



## **Analyzing Reading Errors among Dyslexic Students According to the Dual-Route Model**

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This study aimed at analyzing reading errors in the Arabic language among the dyslexic students based on the dual-route model for reading as well as determining the subtypes of dyslexia according to the reading errors manifested by the dyslexic students. The study sample consisted of eighty students divided equally between dyslexic and non-dyslexic students from the same age category. The dyslexic group were distributed into six students with surface dyslexia, four with phonological dyslexia, five with deep dyslexia and twenty five dyslexic students weren't identified in any of the above-mentioned types, accounting for (62.5%) of the total dyslexic sample. A battery of three domains was developed (reading errors, orthographic and phonological abilities and semantic abilities) with ten subdomains comprising of 200 items. A simple regression method and MANOVA were used for analysis. Results showed that students with surface dyslexia demonstrated visual errors in recognizing words, whereas the students with phonological dyslexia demonstrated phonological errors. However, the students with deep dyslexia mainly displayed semantic and phonological errors. Further implications were discussed.

Keywords: dyslexic, Arabic language, dual-route model, students, language learning

### **INTRODUCTION**

Reading is a vital skill needed for learning, students who are unable to read experience future difficulties in school and in life, especially for students with dyslexia. (Meeks, Martinez, & Pienta, 2014). Dyslexia is considered as one of the most common learning difficulties, with a high prevalence rate of around 80%, (. it affects nearly (5-10%) of school age students (Wajuihian & Naidoo, 2010; Huang, He, Li, Lin, Zhang & Wu, 2020). The International Dyslexia Association )2002( defined dyslexia as one of the specified learning difficulties, which are manifested in the form of a weakness in the

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skills of decoding, orthography as well as the difficulties in recognizing words accurately and fluently, resulting from a disorder in the phonological component.

Nevertheless, dyslexic student maintains a normal mental ability that helps them pass through high-quality educational experiences. The previous definition emphasizes that most reading errors among dyslexic students are mainly represented by a weakness in the skills of decoding as well as recognizing words accurately and fluently.

Previous research suggested that the skill of decoding can be understood by the skill of recognizing words. Whereas the weakness in decoding reflects a general weakness in the skill of recognizing words (Abu-Rabia & Taha, 2004; Dias, Seabra, & Montiel, 2014). The errors resulting from the difficulties of recognizing words and decoding was analyzed through various reading models, including the dual-route model that. Sprenger-Charolles, Siegel, Jimenez, & Zeigler (2011)

considered the dual-route model as one of the most studied models, especially in the domain of reading and spelling. According to the dual-route model, recognizing words takes place in either of two ways; decoding by recognizing the grapheme and phoneme rules through the non-lexical route, or by the visual recognition of words through the lexical route (Ellis & Young, 1988).

Several studies that analyzed reading errors according to the dual-route model, proposed several classifications for the reading errors made by the dyslexic students in different languages in relation to deep orthography, and classified those errors into dyslexia subtypes (Moats, 1993). However, paucity was noticed in the studies that analyzed and classified reading errors among students who speak the Arabic language as their mother tongue according to the dual-route model of reading.

The current study could contribute to verifying the ability of this model to predict dyslexia subtypes among native Arabic speakers. Furthermore, Taha (2016) noted that current research has started to address the orthographic characteristics of the different languages and their impact on causing certain reading errors. Therefore, the current study aimed at analyzing reading errors by using a number of tests that measure semantic, phonological, and orthographic abilities in the Arabic language among dyslexic students, compared with a control group (non-dyslexic students) from the same age group in addition to determining dyslexia subtypes according to the dual-route model.

Indeed, this research has the potential of introducing a foresight concerning the types of errors that native Arabic students may commit according to the dual-route model, and the identification of dyslexia subtypes in the Arabic language in case they existed.

This might contribute in identifying the extent to which the dual-route model for reading provide a concrete classification approach for dyslexia subtypes in Arabic language, in a way that corresponds with those dyslexia subtypes identified in languages with different orthographic depth. This may gear further research into experimenting different teaching approaches that is specifically designed to a certain subtype.

