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Phonological Abilities of Children with Dyslexia in Jordan: A Whole-Word Approach

Anas Huneety[a*], Nedaa Khashashneh[b], Bassil Mashaqba[c], Mohammed Nour Abu Guba[d], Abdallah Alshdaifat[e]

[a] *Department of English Language and Literature, Faculty of Arts, The Hashemite University, Zarqa, Jordan. Email: anasi@hu.edu.jo*

[b] *Department of English Language and Literature, Faculty of Arts, The Hashemite University, Zarqa, Jordan. Email: nedaakh94@gmail.com*

[c] *Department of English Language and Literature, Faculty of Arts, The Hashemite University, Zarqa, Jordan. Email: b_mashaqba@hu.edu.jo*

[d] *Sharjah University. Email: mabu-Gub@sharjah.ac.ae*

[e] *Mohammed Bin Zayed University for Humanities: Abu Dhabi, UAE. Email: abdallah.alshdaifat@mbzuh.ac.ae*

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Abstract
Dyslexia is a learning disability mostly evident in inaccurately recognizing a word, mainly because of the deficit of the phonological components of a language. This research aimed to investigate the phonological abilities of Jordanian Arabic (JA) speaking children with and without dyslexia using whole-word measures. Data from Jordanian dyslexic children were compared between three reading groups (poor readers, typical readers, and advanced readers) through three tests: (i) phonological mean length of utterance (pMLU), (ii) the Percentage of Consonant Correct (PCC) and (iii) the Proportion of Whole-Word Proximity (PWP). Findings show that the typical and the advanced readers had a relative score in pMLU, PWP and PCC, which were significantly higher than those registered by dyslexic and poor readers. Additionally, three phonological processes were found in Jordanian dyslexic children's readings: omission, substitution, and metathesis. Omission was the most frequent process employed by Jordanian dyslexics, particularly in di- and polysyllabic nonsense words. The study concludes that whole-word measures can reflect the phonological abilities of children using both real and nonsense words.

Keywords: Dyslexic Children, Jordanian Arabic, Language Acquisition, Reading Abilities, Whole-Word Measures.

Introduction

Dyslexia is popularly known as a disconnection syndrome, a functional abnormality and a neurobiological glitch that causes a specific learning disability, such as the inaccuracy in recognizing a word. It is caused due to some kind of malfunctioning in the brain, which fluctuates abnormally weakening the phonological processing. This fluctuation causes a phonological deficit making it difficult to process the

*Corresponding Author
Email: anasi@hu.edu.jo
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linguistic sounds or acquiring phonetic spelling. Such a deficit of the phonological components of a language leads to reading difficulty (International Dyslexia Association, 2018).

Anatomically, dyslexics rely on the right hemisphere and frontal lobe than the left one (Richlan et al., 2010). The right region of the brain (which handles spatial activities like music and art) is over-activated, while the left brain (in charge of language; reading ultimately) is under-activated. The inactivity of the Parieto-temporal region, which is responsible for word analysis, and the Occipito-temporal area, which is responsible for word form and the recognition of the word, in the left side of the brain, causes a neurobiological glitch (Richlan et al., 2010). This "neurobiological disability" explains reading and spelling impediments that dyslexics have, which results from the lack of the phonological building blocks of a given language (Kovelman, Christodoulou, & Gabrieli, 2012) as evident in Figure 1.

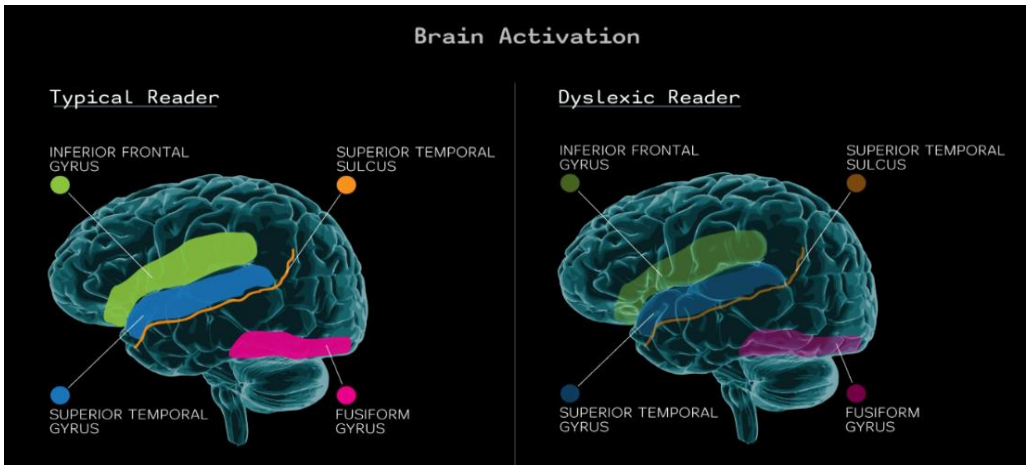

Figure 1: *A Comparison Between Typical Brain and Dyslexic Brain (Peretić,2021).*

A phonological deficit is a deficiency in processing the linguistic sounds that are crucial in learning or acquiring phonetic spelling (sounds that correspond to letters, like in English and Arabic) or the phonetic symbols (sounds that correspond to symbols such as Chinese and Japanese) (Perfetti, Van Dyke, & Hart, 2001). Peterson and Pennington (2015) treat dyslexia as a disconnection syndrome, arguing that there is a functional abnormality in the front and inferior parts of the brain. They claim that because some parts of the brain fluctuate and do not function well, phonological deficit occurs. Thus, dyslexia manifests itself among individuals who experience learning difficulty in accessing the sounds of their primary language (Shaywitz & Shaywitz, 2005).

Dyslexics also face severe learning problems in languages with less consistency between letter and sound like English compared to consistent languages like Italian or Finnish (Landerl et al., 2013). Thus, beginner readers of Italian, Spanish and Greek show few difficulties compared to English and French language readers since the latter has low transparency between the written symbol and its sound (Wimmer & Mayringer, 2002). It has also been reported that poor readers of all general levels typically have a poor ability in phonological processing. Thus, diagnosing someone with dyslexia requires clinical judgment and not a quantifiable test course. One reason for why it is hard to diagnose this disorder is its unclear phonological picture. For instance, it has been argued that the misrepresentation of phonology (Elbro & Jensen, 2005), poor awareness of phonology (Muter et al., 2004), shabbiness in processing phonology (Vellutino et al., 2004), or short-term phonological memory (Kamhi & Catts, 1986) are causes of the learning disorder. Although the phonological deficit is the reason, its exact nature is still indefinite.

