and Liao 2008; Norton et al. 2012). The test involves tasks that assess and evaluate naming speed of four subtests of colors, digits, letters and objects. In the subtest involving colors, six colors were presented (black, green, blue, red, brown and yellow) in four rows, each containing 9 items. Similar formats occurred in the digits (4, 8, 7, 2, 5 and 3), letters (a, t, s, k, c, and n) and objects (boat, star, pencil, chair, fish and key) subtests. Test-retest reliabilities exceed .80 for all subtests (Haight 2006). Prior to the test, a practice was conducted in which participants were shown the 6 items for each subtest and were asked to name them. Testing started when participants were able to successfully complete the practice. They were instructed to name aloud each item as quickly as they could. The time taken for participants to complete the task as well as the number of errors for each subtest were recorded. The average internal consistency for all subtests was reported by the publishers at .85 (Cronbach's α) or higher.

2.4.3 Test of word spelling

The Wide Range Achievement Test of Spelling - Fourth Edition (Wilkinson and Robertson 2006) was utilized for measuring participants' word spelling ability. It is a standardized test of spelling with 45 common English words, which is frequently included in a battery of assessments for dyslexia (Phillips, Kelly and Symes 2013; Warmington, Stothard and Snowling 2013). The test manual reports a split-half reliability of .97.

2.4.4 Test of word reading

The Graded Word Reading Test (GWRT) (Schonell 1950) was used to establish word reading ability. Participants were presented with 100 context-free words, ordered from easier to more difficult, and asked to read as many words as they could. Testing stopped when participants made 10 consecutive errors. This test has been

recommended for use among dyslexics (Beech and Singleton 1997; Levy and Goldstein 2014). Kiely, Piguet, Christensen, Bennett and Anstey (2011) found a correlation of .91 between the GWRT and the National Adult Reading Test (Nelson 1982).

2.4.5 Test of pseudoword reading

The Bryant Test of Basic Decoding Skills (Bryant 1975) assessed pseudoword reading skills and thus served as a measure of decoding ability. Participants were presented with a list of 50 pseudowords which started with easy three letter combinations, such as “kib”, and moved on to more complex combinations, such as “fute”, and “bufkibber”. It was explained to the participants that these were not real words, and then they were asked to read the words aloud. Testing was stopped following 10 consecutive errors. The test has been used in several research studies in diagnosing dyslexia (Dymock et al. 2012; Blachman 2013; Reid 2016). According to Juel (1988, 1994), the test has Cronbach alpha reliabilities between .90 and .96.

3 Results

The research question for the study asked if the BDA survey was able to distinguish between Arabic L1, English L2 freshmen students who were non-dyslexic, mildly dyslexic or dyslexic in English. To address this question, we compared the students who were classified in each group by the BDA survey according to their scores on follow-up literacy measures. For each follow-up measure, a one-way analysis of variance (ANOVA) was performed to evaluate the relationship among the three groups. Results were examined for significant differences between groups and these are discussed below. Tables 3 to 5 show the means, standard deviations, ANOVA and Tukey post hoc analyses results for all assessments.

Table 3. Means and standard deviations for ANOVA for the measures of spelling of real words, reading of real words and pseudowords ($N = 110$)

Measure	Non-Dyslexic	Mildly Dyslexic	Dyslexic	$F_{(2,107)}$	η^2	Contrasts
Word Spelling	12.38 (3.08)	9.37 (3.20)	7.78 (3.22)	19.10***	.26	ND>MD>D
Word Reading	45.81 (8.44)	28.37 (5.65)	23.56 (5.68)	108.30***	.67	ND>MD>D
Pseudoword Reading	34.43 (7.36)	23.41 (7.66)	15.06 (7.05)	59.99***	.53	ND>MD>D

ND – non-dyslexic group, MD – mildly dyslexic group, D – dyslexic group

*** = $p < .001$ ** = $p < .01$

η^2 - small = .01, medium = .06, large = .14

Table 4. Means and standard deviations for ANOVA for the PA measures ($N = 110$)