### **The Dual-Route Model**

Coltheart, Curtis, Atkins, & Haller (1993) introduced an interpretative description for loud reading of single words by developing the dual-route model and attempting to answer six basic facts in reading, that involves the method of recognizing words, the method through which decoding takes place, and the method by which developmental dyslexia takes place. Although the dual-route model was developed in its preliminary version to explain acquired dyslexia subtypes, this model is also used in the conversion of the written words into spoken words through using two routes: lexical route and non-lexical route. The lexical route includes two paths: the orthographic input lexicon and the phonological output lexicon (Coltheart & Rustle, 1994).

Friedmann & Haddad-Hanna, (2014) suggested that the orthographic input lexicon includes information about the visual form of the word, whereas the phonological output lexicon includes information about the correct pronunciation of the word by providing information about vowels, consonants, aggravated letters, and the number of syllables of the word. As long as the relationship between the two lexicons (the orthographic input lexicon and the phonological output lexicon) inside the lexical path is intact, the individual will be quickly able to recognize the form of the word and link it well with its correct sound. In terms of the non-lexical route, Grainger & Zeigler, (2011) suggested that this route follows the rules of reading the word according to (grapheme-phoneme correspondence rules) by dividing the word into letters and syllables and then reading them. Levy, Pernet, Treserras, Boulanouar, Aubry, Demonet & celsis (2009) proposed that the non-lexical route is distinctive from the lexical route especially with slow reading, where the individual needs more time to recognize sounds, integrate them and form words. Although this explains the distinction, the main purpose of the reading process is to understand what is being read, this issue was not overlooked by the developers of the dual-route model and was further investigated. Castle (2006) suggested that there is a sub-route linked with the lexical route, called the semantic system which provides meaning for the familiar words, in that any error in any of these lexicons will lead to a dyslexia subtype, an issue that we will address below.

### **Analysing reading errors according to the dual-route model**

The process of analyzing errors according to the dual-route model depends on the principle of depth and shallowness of the word that should be read; the shallow words are the words to which the rules of reading are applied based on the application of phoneme correspondence by recognizing the phonemes in the word, linking them together, forming syllables and integrating them together to form a word and read it. If these rules are applied to a regular word, they will result in a correct reading of the word, whereas if these rules are applied to irregular words, they will result in a wrong reading of the word.

Therefore, according to the rules of phoneme correspondence in the dual-route model the non-lexical route is responsible for reading regular words, whereas the lexical route is responsible for reading the irregular words (Coltheart et al., 1994). Accordingly, Wybrow & Hanley (2015) suggested that a reader with a deficit in the lexical route,

while having an intact non-lexical route, will result in errors in reading the irregular words, with a relative ability in reading non-words.

This reading error was classified as a dyslexia subtype, called surface dyslexia. Coslett & Turkeltaub, (2016) mentioned that the first researchers who referred to "surface dyslexia" are Marshall & Newcombe, (1973) where they defined it as a disorder that is manifested in the form of errors in reading irregular words. Coltheart, Byng, Masterson, Prior & Riddoch, (1983) mentioned two cases of surface dyslexia; one of them is acquired, while the other is developmental. They suggested that both types demonstrate similar performance in terms of reading errors. errors in reading irregular words, where the individuals' errors were characterized by (regularization), in that irregular words were read according to the rules of linking between graphemes and phonemes as well as the rules of forming syllables and reading words. Furthermore, both cases did not manifest phonological errors, where most errors were orthographic.

In contrast, if dyslexic students demonstrate a relative ability in reading irregular words while manifesting clear errors in reading non-words, this type of reading errors is classified as phonological dyslexia, which is characterized by errors in reading non-words that require the skill of decoding and spelling as well phonological correspondence. These errors are attributed to a deficit in the non-lexical route, with the ability in recognizing irregular words, resulting due to the efficiency of the lexical route; this case places excessive dependency on the intact lexical route in reading non-words (Birch & Chase, 2014). Purdy & Newman, (2012) suggested that phonological dyslexia –due to the damage to the non-lexical route –resulted in a deficit in the process of phonological correspondence for phonemes and graphemes related to non-words and unfamiliar words, and this leads to more dependency on the intact lexical route in reading non-words and regular words. The reading errors committed by phonologically dyslexic students are characterized by a deficit in reading non-words and a relative ability in reading irregular words, with the non-existence of semantic errors. This case was supported by Valdois, Bosse, Ans, Zorman, David, Pellat, & Carbonnel, (2003) when they conducted a study on two French-speaking cases in comparison with a control group that consisted of non-dyslexic participants of the same age category and reading level. The results revealed that phonological dyslexia resulted from errors in reading non-words and spelling, with the ability to read irregular words. This case is different from surface dyslexia, in which there are errors in reading irregular words, while reading non-words.