Miles et al. (2006) states that although several studies tackle dyslexia from a linguistic standpoint, these studies have dealt with monolingual English speakers of America, Canada and Britain. He notes that although dyslexia corresponds among languages differently, the assumption of the dyslexic nature is based on the linguistic features of the English language. The phonological analysis of dyslexia differs according to the phonological component of each language (Miles et al., 2006). Everatt et al. (2004) note that although dyslexia is recognized worldwide, few studies are conducted on dyslexic individuals in correlation with the phonological aspects of a given language.

Only few studies have dealt with dyslexic readers of Arabic. Treating Jordanians who have been diagnosed with dyslexia with an international view of the disorder is unfair. Children have the right to learn and learning to read by decoding letters is the basic process of a bigger picture. According to the Working Party of the Division of Educational and Child Psychology of the British Psychological Society (1999), "entitlement to literacy is considered a basic human right and so reflects the central role of reading and writing in all societies". This means that the evaluation process and the remedial curriculum plan for children at risk of dyslexia will be negatively affected. Therefore, the current study aimed to fill in a gap in the literature by offering a new tool for analyzing the phonological abilities of JADC, which might help to support the argument that dyslexia differs across languages.

To that end, different tools have been used to diagnose and evaluate Jordanian dyslexics, including (i) the Phonological Mean Length of Utterance (pMLU), (ii) the Percentage Consonant Correct (PCC), and (iii) the Proportion of Whole-Word Proximity (PWP). A comparison between JADC and poor, typical, and advanced Jordanian readers is made via the three phonological measures to provide a clear image of the phonological abilities of JADC. The study hypothesizes that Dyslexic children have poor reading abilities compared to those of Advanced and Typical readers. Additionally, since reading is a basic human right and a fundamental element of individual achievements, the objective of the present study is to investigate and track the speech of Jordanian Arabic dyslexic children (JADC) by analyzing the phonological aspects that aim to draw a close image of the most common and repetitive errors.

Theoretical Background

There are several available standardized tests on other languages that assess dyslexia, yet most of them have the Western linguistic features basis (in particular English-speaking countries) and their cultural aspects (Elbeheri et al., 2006). These standardized tests for English-speaking community do not fit Arabic-speaking individuals for many reasons, including the cultural gap between Arabic and English during the translation process and the diacritic system that is used in the Arabic language but not in English (Elbeheri et al., 2006). Alsheikh et al. (2022) found that having a cultural background can help interpret and comprehend a given text. Saaristo-Helin, Kunnari, and Savinainen-Makkonen (2011) argue that experts must reset these tests to suit the phonological deficit of each language.

Ingram and Ingram (2001) offered a new tool for assessing the development of children's phonological skills based on whole-word complexity and is referred to as 'the phonological mean length of utterance' (pMLU). They argue that the pMLU is a robust tool that analyzes the words and their production. The pMLU works by giving one point for each segment of the word and another point for each correct consonant in its right position. For example, if the actual production of the target word 'ski' /skī/ is [kī], then the pMLU score of the target word is 5, while the child's production is 3 (Bunta et al., 2009).

Ingram (2002) emphasizes the need for developing the pMLU measure for each language since each language has its linguistic codes. The following rules are proposed for counting whole-word measures: (a) Each segment in the word is awarded one point; (b) One point is further given to correct consonants; (c) Only consonants used in the right position are correct (positional rule). This is to exclude cases of metathesis and substitution that are common in the language of dyslexics; and (d) Geminates are contrastive units, and they are regarded as two units. This is because failure to produce a geminate, as a singleton for example, would lead to communication breakdown.

To show the applicability of pMLU in Arabic, an example can be cited of the target word /kat.tab/ 'to cause someone to write', and a hypothetical production [tab]. This example does not reflect children's word production in this study. The pMLU of the target word is 10; one point for the six segments of the word and 4 points for the correct consonants. The pMLU of the hypothetical example is 5; 3 points for the three segments and another 2 points for the two correct consonants. In addition to the pMLU, Ingram (2002) also introduces Proportion of Whole-Word Proximity (PWP) and Percentage of Consonant Correct (PCC). PWP measures the percentage of word accuracy (Ingram, 2002). PWP is calculated by dividing the pMLU scores of the target words by the child's pMLU. Thus, if the pMLU score of the target word is 8 and that of the child word is 4, then the PWP is 0.5. Likewise, if a child produced 60 correct consonants out of 90, then the PCC would be 66.6. The PCC measure calculates the number of completely correct words within a given sample. A perfectly articulated form without errors is assigned one point, whereas an incorrect form is given zero points. For example, if a child accurately produces 30 words out of 100 without any errors, the PCC would be 30%.

Therefore, with the view to measure the whole-word, this study used the segmental measure (PCC), which is used in the assessment of children's consonantal profile by counting the number of correct consonants and then dividing it by the total number of consonants. This is consistent with Amayreh and Dyson (1998) and some studies that have focused on the production of syllable and stress in typically developing (TD) children. These studies have recommended that dyslexic children's phonological abilities can be assessed using some articulation tests that focused on the correctness of segments, as in the case of PCC in this study.

Literature Review

This section presents a critical review of studies on Arabic dyslexic children, followed by reviewing studies on dyslexia across languages.