Measure	Non-Dyslexic	Mildly Dyslexic	Dyslexic	$F_{(2,107)}$	η^2	Contrasts
Syllable Segmenting	3.19 (.91)	2.93 (1.08)	2.66 (.87)	2.62	.05	ND~MD~D
Phoneme Blending	3.59 (.60)	3.20 (.72)	2.75 (1.14)	8.93**	.14	ND>MD>D
Phoneme Onset Identification	3.19 (.94)	2.83 (1.05)	2.31 (1.12)	6.20**	.10	ND>MD,D
Phoneme Segmenting	2.92 (.86)	1.66 (.83)	1.38 (.87)	33.51**	.39	ND>MD,D
Phoneme Onset Deletion	3.49 (.77)	1.46 (1.27)	1.44 (1.08)	44.82**	.46	ND>MD,D
Internal Phoneme Consonant Deletion	3.30 (.62)	1.39 (1.22)	.53 (.62)	88.47**	.62	ND>MD>D
Total	19.68 (2.27)	13.46 (3.44)	11.06 (3.04)	79.30**	.60	ND>MD>D

ND – non-dyslexic group, MD – mildly dyslexic group, D – dyslexic group

*** = $p < .001$ ** = $p < .01$

η^2 - small = .01, medium = .06, large = .14

Table 5. Means and standard deviations for ANOVA for the RAN measures ($N = 110$)

Measure	Non-Dyslexic	Mildly Dyslexic	Dyslexic	$F_{(2,107)}$	η^2	Contrasts
Speed (sec)						
Letters	14.98 (2.17)	17.22 (2.95)	20.15 (4.59)	21.02**	.28	ND>MD>D
Digits	15.00 (2.18)	16.96 (2.96)	19.37 (4.14)	16.69**	.24	ND>MD>D
Colors	28.84 (4.70)	31.90 (5.07)	35.19 (5.86)	12.86**	.19	ND>MD>D
Objects	29.32 (5.83)	32.90 (5.10)	35.86 (7.83)	9.55**	.15	ND>MD>D
Errors						
Letters	.11 (.35)	.22 (.48)	.22 (.49)	.74	.01	ND~MD~D
Digits	.08 (.36)	.02 (.16)	.03 (.18)	.59	.01	ND~MD~D
Colors	.00 (.00)	.12 (.33)	.16 (.39)	3.00	.05	ND~MD~D
Objects	.08 (.36)	.07 (.35)	.06 (.35)	.02	.00	ND~MD~D

ND – non-dyslexic group, MD – mildly dyslexic group, D – dyslexic group

*** = $p < .001$ ** = $p < .01$

η^2 - small = .01, medium = .06, large = .14

3.1 Follow up literacy measures

3.1.1 Spelling and reading measures

As seen in Table 3, there was a significant difference among the groups in word spelling ($F(2,107) = 19.10, p < .001, \eta^2 = .26$), word reading ($F(2,107) = 108.30, p < .001, \eta^2 = .67$), and pseudoword reading ($F(2,107) = 59.99, p < .001, \eta^2 = .53$). Follow up contrasts showed that the non-dyslexic group outperformed the mildly dyslexic group and the mildly dyslexic group outperformed the dyslexic group for all reading and spelling measures. The effect sizes were large.

3.1.2 PA measures

There was a significant difference among the three groups for all the PA measures except the syllable segmenting task (see Table 4). Follow up contrasts showed that the non-dyslexic students outperformed the mildly dyslexic and dyslexic students for blending phonemes ($F(2,107) = 8.93, p < .01, \eta^2 = .14$), for internal phoneme consonant deletion ($F(2,107) = 88.47, p < .01, \eta^2 = .62$), and for total scores ($F(2,107) = 79.30, p < .01, \eta^2 = .60$). The non-dyslexic students outperformed the dyslexic students for phoneme onset identification ($F(2,107) = 6.20, p < .01, \eta^2 = .10$) but there was no difference between the non-dyslexic and mildly dyslexic students for that measure. For phoneme segmentation ($F(2,107) = 33.51, p < .01, \eta^2 = .39$) and phoneme onset deletion ($F(2,107) = 44.82, p < .01, \eta^2 = .46$), the non-dyslexic students outperformed the mildly dyslexic and dyslexic students but there was no difference between the mildly dyslexic and dyslexic groups. The effect sizes were small for syllable segmenting, moderate for phoneme onset identification, and large for all the other measures.