Law & Cupples, (2016) suggested that deficit in both routes: lexical route and non-lexical route, causes a subtype of dyslexia, called mixed or deep dyslexia. Deep dyslexia is characterized by a defect in reading irregular words (lexical route) and non-words (non-lexical route). This case is also accompanied by a number of reading errors, suggested by Malhi, McAuley, Lansue & Buchanan, (2019), such as main semantic errors, in that the student reads the word "shout" as "loudly"; phonological errors, such as "dog" and, "gog"; morphological errors "swim" and "swimming" as well as visual errors "realm" and "ream". (Lambon Ralph & Graham, 2000) suggested that the individuals with deep dyslexia have a defect in both routes: lexical route and the non-

lexical route; therefore, they can't recognize words completely. This results in semantic errors and replacing the targeted words with other visually similar words as well as errors in reading functional words and abstract words. It was suggested that there is an important criterion for the errors manifested by the students with deep dyslexia, which is related to the criterion of relative ability to read concrete words, with the existence of errors and difficulties in reading the abstract words (Malhi et al., 2019).

Shallice & Cooper, (2013) explained the cause of the existence of errors in reading abstract words as compared to the relative ability in reading concrete words to the fact that the defect of semantic representation in the lexical route among the students with deep dyslexia, this defect is manifested by abstract words rather than concrete words, even though they could have a poor performance in abstract and concrete words. Riley & Thompson, (2010) suggested that most reading errors among the students with deep dyslexia are represented by a deficit in the semantic processing of words (the words with the same meaning, synonyms, antonyms, metaphors...), which are manifested in the form of poor performance on all semantic tasks, either as phonological, auditory or visual. Based on the above-mentioned, we can see that most studies addressed a number of languages, such as the English and French languages. However, reading errors weren't described according to the dual-route model for the native speakers of the Arabic language, except for one study, which is (Friedmann, et al, 2014), where the researchers described ten types of dyslexia, including the surface and deep dyslexia. Researchers noticed that surface dyslexia in the Arabic language is represented by a defect in reading the words that contain short diacritics (short vowels), where the individual reads it through the non-lexical route and changes these short diacritics into a sound. For example, the "damma", which is a diacritic that corresponds with the phoneme "u" is pronounced as "waw", with difficulties in reading the words that correspond with their local dialect. As for the types of errors related to deep dyslexia, they were morphological and semantic in nature.

### **The morphological and orthographic characteristics of the Arabic language**

Sounds in the Arabic language are divided into consonants and vowels. Consonants are considered as the bases of the Arabic language, and include (27) phonemes as well as (6) vowels, including three (short diacritics):

1. The open front diacritic (Fatiha) /a/ /ā/ in return The long open front diacritic (Alif) /aa/ /ā
2. The narrow front diacritic (Kasra) /i/ // The long narrow front diacritic (Ya') /ii/ /ī
3. The narrow back diacritic (damma) /u/ /ū/ The long narrow back diacritic (waw) /uu/ /ū/ (Saadi, 2018).

The Arabic language is different from the English language with regard to the difference between short and long vowels; in the Arabic language, the difference is more related to the time period that the reader spends without change in the phonological characteristics. For example, the long damma (waw) is equivalent to the short diacritic // plus a long phoneme /w/ the difference is quantitative, but not qualitative. Even though