- *Studies on Dyslexic Arabic-Speaking Children*

Various studies have examined the language profile of Dyslexic Arabic-Speaking Children. Abu-Rabia and Abu-Rahmoun (2012) investigated the phonology and morphology of 27 dyslexic Arabic-speaking children. One

hundred sixteen participants from grades 6 and 8 were tested, and 27 were diagnosed as dyslexic readers. The study analyzes only the vowelized and non-vowelized Arabic words. It finds that their reading skill in performing the vowelized words with the assistance of the morphological root is better than in the non-vowelized words. Elbeheri et al. (2006) examined the profile of monolingual Egyptian dyslexic children. The researcher tested many children from the fourth and fifth grades from three schools in Egypt and then identified three dyslexic children and compared their performance to their age-matching peers. The study found that the dyslexic group experienced phonological defects, particularly phonemic awareness, and phoneme deletion. The study emphasized the need to test phonological processing to identify dyslexic children.One investigation was conducted on the developmental letter position in Palestinian dyslexics (Friedmann & Haddad-Hanna, 2014). Data were taken from 12 Palestinian dyslexics aged 10 to 17.5 years (average 12.1 years). Children were given 207 real words, 27 non-words, and 23-word pairs to read loudly. The study found that most of the errors involved moving the letters within the words. Moreover, Palestinian dyslexics tended to migrate letters from their middle position, e.g., /ta.mah.hal/ as /ta.ham.mal/ 'to slow down' in a process called metathesis. They explained that this error occurred because the letter form is determined and affected by the letter position (ligation). Migration of letters within words also occurred in other languages, such as English, Italian, and Hebrew, of diagnosed dyslexics (Friedmann & Haddad-Hanna, 2014). Moreover, the researchers proved that Palestinian dyslexics (who speak vernacular Arabic) made migration errors because Standard Arabic (SA) is viewed as a second language. They claim that Palestinian dyslexics are exposed to SA marginally in prayers, Arabic classes at school, and some TV shows. Another explanation of changing the letter position by Palestinian dyslectics is the reliance on the sub-lexical route instead of the lexical route, which needs more time to produce the word.

Recently, Al-Natour, Al-Mashayek, and Alkhamra (2022) investigated reading errors among Arabic dyslexic readers based on the dual-route model. Data came from two groups: 40 dyslexic participants (including 6 participants diagnosed with surface dyslexia, four with phonological dyslexia, 5 with deep dyslexia, and 25 unidentified dyslexic cases). Analysis of data explored those readers with surface dyslexia had visual errors in word recognition, and the readers with phonological dyslexia did phonological errors, including deletion, substitution, and segment addition.

- *Dyslexia Across Languages*

Comparing studies on dyslexia in Arabic and English language studies from a phonological perspective, Arabic is found significantly modest and not in enough depth. Several relevant studies have been devoted to the phonological aspects of English dyslexic children (Komesidou et al., 2022). Mugford (2002) investigates the production of /s/-obstruent clusters by English dyslexic children. Findings show that the performance of the control group outperformed the dyslexic children, although they were twice as old. Their performance in a consonant cluster comprised of /s/ plus a consonant was worse than on an obstruent-approximate cluster because of its underlying presentation nature. Most of the errors by dyslexics were in longer nonsense words (two syllables) than in shorter real words (one syllable).

Appiah, Appiah-Kubi, and Boe-Doe (2023) analyzes the linguistic nature of errors made by 54 senior dyslexic students reading unfamiliar words. They were asked to encode unfamiliar words given by Achieve program test (as an assessment reading program). Results found that errors by dyslexics are phonetically based and mainly result from poor awareness as well as poor spelling rules. Substitution and deletion were noticed in multisyllabic words. For instance, most participants misspelled the word 'psychiatrist', where the first syllable psy- was substituted by phy. Stanley (2020) analyzes the repetition of English nonwords errors based on the phonological processing of children with dyslexia. Sixteen non-English words of (CVC) pattern were given to 75 dyslexic children. Words with a consonant error were classified into phonological processes such as substitutions, omissions, insertions, and transpositions. Errors were observed exclusively in omissions, with no apparent weaknesses in other aspects.

Several studies have thus compared English dyslexic speakers with other languages. For instance, Komesidou et al. (2022) and Stanley (2020) compare dyslexia in Arabic and English languages from a phonological perspective. Andreou and Baseki (2012) compare the occurrence of the number of errors by dyslexics in Greek and English. The results show that the difference between the two languages in spelling errors is not remarkable. However, more phonological errors are made in English since its sounds are less transparent to the letters, than in any other language. The existing literature on Arabic and English phonology have presented dyslexics tend to have a weakness in the phonological component of language. Hence, there is a dearth of studies analyzing the performance of JADC phonologically.

The present study aimed to fill in a gap by taking a representative sample of dyslexic children and analyzing their language phonologically. A new tool was used for assessing children's phonological abilities using Ingram's whole-word model with some adaptations. Besides, three measures—pMLU, PWP, and PCC—were employed to assess the phonological abilities among the four groups and to report any differences between them. Following Ingram (2002) suggestion that the applicability and validity of whole-word measures differ from one language to another, the study also tested whether the three measures were

reliable tools for evaluating children's phonological abilities in four groups: dyslexic children, poor readers, typical readers, and advanced readers.

Methods and Materials

- *Sampling and Research Setting*

The sample of the study comprised four groups of Jordanian dyslexic children. Group one comprised six children, aged between 9 and 10 years old, diagnosed with dyslexia by a trained speech pathologist. These dyslexic children were from a center in Amman. Group two comprised another six participants with poor reading abilities, aged between 8 and 9 years old. Group three comprised six typical Jordanian readers, aged between 8 years and 9 years old. Group four consisted of six advanced Jordanian readers, all aged 8 years old. Non-dyslexics were from two different schools in Amman in the same area. They were guaranteed by their school's medical record that they did not have any neurological impairment or visual or auditory issues. To guarantee confidentiality, fake names were used to refer to the participants.

All data was recorded in a quiet room in the center on individual basis. The difficulty of their reading ability was decided by their teachers: those who scored below 50% in the reading task were considered poor readers, 50-87% were the typical, while 88% or more were advanced readers. The reason behind choosing a younger stage level was that the performance of children with speech disorders equals children at a younger age (Ingram, 2002). Both teachers and speech pathologists noted that group one and group two reading disability varied from severe, medium to shallow difficulty. A consent form was prepared, and it was signed by both parents and teachers. The ethical approval ensured their parents that data would be deleted after conducting this research and that it would not be shared with anybody else.

- *Data Collection*

Following the lexical-size rule (Ingram & Ingram, 2001), which states that a minimum sample size of 25 words and preferably of 50 words, should be chosen from each participant. However, each of the four groups was given a list of 70 words to read loudly. The words in the list were of two types: 31 real words and 39 nonsense words, which ranged from monosyllabic, disyllabic, and multisyllabic. Fifteen nonsense words were given to the four groups through a list, and the other fifty-five words and nonsense words were divided into three short paragraphs. The paragraphs were a combination of real words and nonsense words to add more credibility in measuring their production. Nonsense words were created by changing or substituting at least one of the letters of a real word. Some nonsense words were randomly created with no phonological similarity. Nonsense words were used because dyslexics can read well what they have learned (Cavalli et al., 2017). The ability to read nonsense (novel) words was significant because this necessitated dyslexic readers to apply reading knowledge rather than memory (Shaywitz & Shaywitz, 2005).