3.1.3 RAN measures

There was a significant difference among the three groups for all the RAN measures in terms of time taken to identify letters ($F(2,107) = 21.02, p < .01, \eta^2 = .28$), digits ($F(2,107) = 16.69, p < .01, \eta^2 = .24$), colors ($F(2,107) = 12.86, p < .01, \eta^2 = .19$) and objects ($F(2,107) = 9.55, p < .01, \eta^2 = .15$), as illustrated in Table 5. Follow up contrasts showed that the non-dyslexic group outperformed the mildly dyslexic group and the mildly dyslexic group outperformed the dyslexic group. The effect sizes were large. In contrast, there was no significant difference among the groups in terms of errors made in each of the RAN measures.

4 Discussion

The present study used the BDA survey to classify Arabic L1 female students in an EAP course into groups who were likely to be non-dyslexics, mild dyslexics and dyslexics. To validate this survey, we conducted further diagnostic testing among samples of the three groups using measures that were key indicators of dyslexia.

These were PA, RAN, word and pseudoword reading ability and spelling ability. Results showed that the non-dyslexic group performed significantly better in all measures than the dyslexic group with the mild dyslexics placed in between the former two groups. There were no significant differences between groups in mean age and time spent learning EFL. For the latter, all participants had spent at least 12 years in EFL study, thus crossing the threshold of 5 to 7 years after which language proficiency issues may be differentiated from issues with dyslexia (Geva et al. 2016). Additionally, they had all met the university's English language entry requirement of IELTS 5. This adds to the case that the dyslexic group was indeed reading disabled as opposed to having issues with uptake and language proficiency in an EFL context.

The findings of the study add to the literature, particularly in reference to the study by Aboudan et al. (2011) among Arabic-speaking EFL students, which found approximately 17% of students in HE to be dyslexic. While that study was limited to online screening, the present study compared non-dyslexics with dyslexics in examining participants in skills related to PA, RAN, word spelling and reading, and pseudoword reading. The BDA survey was able to identify dyslexia among Arabic L1 females in an EFL environment.

The findings also add to the literature in that prior to this, the BDA survey has been used largely among English L1 students to screen for dyslexia in English (Pothos et al. 2004; Jones et al. 2008; Patel et al. 2010; MacFarlane et al. 2012; Snowling et al. 2012). A small number of studies have used the BDA survey translated into other languages to identify dyslexia in those languages (Hategan et al. 2015; Stampoltzis et al. 2017). However, the present study was the first instance of the BDA being used as a screening tool translated into Arabic for Arabic L1 EAP students who were potentially dyslexic in EFL. As mentioned, Arabic L1, EFL/ESL students represent a large number of students engaged in HE in the gulf as well as part of the international student cohort in tertiary institutions in English L1 countries. The Arabic translated version of the BDA screening tool could potentially be used to identify HE at risk for dyslexia in EFL and who may need additional reading support in English.

Turning to the PA result, a cumulative total score of all tasks showed that the non-dyslexic group had significantly better PA compared to the mildly dyslexic group which had better PA than the dyslexic group. This adds to the validity of the BDA in identifying those groups. The 6 PA tasks represented a progressive order of difficulty, commencing with the first task based on syllabic level awareness and the remaining 5 tasks at the phoneme level. This was consistent with Anthony et al.'s (2003) hierarchy of PA skill development.

The single syllabic segmentation task was not able to discriminate between the groups, even though raw scores followed a similar trend as the cumulative total scores for this measure. The result could be due to syllable counting being lower in the hierarchy of PA development compared to the more complex and demanding phoneme identification and manipulation tasks (Tremain & Zukowski 1996; Anthony et al. 2003; Anthony et al. 2005). Future research could include items with

a greater number of syllables to be tested or replace this task with higher-order tasks at the phoneme segmentation and manipulation level.