vowels are few in relation to consonants, they are too important in the Arabic language, in terms of their impact on the semantic meaning and the syntactic domain. When consonants and vowels are activated and integrated, they give a stronger syntactic, morphological, and semantic meaning (Bahre, 2010). Taha & Saiegh Haddad, (2015) suggested that the existence of short vowels in the word represents the shallow orthographic type in the Arabic language since the student will read smoothly, connecting each phoneme with its diacritic and the adjacent letter to form syllables in accordance with the rules of phonological correspondence between phonemes. Additionally, deleting these short vowels represents a type of deep orthography in the Arabic language. For example, the words (Kataba) /كَتَبَ and (Kotob) /كُتِبَ are composed of three letters with the same orthographic system. However, the difference is manifested by the existence of short vowels that caused a change in meaning, the Arabic word (Kataba/كَتَبَ) is translated as written in the English language, whereas the Arabic word (Kotob /كُتِبَ) is translated as (books) in the English language. (Abu-Rabia & Abu-Rahmoun, 2012) suggested that short vowels in the Arabic language are usually omitted, where the skilful students and the students with advanced levels in reading can read the words mentioned in texts, without short vowels, based on the text, whereas the beginner students in reading and those with poor reading skills need the existence of such short vowels in order to be able to read correctly. This finding was also advocated by the results of (Abu-Rabia & Hijjazi, 2020), which revealed that there is an impact for the short vowels in the Arabic language, where they increase the reading comprehension among students, especially in the elementary school stage.

Aldera, (2017) noted that based on the orthographic characteristics of the targeted word (deep or surface), the reader uses both lexical and non-lexical routes in the Arabic language. Therefore, analyzing errors among the dyslexic students according to the dual-route model may contribute to recognizing the nature of reading errors committed by the dyslexic students who speak Arabic as their native language as well as classifying them within the dyslexia subtypes in the Arabic language, especially with paucity in the studies that addressed this topic.

The theoretical research and the previous studies demonstrated the methods of analyzing reading errors according to the dual-route model among dyslexic students. A gap in research is noticed with the scarcity of studies addressing reading errors according to the dual-route model among native Arabic language speakers. The current study attempted to fill the missing gaps by determining dyslexia subtypes, analyse reading errors according to the dual-route model and verify the validity of this model among native Arabic language speakers. Therefore, the study aimed to answer the following questions:

1. What are the dyslexia subtypes manifested by the dyslexic students according to the dual-route model?
2. What are the types of reading errors manifested by dyslexia subtypes in the Arabic language according to the dual-route model compared to the control group?

## METHOD

### Participants

The study sample was chosen using the simple random method, it consisted of (40) dyslexic students from the fourth grade, with an average age of (10.39) years old and a standard deviation of (0.27); they speak Arabic as their native language and were receiving special education in the resource rooms specified for the dyslexic students. Furthermore, the control group consisted of (40) non-dyslexic students (with a good reading level). The control group was selected to verify that the criteria used in the assessment are correct and valid in sorting out the dyslexic students, and not to compare the performance of dyslexia types with it. The control group were also selected using the simple random method from the fourth grade, speaking Arabic as their native language, with an average age of (10.27) years and a standard deviation of (0.34).

### Research Instrument:

To achieve the purpose of this research, a battery consisting of three main domains assessing a) reading errors, b) orthographic and phonological abilities and c) **semantic abilities**. Each test consisted of subtests to measure the needed outcome. The following is a description of all.

#### **The battery for analyzing reading errors among dyslexic students according to the dual-route model**

1. Testing irregular words: This test measures the student's ability to read words that have irregularity between the written form and the pronounced form, such as the words with short vowels, the words that include deleted letters that should be pronounced, and the words that have letters that should be deleted. The developed test consisted of (20) irregular words taken from the Arabic textbook for the third grade, split half reliability (0.72)

2. Fluency test in reading non-words: This test measures the student's ability of decoding. This test consisted of (20) non-words, with different lengths that don't contradict the rules of Arabic language. The final score of the test was (20), which is calculated by the number of the correctly-pronounced words in one minute. Split half reliability (0.82).

#### **The battery for Orthographic and Phonological Abilities**

1. The test of familiar words: This test measures the student's ability to read high-frequency words that are commonly used in reading texts. The process of screening the reading texts was performed by using the Arabic textbook for the first three grades. The final score of this sub-test was (20), which is calculated by the number of the correctly-pronounced words in one minute. Split half reliability (0.77).

2. The test of the words with similar sounds: this test measures the student's ability to read (10) words with letters similar in form and (10) words with letters similar in

pronunciation. The final score of this sub-test was (20), which is calculated by the number of the correctly-pronounced words. Split half reliability (0.87).

3. Regular words test: this test measures the student's ability to read regular words, where the written form corresponds with the pronounced form, such as the word (دَهَبٌ), which is read as (دَهَبٌ) without any addition or deletion. The regular words were selected from the textbook of Arabic language for the third grade, with a total of (20) words for the whole test. The final score of this sub-test was (20), which is calculated by the number of correctly pronounced words. Split half reliability (0.72).