- *Data Analysis*

For the purpose of analysis, both real and nonsense word types were mingled within the data to have more reliable results while measuring their production. Data was recorded using a USB Desktop microphone (Sensitivity: -67 dBV/ pBar, -47 dBV/ Pascal +/ -4 Db), (Frequency response: 100-16 KHz). The microphone was kept 15 cm away from the mouth of readers. Data then was saved on the researcher's laptop. The researchers equally transcribed the data. The nonsense words were transcribed according to the pronunciation of the first two authors. Counting rules of Ingram (2002) as mentioned above were followed.

To ensure the reliability of the transcriptions, 25% of the corpus was randomly selected and transcribed by two language consultants who were specialized in Arabic. Transcriptions were compared and agreement between analyzers was 91% and 94%, with an average of 92.2%. Cases of disagreement were double-checked, and an agreement was finally reached. However, the analysis of samples taken from the four groups showed some variations. Statistical analysis was conducted to report any significant differences in the scores of pMLU, PWP and PCC.

Results

- *Pmlu Results*

A slight variance was observed in children's pMLU scores across the four groups. Table 1 gives the means and the Standard Deviations of children's pMLU across the four groups (Dyslexics, Poor Readers, Typical Readers, and Advanced Readers.

Table 1*: Means & Standard Deviations of Children's pMLU Across the four Groups.*

Group	Mean	Std. Deviation
Dyslexics	9.30	1.05
Poor readers	10.10	1.01
Typical readers	11.22	0.19
Advanced readers	12.00	0.21
Total	10.65	1.26

The highest pMLU mean score recorded by advanced readers groups is 12.0 (SD=0.21), with scores ranging between 11.3 and 13.1. Typical readers recorded a slight decrease in pMLU score 11.22 (SD=0.19), with scores ranging between 10.9 and 11.6. Both poor readers and dyslexic readers recorded very close pMLU scores. The dyslexics' mean score was 9.3 (SD=1.05), just slightly lower than that of the poor readers with 10.1(SD=0.01).

A one-way ANOVA test was conducted to test the statistical significance of these differences and to report any statistically significant differences in pMLU scores. As Table 2 shows, there were significant differences between the means of children's pMLU across the groups.

Table 2*: One Way ANOVA Analysis of the four Groups.*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.611	3	8.537	15.398	0.00*
Within Groups	11.088	20	.554		
Total	36.700	23			

Pairwise multiple comparisons post hoc test using (LSD) method was further conducted to compare the pairs of means. As can be seen in Table 3 below, significant statistical differences were found in the means of children's PMLU according to the group. That is, the advanced readers group and typical readers group performed significantly higher than the poor and dyslexic readers' groups. No significant differences were reported between poor and dyslexic readers in the use of pMLU.

Table 3: *Results of Pairwise Multiple Comparisons Post Hoc Test.*

Group	Mean	Dyslexics	Poor readers	Typical readers	Advanced readers
Dyslexics	9.30	-		*P value* 0.00* 1.92*	*P value* 0.00* 2.70*
Poor readers	10.10		-	*P value* 0.017* 1.12*	*P value* 0.00* 1.90*
Typical readers	11.22			-	
Advanced readers	12.00				-

- *PWP Statistical Results*

Analysis of the PWP scores showed some variation across the four groups. Table 4 summarizes the mean scores of PWP of the four groups.

Table 4*: Means & Standard Deviations of PWP Due to the four Groups.*

Group	Mean	Std. Deviation
Dyslexics	0.68	0.099
Poor readers	0.73	0.075
Typical readers	0.84	0.006
Advanced readers	0.92	0.008
Total	0.79	0.112

The advanced readers group did quite well, where their reading accuracy score reached 92% (SD=0.008). One of the participants scored 98%, and the lowest score was 90.1. Next comes the typical readers' group with a mean proximity score of 84% (SD=0.006). Scores ranged between 81% and 86%. Both groups scored very high, which shows their mastery of the reading skill. PWP scores of poor readers and dyslexic readers were relatively low. Where Jordanian dyslexics scored 68% (SD=0.099), poor readers scored slightly above the first group with a 5% difference in an overall average of 73% (SD=0.075).

It is worth mentioning that dyslexic scores ranged between 50% and 73%. It is important to make a distinction between children with severe dyslexia whose mean PWP score was 55%, with scores ranging between 47% and 55%. On the other hand, children with mild dyslexia performed better, achieving scores ranging between 70% and 78%.

An ANOVA test was carried out to find any statistically significant differences across the four groups in PWP means. As shown in Table 5, significant differences were observed between the means of PWP across the four groups.

Table 5: *One Way ANOVA Results of the PWP for the for Groups.*

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.213	3	0.071	18.275	0.00*
Within Groups	0.078	20	0.004		
Total	0.29	23			

Pairwise, multiple comparisons post hoc test using (LSD) method was conducted as in the Table 6 to see whether there is any significance between the four groups.

Table 6: *Multiple Comparisons Post Hoc Test Using LSD Method Among the Groups.*

Group	Mean	Dyslexics	Poor readers	Typical readers	Advanced readers
Dyslexics	0.68	-		*P value* 0.00* 0.163*	*P value* 0.00* 0.239*
Poor readers	0.73		-	*P value* 0.004* 0.115*	*P value* 0.00* 0.191*
Typical readers	0.84			-	
Advanced readers	0.92			*P value* 0.047* 0.076*	-

Table 6 indicates that there are statistically significant differences in the means of PWP across the groups in favor of advanced readers as compared to dyslexics, poor readers, and typical readers. It also shows that there are statistically significant differences in the means of PWP due to the group in favor of typical readers compared to dyslexics and poor readers.