For the remaining five tasks, it was expected that discrimination among groups would be finer as tasks progressed from measuring the lower-order to higher-order PA skill levels detailed by Anthony et al. (2003) and Padeliadu et al. (1998). This was the case for four of the tasks. However, the lowest order task involving phoneme blending had similar discriminatory power as the highest order task, i.e., the one involving manipulating an internal phoneme. A possible explanation for this is that the non-dyslexic group may have had greater familiarity with the lexical items in the lower-order phoneme blending task and thus were better able to retrieve the words from their mental lexicon compared to their mildly dyslexic counterparts who were in turn better able to access lexical items than those in the dyslexic group. Additionally, as explained by Anthony et al. (2003), phonological skill development does not necessarily occur in a strictly linear progression and this could impact on participants' performance on tasks of varying difficulty.

Looking at the RAN result, the non-dyslexic group performed significantly better than the mild dyslexics and these two groups performed significantly better than the dyslexic group. This was in line with other studies that point to RAN deficits being key indicators of dyslexia in general populations (McBride-Chang and Manis 1996; Araújo et al. 2011; Norton et al. 2012; Gharaibeh et al. 2019) as well as among HE students (Vukovic et al. 2004; Lindgrén et al. 2011; Beidas et al. 2013). Additionally, because the dyslexic group had significantly slower naming speeds in all four visual stimuli, this finding could confirm that they were distinct from other garden variety poor readers or readers with other learning disabilities, as suggested by Araújo et al. (2015). The result of this study could also indicate that the relationship between RAN and reading performance among EFL students is similar to that among L1 populations. This could be because RAN and reading rely on cognitive processes that are closely related, including focus on visual stimuli in the RAN test, differentiating this information from other known stimuli and mapping this to pre-existing phonological and orthographic knowledge (Manis et al. 1999; Wolf and Bowers 1999).

In this study, RAN alphanumeric speeds were faster compared to non-alphanumeric stimuli, which is consistent with other studies (Vukovic et al. 2004). It should be borne in mind that because the participants in this study were EFL students, additional levels of processing might have been required over and above that for an English L1 participant. Further research could explore the nature of the additional processing load and its impact on the time lag between alphanumeric and non-alphanumeric RAN speeds.

The results of PA and RAN ability parallel the reading and spelling results among the three groups identified from the BDA scores. The dyslexic group that showed the lowest overall PA and RAN abilities also displayed the least ability in word and pseudoword reading and spelling. The converse was true for the non-dyslexic group, with the mildly dyslexic group placed in between.

The study has strong educational implications. For the significant number of potentially dyslexic Arabic L1 students in English instruction medium HE institutions, the lack of formal diagnosis and support could present a severe academic disadvantage. Additionally, funding for clinical diagnosis may not always be accessible, while the lack of knowledge and understanding of this learning disability among academic staff further compounds the issue (Hanafin et al. 2007; Cameron et al. 2012). A cost-effective tool such as the Arabic translated BDA survey, easily administered to all students entering HE may be able to identify those who may need additional support. Alternatively, academic staff hesitant to subjectively identify students as dyslexic may find confidence in the administration of the BDA screening tool. Further in-depth testing could be part of a clinical diagnosis carried out on students identified as most at risk of dyslexia. This would allow such students to access support systems for issues identified by Pino and Mortari (2014) and thus hopefully experience greater academic success.

5 Limitations and conclusion

There were several limitations in this study. Firstly, the sample participants were only female students. Hence, the results may not be generalizable across genders. Additionally, clinical diagnosis of dyslexia was not carried out. Although factors identified as strong indicators of dyslexia, such as PA and RAN, were evaluated and found to show significant relationships with the scores of the Arabic version of the BDA, diagnosis of dyslexia by qualified medical professionals would have further validated the screening tool. Future research could undertake this. Another possible limitation was that because the BDA survey was an online self-report tool, it was difficult to determine if participants' responses were truly reflective of their reality. Nevertheless, in this study, the Arabic-translated version of the BDA screening tool was found to effectively identify undergraduate Arabic L1 students at risk of dyslexia in an EFL context. Students who were identified by the screening tool as dyslexic and mildly dyslexic had reduced PA and RAN speeds and corresponding reading, and spelling difficulties in English. These students would benefit from greater academic support beyond learning EFL. A more widespread use of this tool would serve to further validate its predictive ability.

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