### **The Battery for Semantic Abilities**

1. Test of concrete words: this test measures the student's ability to read (20) concrete words which have different length and morphological structures. The final score of this sub-test was is calculated by the number of the correctly-pronounced words. Split half reliability (0.83).

2. The test of fluency in reading abstract words: this test measures the student's ability to read the abstract words that are free from concrete perceptual experiences. (20) abstract words were selected from the textbook of the Arabic language for the third grade. The final score of this sub-test was (20), which is calculated by the number of the correctly-pronounced words in one minute. Split half reliability (0.76).

3. The test of fluency in reading functional words: this test measures the student's ability to read functional words that have an important role in paraphrasing and understanding sentences, such as prepositions, conjunctions, conditional tools, and question marks. The test consisted of (20) functional words. The final score of this sub-test was (20), which is calculated by the number of the correctly-pronounced words in one minute. Split half reliability (0.82).

4. The test of fluency in reading morphological words: this test measures the student's ability to conjugate verbs and change verbs into past and present tenses. The test consisted of (20) items. The final score of this sub-test was (20), which is calculated by the number of the correctly-pronounced words in one minute. Split half reliability (0.77).

5. Test of words with approximate meaning/ auditory: this test measures the student's ability to read a number of words with approximate meaning. The test consisted of (20) words. The final score of this sub-test was calculated by the number of correctly pronounced words in one minute. Split half reliability (0.94).

### **Data Analysis**

To determine the different dyslexia subtypes, this study rely on previous research work of Sprenger-Charolles, et al. (2011), they suggested two approaches; the classical method and the soft method. The classical method, where the students who manifest a defect in the philological domains are classified as suffering from phonological dyslexia, whereas those with orthographic difficulties are classified within the subtype of surface dyslexia. As for the soft method (Colthert et al., 1993) types are examined based on



analyzing regression analysis and determining confidence intervals of about (95%) or (90%) as compared with the control group. The study utilized the soft method through calculating a confidence interval of (90%), such as the case in (Ho, Chan, Chung, Lee, & Tsang 2007).

Accordingly, this study used different technique of data analysis; inferential statistics using a simple regression method, MANOVA and Wilkes lambda test were used for the analysis of the different types of reading errors by dyslexia subtypes.

**FINDINGS**

To answer the first research question related to the dyslexia subtypes manifested by the dyslexic students according to the dual-route model. Results showed that six of the dyslexic students exhibited Surface Dyslexia, with a percentage of 15%, since they demonstrated low performance in the test of irregular words, in comparison with better performance on non-words, as shown in figure (1). The results also revealed that four students exhibited Phonological Dyslexia, with a percentage of 10%, where they had low ability in reading non-words, in comparison with a better performance in reading irregular words, as illustrated in figure (2). However, five dyslexic students demonstrated a defect in both variables (non-words and irregular words), with a percentage of 12%, as shown in figures (1) and (2), whereas 25 students weren't identified in any of these types, with a percentage of 62%. The percentage of non-dyslexic students was 50%, who have a good reading level.

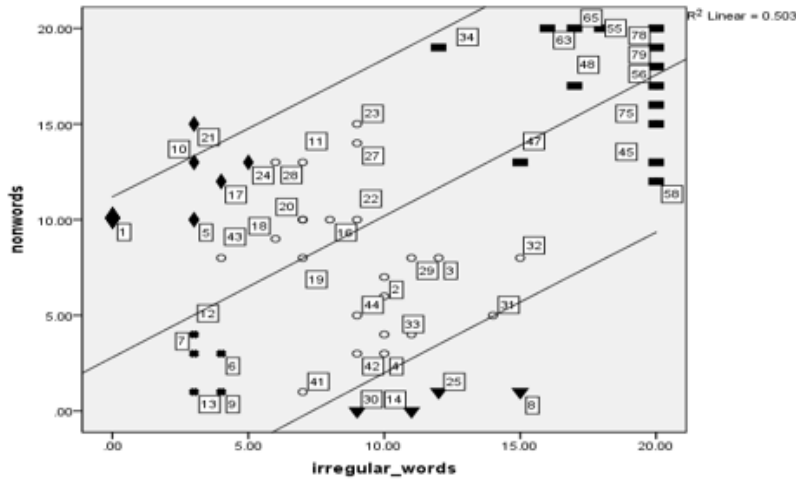


Figure 1 Irregular reading by non-word character reading for the CA and dyslexia groups, with regression line and 90% confidence intervals. The students with phonological dyslexia are represented by the shape of a triangle (30,14,25,8), and the students who have difficulties in both non-words and irregular words are manifested by the symbol (\*) (12,7,6,13,9).