- *PCC Statistical Results*

Both advanced readers and typical readers performed very well in the PCC, scoring 80.33% (SD=1.03) and 70% (SD=0.89) respectively. PCC scores of advanced readers fluctuated between 79% and 87%, whereas those of typical readers ranged between 67% and 71%. The performance of dyslexic readers and poor readers was not satisfying; the former's scores ranged between 30% and 58%, with a mean score of 41.8 (SD=12.61), whereas the latter's scores ranged between 41% and 58%, with a mean PCC of 48.5 (SD=10.13). Among the dyslexic group, children with severe dyslexia scored very low, i.e., between 26% and 30%, while the scores of children with mild dyslexia were between 45% and 58% .as evident in Table 7.

Table 7*: Means & Standard Deviations of PCC Of The four Groups.*

Group	Mean	Std. Deviation
Dyslexics	41.83	12.61
Poor readers	48.50	10.13
Typical readers	70.00	0.89
Advanced readers	80.33	1.03
Total	60.17	17.66

ANOVA was used to see whether there were statistically significant differences in these means. Results are shown in Table 8.

Table 8*: One Way ANOVA results.*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5853.67	3	1951.22	29.62	0.00*
Within Groups	1317.67	20	65.88		
Total	7171.33	23			

As seen in Table 9, there were significant differences between the means of PCC across the four groups. A pairwise, multiple comparisons post hoc test using the (LSD) method was conducted to identify any significant differences between them, as shown in the Table 9.

Table 9: *Results of (LSD) Test to Measure the Differences in the Responses According to Group.*

Group	Mean	Dyslexics	Poor readers	Typical readers	Advanced readers
Dyslexics	41.83	-		*P value* 0.00* 28.17*	*P value* 0.00* 38.5*
Poor readers			-	*P value* 0.00* 21.5*	*P value* 0.00* 31.8*
Typical readers	70.00			-	*P value* 0.039* 10.33*
Advanced readers	80.33				-

Table 9 shows that statistically significant differences were found in the means of PCC across the four groups, in favor of advanced readers compared to (dyslexics, poor readers and typical readers). Moreover, it found statistically significant differences in the means of PCC in the four groups, in favor of typical readers compared to (dyslexics and poor readers).

Discussion

This study examined the phonological abilities of JADC in comparison to three reading groups: poor readers, typical readers, and advanced readers. The phonological abilities were assessed through three tests: pMLU, PWP, and PCC. Observed differences were noted in the overall scores of the three measures across the four groups. For instance, the mean PCC scores for advanced and typical readers were 80.33% and 71%, respectively, but decreased to 41.8 for the dyslexic group and 48.5 for the poor readers group. The performance order of the four groups was as follows: advanced readers < typical readers < poor readers < dyslexic readers. Given that most errors are phonologically based, the low scores of poor readers and dyslexics reflect difficulties in the phonological component of their language (International Dyslexia Association, 2018). It appears that these children struggle with using phonological memory codes to accurately decode words (Kamhi & Catts, 1986).

According to Dual-Route Theory, individuals rely on either the lexical route (whole word form) or the sub-lexical route (word's segments) (Friedmann & Haddad-Hanna, 2014). The argument is that when dyslexics fail to retrieve a word from their mental lexicon (lexical route), their brain resorts to the alternative cognitive mechanism (sub-lexical route), where the word's segments are decoded phoneme by phoneme. However, due to the under-activation of the sub-lexical route in the left side of the dyslexic brain, a phonological glitch is likely to occur.

Thus, the three tests have successfully captured differences in the phonological abilities of children in the four groups. They, however, did not reveal any significant differences between poor readers and mild dyslexics. This finding goes against Stanovich (1988) who hypothesized that dyslexics have a severe phonological deficit compared to poor readers. The variation between the two studies may be accounted for by the fact that the performance of dyslexia differs across languages. Findings have shown that both groups failed to access their knowledge about real words to decode nonwords. That is, taking the overall scores of poor readers and dyslexics, we find that the performance of poor readers was poor in both read words and nonsense words of analogical (high phonological similarity) and less analogical words (no phonological similarity). However, typical, and advanced readers of a younger age had succeeded in reading most of the nonwords correctly. This contrasts with Felton and Wood (1989) who found that poor readers of third graders performed well in real words, but they performed poorly in nonsense words of analogical and less analogical words.

In the literature, to better characterize their linguistic abilities, the performance of dyslexics is compared with that of typical readers of a younger age to report any differences. For example, in Cassar et al. (2005), dyslexics of the second graders performed similarly to the typical non-dyslexics of a younger age in a spelling test. Komesidou et al. (2022) also claims that grade one, two and four typical children performed similarly to dyslexics. On the other hand, Mugford (2002) shows that the performance of the control group outperformed the dyslexic children, although they were twice as old. In the present study, the typical and advanced readers of a younger age (grade two) produced considerably more accurate nonsense words and real words than JDAC (grade four). Their scores in the three measures were significantly higher than those of poor and dyslexic readers of an older age. This highlights the phonological deficit that these dyslexics have and support the usefulness of these measures in describing phonological abilities of the four reading groups.

Where both poor readers and dyslexics, particularly mild dyslexics, had relatively similar scores in the three measures, they used several phonological processes resulting in poor pMLU, PWP, and PCC scores. Data analyses contain three phonological processes: syllable deletion, consonant deletion, substitution, and metathesis.

- *Syllable Deletion*

Weak syllable deletion is a process that drops an entire syllable from a multisyllabic word. It has been reported as one of the predictors of dyslexia in Chinese (Ho, 2014). The process was frequent in the production of multisyllabic nonsense words as well as in real words to ease their pronunciation, as in /tan.ta.ḏi.ru/ "she waits" which was pronounced as [tan.ḏi.ru]. This can be explained with reference to the fact that children with dyslexia rely more on the non-lexical (sub-lexical) route to read irregular or nonwords, which is likely to result in errors when reading such words (Friedmann & Haddad-Hanna, 2014). In other words, this route connects the orthographic input lexicon with the phonological output lexicon, both are located in the left hemisphere of the brain which is under-activated when it comes to dyslexics.