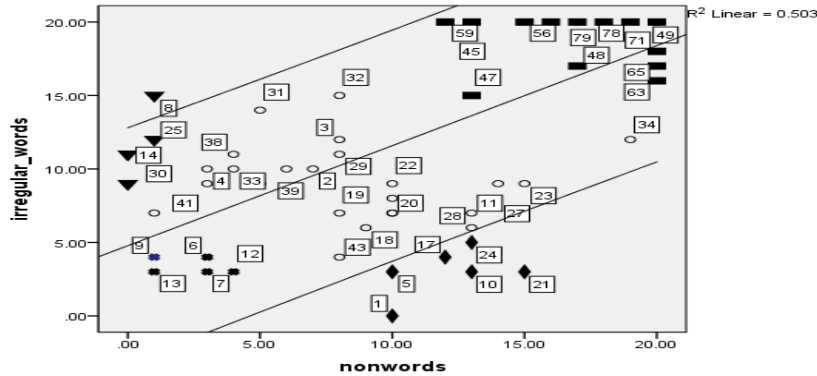


Figure 2

Irregular character reading by non-words reading for the CA and dyslexia groups, with regression line and 90% confidence intervals. The students with surface dyslexia are represented by the shape of a rhombus (1,5,17,24,10,21), and the students confined between the two lines represent the students who have difficulties in both variables and are manifested by the symbol (\*) (9,6,12,13,7).

To answer the second research question related to the types of reading errors by dyslexia subtypes compared to the control age group. MANOVA analysis and Wilkes lambda test were used in relation to tests of phonemic, spelling, and semantic abilities within the dyslexia subtypes and control group according to the dual-route model Table No (1).

Table 1

Multivariate analysis of variance (MANOVA) Summary Table

Wilks' Lambda=value=0.007/f=25.85/df=28/sig=.000							
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	ηp2
GROUP	Similar sounds	2658.569	4	664.642	144.522	.000	.885
	regular words	2358.725	4	589.681	98.835	.000	.841
	abstract word	1725.819	4	431.455	37.554	.000	.667
	Sensible words	1505.602	4	376.400	54.019	.000	.742
	Functional words	1263.152	4	315.788	60.288	.000	.763
	Morphological words	2099.429	4	524.857	60.958	.000	.765
	Meaning words	1475.475	4	368.869	31.606	.000	.628
Error	Similar sounds	344.918	75	4.599			
	regular words	447.475	75	5.966			
	abstract word	861.668	75	11.489			
	Sensible words	522.598	75	6.968			
	Functional words	392.848	75	5.238			
	Morphological words	645.758	75	8.610			
	Meaning words	875.325	75	11.671			
Corrected Total	Similar sounds	3003.488	79				
	regular words	2806.200	79				
	abstract word	2587.488	79				
	Sensible words	2028.200	79				
	Functional words	1656.000	79				
	Morphological words	2745.188	79				
	Meaning words	2350.800	79				

Table 2  
Comparison of means for all Arabic dyslexia subtypes compared to the control age group

	PD	SD	DD	ND	CA	Group comparison
Abstract	8.50	11.33	2.60	10.84	18.0	CA>SD;SD=ND=PD>DD
Sensible	8.75	13.83	5.80	12.32	19.3	CA>SD;SD=PD=ND>DD
Functional	16.00	16.16	2.80	16.32	19.42	CA>ND=SD=PD>DD
Morphological	9.75	9.83	1.60	12.00	19.22	CA> ND;ND= SD=PD>DD
Meaning	13.75	17.00	4.40	12.40	19.37	CA=SD=PD >ND>DD
Similar	10.25	2.83	6.40	9.840	19.32	CA>PD;PD=ND>SD
regular	5.50	14.50	8.00	6.440	18.97	CA>SD;DD=PD;PD=ND=DD

Note.CA=age control, PD=phonological dyslexia, SD=surface dyslexia, DD = deep dyslexia, ND = non-subtype dyslexia. Number of CA= 40; PD=4; SD=7; DD=6; ND= 25. \* $p < .05$ .

The results showed F-values of all dependent variables that showed significant difference between the five groups. Based on the above table, we can conclude that the students with surface dyslexia demonstrated more decline in the tests that required the ability to recognize words, such as familiar words test, whereas their performance was better on regular words and in tests which measure semantic abilities. The performance of the students with phonological dyslexia was low in the tests that measure phonological abilities, whereas they demonstrated a relatively better orthographic ability. The deep-dyslexic students demonstrated poor performance in both semantic and phonological tests. These results confirmed the validity of the dual-route model in classifying dyslexia subtypes among native Arabic language speakers. Figure (3) shows the results.

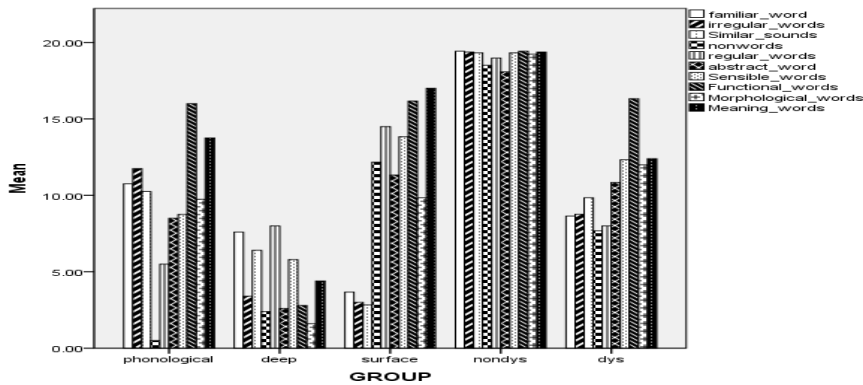


Figure 3  
Differences between the mean scores for the performance of the five groups

Regarding the subtypes of dyslexia, the students demonstrated (6) types of reading errors as follows:

1-Phonological errors: the students' difficulty was related to the phonological, represented by deletion, addition, and substitution in phonemes, whereas there were no difficulties related to rhyme.

2. Visual errors: these errors were manifested in the form of poor ability in recognizing the words visually, even if the words are familiar at the phonological level, while there was a type of latency that precedes the process of reading.
3. Semantic errors: some students manifested an obvious difficulty in substituting the words by their meaning while reading or difficulties in reading the words that have approximate meaning. Such errors were also while reading the non-words, where some students changed those words into meaningful words or words approximate to the local dialect.
4. Morphological errors: the difficulty of inflecting verbs and changing them from one tense to another was obvious among most students.
5. Errors in reading irregular words: some students read these words as regular ones.
6. Errors in reading non-words: while some students manifested difficulty in orthography, others changed words into real ones.

## DISCUSSION

This study aimed at analyzing reading errors in the Arabic language among dyslexic students according to the dual-route model. The results showed that we can use the dual-route model in analysing reading errors in the Arabic language. The reading errors of these subtypes corresponded with the errors that were mentioned in the languages with different orthographic depth

The reading errors among students with surface dyslexia were characterized by poor abilities in reading irregular words and familiar words. This finding agrees with (Purdy et al., 2012), where the following characteristics were manifested.

The characteristics of regularization and compromising referred to (Coltheart et al., 1983) revealed that students regularize the irregular words, were they read the word (but /لكن) as (ل+ك+ن), which has no meaning in Arabic language, but it could have a meaning in the slang language. Students also read letters that are not pronounced; the word (small /الصغير) was read as (ا+ل+ص+غ+ي+ر), even though the letter (اللام) is not pronounced if followed by (shaddah, emphasis sign) ( ّ ) since it is an irregular word, but they regularized it.

Furthermore, they manifested errors in reading the tied "t-ة" at the end of the word (رسالة), which is read at the stopping point as ( ة ), but they read it as ( ة ). They also mispronounced the words ending by plural (waw/ واو) followed by ( ا ), where they read the word (شكروا) as ( ش+ك+ر+و+ا ) and the word (وقفوا) as ( و+ق+ف+و+ا ) by reading the letter (ا) which is written, but not pronounced. This finding agrees with (Friedmann, et al, 2014).