Dyslexics tend to omit initial and medial syllables more frequently than final unstressed syllables. For example, the non-word /ʔal.fam.taš.sā/ was reduced to [fam.ta.ša.ʔa] by one participant and as [fam.ti.sā] by

another participant, and /ʔa.bū/ "father" was pronounced as [bū]. Neglecting one side of the word results in omission when dyslexics use the sub-lexical route (Friedmann & Haddad-Hanna, 2014). It was proved that in Hebrew dyslexics the left side of the word is deleted if it is an affix (Reznick & Friedmann, 2015). Most of these errors involved the initial parts of words, which can be explained with reference to 'left neglect Dyslexia' (Andrews, Veldre, & Clarke, 2020). This notion is valid in Jordanian Arabic because JADC omitted the initial syllable of a multisyllabic word most frequently. This finding has been reported by Appiah et al. (2023) who points out that English-speaking dyslexics deleted syllables in initial and medial position in multisyllabic real words. For instance, most participants misspelled the word (psychiatrist). The first syllable psy- was substituted by phy. The h- was deleted in the second syllable chi-. The /a/ in the third syllable was substituted with /o/, while the final syllable trist- was spelled correctly by most participants.

- *Consonant Deletion*

The low PCC scores of dyslexics result from letter deletion or substitution or reduction of consonant clusters (Friedmann & Haddad-Hanna, 2014) or from reduction of consonant clusters (Bruck & Treiman, 1990). These consonant errors may result from poor phonological awareness of dyslexics and their overreliance on the orthography of Arabic letters to read words. In this regard, Spencer (2001) distinguished between languages with transparent orthography and with deep orthography. in languages with transparent orthography, dyslexics perform better because the production of language doesn't involve much activation of the brain, while languages with deep orthography like Arabic depend more on memory and involve more activation of the brain which accounts for the phonological errors they make.

Across languages, dyslexics tend to maintain letters in the final position. JADC sometimes deleted letters which can be accounted for by the nature of the Arabic language orthography. That is, ligation (letters connection in a word) is one feature of Arabic letters (Friedmann & Haddad-Hanna, 2014). JDAC might be confused while they analyze and identify the letters in the sub-lexical route which results in deletion and sometimes substitution. For example, two participants deleted the /f/ sound in the nonsense word /tay.rū.sāf/ and pronounced it as [tay.rū.sā/ and [tī.rū.sā].

Omitting letter sounds may result from the reliance of dyslexics on the sub-lexical route. When a child cannot retrieve a lexeme from the lexical route, he/she tries using the non-lexical route (which is responsible for decoding the phonemes of the words); this part, however, is under-activated, which leads to phonological issues like omission. Frequently, dyslexic children reduced the glottal /ʔ/ in the initial position followed by the definite article /al/ in the same syllable. For instance, /ʔal/ in the nonsense word /ʔal.maf.ʔad.yā.ti/ was deleted and pronounced as [fa.ʔa.dāt]/.

- *Substitution*

Substitution is a phonological process in which a child usually replaces a harder phoneme with an easier one (Asare & Orfson-Offei, 2023). Some studies consider substitution systematic and can be patterned under common sounds, such as replacing a fricative with a corresponding stop, a liquid by a glide, or a nasal stop by a non-nasal counterpart (Asare & Orfson-Offei, 2023; Kiparsky, 2003). However, the details of such patterns and their sequences are not agreed upon by many scholars (Menn, 1983). In the data, the fricative /ḥ/ is replaced repeatedly with the voiced pharyngeal fricative /ʿ/, as in the disyllabic nonsense word /ha.bīṭ/ which is pronounced as [ʿa.bīṭ]. Although the two sounds are pharyngeals, the manner of articulation for the /ʿ/ sounds needs less narrowing to the vocal tract which leads to less turbulence of the airstream. This way is easier than constructing the airflow through a narrow channel to cause much turbulence to articulate the fricative /ḥ/. The fricative /h/ is replaced with /ʿ/ as well as in the multisyllabic nonsense word /ʔaṭ.ṭa.biḥ/ pronounced as [ʔal.ṭa.biʿ]. , Interestingly, all these sounds share the [guttural] zone feature, which shows that these substitutions are systematic.

- *Metathesis*

Metathesis is a phonological process in which two sounds switch or transpose places. The process occurs between two adjacent or non-adjacent vowels or consonants (Carr, 2008). Sohn (1980) argues that metathesis is not patterned, while Lehmann (1962) illustrates that the phonological process makes some changes within the words sporadically. The process occurs due to a problem in the temporal-spatial ordering abilities of dyslexics. Metathesis occurs in the data with few words and not repeatedly. It was most noticed between tautosyllabic segments, as in nonsense word /ʔal.mā. liʿ/ which was attested as [ʔal.mā.ʿil], where /l/ is switched with the pharyngeal /ʿ/. Metathesis was also observed between segments in adjacent syllables. The multisyllabic nonsense word /lil.ra.biš/ is read as [lil.ba.riš]; here, the alveolar /r/ in the transposed to the adjacent syllable and switches positions with the bilabial /b/ in the adjacent syllable. Transportation of vowels was not found within the data.

Most often, the metathesis process targets word-internal and final syllables. In some cases, the coda of a CVC final syllable comes to function as the onset of the syllable, as in /ʔal.mā.liʿ/ which was attested as [ʔal.mā.ʿil]. It seems that dyslexics tend to avoid consonants in the coda position by using metathesis, epenthesis,

or deletion. This agrees with Schneider-Zioga (2012) who found that dyslexics often misread medial CVC syllables as CV syllables instead. Where sometimes JDAC tend to delete, substitute, and transport letters from the final syllable, in other languages (e.g., Spanish or English), dyslexics only apply the three phonological processes in the initial and middle syllables (Alvarez-Canizo, Suarez-Coalla, & Cuetos, 2018; Appiah et al., 2023).

Conclusion and Implications

The three tests have successfully captured differences in the phonological abilities of children in the four groups. It, however, did not reveal any significant differences between poor readers and mild dyslexics. The model of Ingram and Ingram (2001) of counting pMLU was adapted to fit the language of dyslexics: positional rule to account for metathesis which is frequent in the language of dyslexics and the gemination rule which treats geminates as identical sounds, each one is awarded one point for production and another point for correct production. If a child mispronounces the geminate but preserves the geminate length as in *the bal.la* for *bar.ra 'outisde'*, one point is awarded for each of the geminate *l* because geminates are contrastive units in Arabic and even when mispronounced, they preserve the length of the geminate and help in deducing the intended word.

The findings of this research are of great interest to both researchers and speech pathologists. That is, the three measures provide researchers on Arabic with a tool that describes the phonological abilities of JADC and highlights language-specific features. This is significant because the existing standardized tests designed for the English-speaking community are not suitable for Arabic-speaking individuals. This is primarily due to the cultural disparities that arise during the translation process and the presence of diacritic marks in th/e Arabic language, which are absent in English (Elbeheri et al., 2006).

Moreover, as clinicians and speech pathologists seek to find ways to diagnose children with normal development versus children with language delay/deviant development, the findings of this research would provide good indicators for the diagnosis and clinical follow-up of dyslexics. This is important because the first step of assessment is to find out the child's stage of development and then compare his/her scores with age-matched peers. Comparing dyslexic scores with children of a younger age helps in both showing their reading abilities, i.e. if they have any reading disabilities, and in finding any progress in the child's abilities after taking some speech therapy sessions.

The findings of this study can be generalized to dyslexic children in other languages. Future research should focus on the phonological awareness of JADC in different groups of children. Given the recognized importance of short stories in enhancing children's reading skills (Zainal & Saad, 2022), forthcoming studies could investigate the influence of short stories on the reading proficiencies of TD children as well as children with dyslexia. Further, as the use of technology can help enhance the reading abilities of learners, future research can examine the impact of using technology on improving the reading skills of TD children.

References

Abu-Rabia, S., & Abu-Rahmoun, N. (2012). The role of phonology and morphology in the development of basic reading skills of dyslexic and normal native Arabic readers. *Creative Education, 3*(07), 1259-1268. http://dx.doi.org/10.4236/ce.2012.37185

Al-Natour, M., Al-Mashayek, F., & Alkhamra, H. A. (2022). Analyzing Reading Errors among Dyslexic Students According to the Dual-Route Model. *International Journal of Instruction, 15*(3), 137-152. https://doi.org/10.29333/iji.2022.1538a

Alsheikh, N., Al Habbash, M., Al Mohammedi, N., Liu, X., Al Othali, S., & AI Kilani, G. (2022). A Conceptual Home for Reading Stories in Arabic, Chinese, and English: A Schema Analysis. *International Journal of Society, Culture & Language, 10*(2), 105-124. https://doi.org/10.22034/ijscl.2022.555303.2659

Alvarez-Canizo, M., Suarez-Coalla, P., & Cuetos, F. (2018). The role of sublexical variables in reading fluency development among Spanish children. *Journal of Child Language, 45*(4), 858-877. https://doi.org/10.1017/S0305000917000514

Amayreh, M. M., & Dyson, A. T. (1998). The acquisition of Arabic consonants. *Journal of Speech, Language, and Hearing Research, 41*(3), 642-653. https://doi.org/10.1044/jslhr.4103.642

Andreou, G., & Baseki, J. (2012). Phonological and spelling mistakes among dyslexic and non-dyslexic children learning two different languages: Greek vs English. *Psychology, 3*(08), 595-600. http://dx.doi.org/10.4236/psych.2012.38089

Andrews, S., Veldre, A., & Clarke, I. E. (2020). Measuring lexical quality: The role of spelling ability. *Behavior Research Methods, 52*, 2257-2282. https://doi.org/10.3758/s13428-020-01387-3

Appiah, S., Appiah-Kubi, E., & Boe-Doe, K. (2023). What Teachers Expect: The Relationship between Student Learning Behaviour and Teacher Expectation. *East African Journal of Arts and Social Sciences, 6*(1), 431-445. https://doi.org/10.37284/eajass.6.1.1312

Asare, T. A. J., & Orfson-Offei, E. (2023). Substitution phonological patterns in the English speech of Ghanaian children. *Social Sciences & Humanities Open, 8*(1), 100631. https://doi.org/10.1016/j.ssaho.2023.100631

Bruck, M., & Treiman, R. (1990). Phonological awareness and spelling in normal children and dyslexics: The case of initial consonant clusters. *Journal of experimental child psychology, 50*(1), 156-178. https://doi.org/10.1016/0022-0965(90)90037-9

Bunta, F., Fabiano-Smith, L., Goldstein, B., & Ingram, D. (2009). Phonological whole-word measures in 3-year-old bilingual children and their age-matched monolingual peers. *Clinical Linguistics & Phonetics, 23*(2), 156-175. https://doi.org/10.1080/02699200802603058

Carr, P. (2008). *A Glossary of Phonology*. Edinburgh University Press. https://www.jstor.org/stable/10.3366/j.ctt1g09xp0

Cassar, M., Treiman, R., Moats, L., Pollo, T. C., & Kessler, B. (2005). How do the spellings of children with dyslexia compare with those of nondyslexic children? *Reading and Writing, 18*, 27-49. https://doi.org/10.1007/s11145-004-2345-x

Cavalli, E., Duncan, L. G., Elbro, C., El Ahmadi, A., & Colé, P. (2017). Phonemic—Morphemic dissociation in university students with dyslexia: An index of reading compensation? *Annals of dyslexia, 67*, 63-84. https://doi.org/10.1007/s11881-016-0138-y

Elbeheri, G., Everatt, J., Reid, G., & Mannai, H. a. (2006). Dyslexia assessment in Arabic. *Journal of Research in Special Educational Needs, 6*(3), 143-152. https://doi.org/10.1111/j.1471-3802.2006.00072.x

Elbro, C., & Jensen, M. N. (2005). Quality of phonological representations, verbal learning, and phoneme awareness in dyslexic and normal readers. *Scandinavian Journal of Psychology, 46*(4), 375-384. https://doi.org/10.1111/j.1467-9450.2005.00468.x

Everatt, J., Smythe, I., Ocampo, D., & Gyarmathy, E. (2004). Issues in the assessment of literacy-related difficulties across language backgrounds: A cross-linguistic comparison. *Journal of Research in Reading, 27*(2), 141-151. https://doi.org/10.1111/j.1467-9817.2004.00222.x

Felton, R. H., & Wood, F. B. (1989). Cognitive deficits in reading disability and attention deficit disorder. *Journal of learning disabilities, 22*(1), 3-13. https://doi.org/10.1177/002221948902200102

Friedmann, N., & Haddad-Hanna, M. (2014). Types of Developmental Dyslexia in Arabic. In *Handbook of Arabic literacy: Insights and perspectives* (pp. 119-151). Springer. https://doi.org/10.1007/978-94-017-8545-7_6