Nevertheless, the words that include letters that are not written but pronounced are considered as irregular words in Arabic languages, such as (هذه، هذان، ذلك). These words represented a difficulty for the students with surface dyslexia, where they were read by regularization and compromising, and the resulting words had no meaning in the Arabic language and were identified as non-words.

On the other spectrum, students with surface dyslexia manifested defect in reading words with short vowels, where the words were read while overlooking their existence in the word. This also affected the meaning of the read words, where the students demonstrated the characteristics of latency while reading these words. This can be explained by the fact that dyslexic students read through the non-lexical route while trying to link phonemes with short vowels and integrating them, in that the words represented a type of stressor on the student in an attempt to read the words. Some students deleted these short vowels, while others were exposed to a period of latency and slowness while reading the words that include short vowels. In addition, results revealed that the performance of the dyslexic students in the tasks of non-words is better than their performance in the tasks of irregular words. This agrees with (Valdois et al., 2003; Birch et al., 2016). Those students had orthographic difficulties while reading non-words as well as attempting decoding, this finding agrees with (Law et al., 2016).

The results showed low scores regarding the performance of the surface dyslexic students in the tasks of the morphologically similar words. It was suggested that the surface dyslexic students experience more difficulties in the morphologically similar words as compared to the phonologically similar words, indicating that the issue is less related to phoneme and more related to grapheme. This agrees with (Birch, 2016) which revealed that the problem of visual recognition of words is a basic one among the students with surface dyslexia. Therefore, the current study provides additional evidence that surface dyslexia exists in the languages that are characterized by being deep and shallow at the same time, such as Arabic language. It also exists in the deep orthography languages and shallow orthography languages. The reading errors among the students with phonological dyslexia are characterized by errors in phonological processing with a better performance in irregular words. This finding agrees with (Valdois, 2003, Law, 2013 and Friedman et al, 2014) which revealed that the reading errors among students with deep dyslexia were phonological and semantic, and morphological.

The results also showed that there are differences in performance between the deep and phonological dyslexia subtypes, where they had an approximate performance in the test of non-words, whereas the performance of the students with phonological dyslexia was better in the morphological words, concrete and abstract words, and the words with approximate meaning. It also revealed that students with deep dyslexia had more defect in the tests that measure semantic abilities as compared to the students with surface and phonological dyslexia. The students with deep dyslexia also had poorer performance in abstract words as compared to concrete words. This agrees with (Malhi, et al, 2019). The semantic errors among the students with deep dyslexia were characterized by introducing a word similar in meaning; for example, they read the word (علم) as (flag) (معلمًا) as (Teacher) and read the word (مدرسة) (School) as (درسًا) (Lesson).

## **CONCLUSION**

It can be concluded that it is possible to rely on the binary track in reading and analysing reading errors in the Arabic language and identifying sub-types of dyslexia.

In general, reading errors of various subtypes corresponded to the errors stated in languages with varying degrees of orthographic depth. The results indicated that surface dyslexia was primarily defined by impaired ability to read irregular and familiar words, including words and short vowels. However, decreased performance levels in tasks involving morphologically identical words were also found.

Regarding the deep dyslexia reading problems, the majority of observed errors were more broadly phonological, semantic, and morphological in nature. It scored lower on tests that assess semantic ability than students with surface and phonological dyslexia.

Additionally, distinctions between deep and phonological dyslexia subtypes were observed, most notably in the test of non-words, where phonological dyslexia performed better with morphological words, concrete and abstract terms, and words with approximate meaning.

Thus, this study adds to the body of evidence that surface dyslexia exist in languages that are both profound and shallow, such as Arabic. This may benefit those in charge of the educational process in preparing diagnostic measures based on the binary track model and directing educational programs to the true weaknesses of students, with studies intensified to detect students who are not classified as being within the subtypes of dyslexia.

With such a high prevalence of students with dyslexia exhibiting various forms of dyslexia, it is recommended that future research, particularly with differentiated instruction, would be extremely beneficial in assisting students in overcoming their disability and succeeding in their learning. This outcome should be considered when designing appropriate instruction for students with reading disabilities.

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