Ho, C. S.-h. (2014). Preschool predictors of dyslexia status in Chinese first graders with high or low familial risk. *Reading and Writing, 27*, 1673-1701. https://doi.org/10.1007/s11145-014-9515-2

Ingram, D. (2002). The measurement of whole-word productions. *Journal of Child Language, 29*(4), 713-733. https://doi.org/10.1017/S0305000902005275

Ingram, D., & Ingram, K. D. (2001). A Whole-Word Approach to Phonological Analysis and Intervention. *Language, Speech, and Hearing Services in Schools, 32*(4), 271-283. https://doi.org/10.1044/0161-1461(2001/024)

Kamhi, A. G., & Catts, H. W. (1986). Toward an understanding of developmental language and reading disorders. *Journal of Speech and Hearing Disorders, 51*(4), 337-347. https://doi.org/10.1044/jshd.5104.337

Kiparsky, P. (2003). The phonological basis of sound change. In *The handbook of historical linguistics* (pp. 311-342). Blackwell Publishing Ltd. https://doi.org/10.1002/9780470756393

Komesidou, R., Feller, M. J., Wolter, J. A., Ricketts, J., Rasner, M. G., Putman, C. A., & Hogan, T. P. (2022). Educators' perceptions of barriers and facilitators to the implementation of screeners for developmental language disorder and dyslexia. *Journal of Research in Reading, 45*(3), 277-298. https://doi.org/10.1111/1467-9817.12381

Kovelman, I., Christodoulou, J. A., & Gabrieli, J. D. (2012). Dyslexia: The brain bases of reading impairments. In *The Handbook of the Neuropsychology of Language* (pp. 868-891). Blackwell Publishing Ltd. https://doi.org/10.1002/9781118432501

Landerl, K., Ramus, F., Moll, K., Lyytinen, H., Leppänen, P. H., Lohvansuu, K., O'Donovan, M., Williams, J., Bartling, J., & Bruder, J. (2013). Predictors of developmental dyslexia in European orthographies with varying complexity. *Journal of Child Psychology and Psychiatry, 54*(6), 686-694. https://doi.org/10.1111/jcpp.12029

Lehmann, I. J. (1962). Some socio-cultural differences in attitudes and values. *The Journal of Educational Sociology, 36*(1), 1-9. https://doi.org/10.2307/2264592

Menn, L. (1983). Development of articulatory, phonetic, and phonological capabilities. In *Language production* (pp. 3-50). Cambridge University Press. https://doi.org/10.1017/CBO9780511980503.009

Miles, T. R., Thierry, G., Roberts, J., & Schiffeldrin, J. (2006). Verbatim and gist recall of sentences by dyslexic and non-dyslexic adults. *Dyslexia, 12*(3), 177-194. https://doi.org/10.1002/dys.320

Mugford, S. C. (2002). *The production and manipulation of /s/+ consonant clusters by phonological dyslexics.* (Doctoral dissertation). Memorial University of Newfoundland. http://research.library.mun.ca/id/eprint/1503

Muter, V., Hulme, C., Snowling, M. J., & Stevenson, J. (2004). Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: evidence from a longitudinal study. *Developmental psychology, 40*(5), 665-681. https://doi.org/10.1037/0012-1649.40.5.665

Perfetti, C. A., Van Dyke, J., & Hart, L. (2001). The psycholinguistics of basic literacy. *Annual review of applied linguistics, 21*, 127-149. https://doi.org/10.1017/S0267190501000083

Peterson, R. L., & Pennington, B. F. (2015). Developmental Dyslexia. *Annual Review of Clinical Psychology, 11*(1), 283-307. https://doi.org/10.1146/annurev-clinpsy-032814-112842

Reznick, J., & Friedmann, N. (2015). Evidence from neglect dyslexia for morphological decomposition at the early stages of orthographic-visual analysis. *Frontiers in Human neuroscience, 9*, 497. https://doi.org/10.3389/fnhum.2015.00497

Richlan, F., Sturm, D., Schurz, M., Kronbichler, M., Ladurner, G., & Wimmer, H. (2010). A common left occipito-temporal dysfunction in developmental dyslexia and acquired letter-by-letter reading? *PloS one, 5*(8), 12073. https://doi.org/10.1371/journal.pone.0012073

Saaristo-Helin, K., Kunnari, S., & Savinainen-Makkonen, T. (2011). Phonological development in children learning Finnish: A review. *First Language, 31*(3), 342-363. https://doi.org/10.1177/0142723710396793

Schneider-Zioga, P. (2012). Phonological precedence in dyslexia: A case study. *Language Acquisition, 19*(3), 183-222. https://doi.org/10.1080/10489223.2012.685025

Shaywitz, S. E., & Shaywitz, B. A. (2005). Dyslexia (specific reading disability). *Biological psychiatry, 57*(11), 1301-1309. https://doi.org/10.1016/j.biopsych.2005.01.043

Sohn, H.-m. (1980). Metathesis in Kwara'ae. *Lingua, 52*(3-4), 305-323. https://doi.org/10.1016/0024-3841(80)90039-X

Spencer, K. (2001). Differential effects of orthographic transparency on dyslexia: Word reading difficulty for common English words. *Dyslexia, 7*(4), 217-228. https://doi.org/10.1002/dys.207

Stanley, R. (2020). Succeeding in practice when you have additional needs. In *How to Succeed on Nursing Placements* (pp. 135-154). Learning Matters. https://eprints.kingston.ac.uk/id/eprint/45083

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological-core variable-difference model. *Journal of learning disabilities, 21*(10), 590-604. https://doi.org/10.1177/002221948802101003

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disability (dyslexia): What have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, 45*(1), 2-40. https://doi.org/10.1046/j.0021-9630.2003.00305.x

Wimmer, H., & Mayringer, H. (2002). Dysfluent reading in the absence of spelling difficulties: a specific disability in regular orthographies. *Journal of Educational psychology, 94*(2), 272-277. https://doi.org/10.1037/0022-0663.94.2.272

Zainal, R. F. A., & Saad, N. A. (2022). Nurturing Children's Reading Skill: Teachers' Approach and Techniques. *Journal of Education and Literacy Studies (JELS), 1*(1), 38-47. https://doi.org/10.37698/jels.v1i1.108