

FEMALES' SUPERIORITY ON PHONOLOGICAL AND LEXICAL PROCESSING

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Abstract

Gender differences in Arabic spelling accuracy of 288 Arabic speaking students from grade 1 to grade 9 were assessed. The spelling errors of these students were analyzed according to the paradigm of Abu-Rabia and Taha (2004). The results showed that generally across all ages/grades girls made fewer spelling errors, especially in the phonological and semiphonological spelling errors categories. The results are discussed in light of the international language research findings.

Introduction

Cognitive gender differences have attracted the attention of psychological scholars. Many studies have tested the specific differences between males and females, and the first comprehensive literature review was published by Maccoby and Jacklin (1974). They focused in their review on three major differences between males and females: a) females have better verbal skills, b) males have better mathematical abilities, c) males have better spatial skills. Since the review of Maccoby and Jacklin (1974), many studies conducted to test cognitive abilities and gender have indicated differences on verbal performance and verbal cognitive processing (Halpern, 1992; Emanuelsson & Svensson, 1990).

The current study tested the spelling ability of students in grades 1 to 9 students. The purpose was to test gender differences in phonological and lexical processing across grades through spelling and spelling error categories. The spelling method of Abu-Rabia and Taha (2004) was used to test phonological and lexical gender differences in spelling.

Literature Review

Verbal abilities are expressed in different verbal skills, basic academic skills, reading and writing. Wagemaker (1996) found that girls performed significantly better than boys on reading. The subjects were 9-14 years of age. These results were consistent in different countries. This superiority of females in verbal skills was also evident in dyslexic populations. In Miles, Haslum and Wheeler's (1998) sample of 269 dyslexic readers, 223 were males and only 46 were females, a 4.51 to 1 ratio favoring females.

Many scholars argue that the acquisition of reading is related to efficient phonological processing and that processing deficits are the basis of reading disability (Olson, 1994; Snowling, 2001). Thus we can argue that superiority of females over males in verbal skills means that they are better phonological processors than males. Norrelgen, Lacerda and Forsberg (2000) did not find significant differences between males and females on phonological processing.

Brain studies indicate that there is a difference between males and females in phonological processing and that different brain hemispheres are responsible for phonological processing of words in males and in females (Coney, 2002; Levy & Heller, 1992; Pugh, Shaywitz, Shaywitz, Constable, Skudlarski, Fulbright, Bronen, Shankweiler, Katz, Fletcher, & Gore, 1996; Shaywitz, Shaywitz, Pugh, Constable, & Skurlarski., 1995).

In testing the hemispheric specialization of phonological processing, Coney (2002) found that the left hemisphere is superior to the right hemisphere. When the data were tested by gender, the results indicated that more males showed phonological processing in the left hemisphere while the results of the females were less consistent.

Similar findings were obtained in experiments by Pugh et al. (1996) and Shaywitz et al. (1995): they found different activation patterns among males and females on reading tasks. Although the frontal regions of males and females were dominant while conducting phonological tasks, differences were found in hemispheric activation between males and females. Among females, bilateral activation was found in Broca's area, whereas among males the left hemisphere was dominant when processing phonological tasks. In addition, the left hemisphere was obviously alert while conducting the phonological, lexical and semantic among males, but there was bilateral hemispheric activation among females.

Frith and Vargha-Khadem (2001) tested reading and spelling of 45 children with brain damage. They found that the male readers' performance was significantly more deficient than female readers' when the damage was located in the left hemisphere and that females did not show deficiencies in their performance when the damage was located in one hemisphere only. This indicates that the cognitive abilities that underlie reading and spelling are in the left hemisphere for males in there is not one specific brain location for females.

Usually the differences between males and females on phonological and verbal measures are attributed to variance in their brain morphology, and this variance benefits females rather than males (Lambe, 1999). The purpose of this study was to test the differences between males and females on phonological spelling errors through spelling error analysis. We are assuming that spelling of words is considered a process that involves phonological and lexical processing (Frith, 1985; Snowling, 1987). The idea in the present study to test the performance of males vs. females on spelling lists across different ages on a paradigm of spelling-error analysis was developed by Abu-Rabia and Taha (2004).

Abu-Rabia and Taha analyzed spelling errors of native Arabic speakers and found seven error categories in the Arabic orthography. Some of these categories related to phonological processing and some were affected by lexical processing and mastery of Arabic spelling rules. Some errors were related to omitting real words and functional words, namely:

- 1) Phonetic errors (Snowing et al., 1996): These types of spelling errors are made when the writer is unable to translate specific phonemes of a certain word into graphemes. This mismatch between orthography and phonology is made when the writer cannot rely on lexical writing. For example, the word *يحضر* /to attend has the letter *ض* which represents the sound of *d* while there is another similar representation to this letter, which is *د* /*d*, that ultimately leads to a different and incorrect word. Further, some phonetic errors are also made because of confusion between the short vowels and long vowels:
 ب /BA can be confused with با /BAH. Some of these errors occur at the end of words when writers have to vowelize the end of words. For example, they may

- confuse a short vowel with a long vowel: The word *مدرسة* /school with a short phoneme *tun* may be written with the long vowel *مدرستن* /school, which is pronounced *madrastoon* with long *oon*. In addition, there may be intervention of the local spoken Arabic into the process of spelling when children hear the literary word, but they write it the way they speak it in their daily life.
- 2) Semiphonetic errors (Snowling et al., 1996): This is when the orthography of a word does not represent the target word phonologically because of lack of internal specific representation. However, the major orthographical-phonological chunk of the word is preserved. These errors are caused by omitting, adding and substituting phonemes. For example, the word *وَأَظِيفَة* /job may be written as *وظفه* /gave him a job.
 - 3) Dysphonetic errors (Boder, 1973; Snowling et al., 1996): This type of error occurs when the words are spelled incorrectly in more than one phoneme and when the spelled orthographic chunk does not represent most of the phonemes of the target words. Namely, there is no correct grapheme-phoneme correspondence and no internal lexical representation. For example, the word *فكرة* /idea may be read as *رفرت*, pronounced *Rifrat*, a nonword. It is more of a pseudohomophone that does not carry any meaning in Arabic.
 - 4) Visual letter-confusion errors: The spelling errors occur when children are confused between the similar shapes of letters: // ن , ث , ت , ب // // ش , س // ض , ص // . For example, the word *تذكرت* /she remembered may be spelled *ندكرت* (which is a nonword), because of substituting the letter *ت* /t for the letter *ن* /n, two visually similar letters with different sounds.
 - 5) Irregular spelling rules: These errors occur because of lack of mastery of the spelling rules of Arabic. For example, *أل* /the is not pronounced when it precedes the “sun” letters; however, it is represented in writing. Further, the consonant *ء* is presented in a word according to the vowel and letter that precede it. Thus, there are different ways of spelling a consonant in a word: *سائل* /liquid, *مسؤول* /responsible, and *أين* /where.
 - 6) Word omission: Errors when children omitted whole words.
 - 7) Functional words omission: Errors when children omitted functional words that preceded words.

Spelling, Reading, Phonology and Mental Lexicon

The relationship between reading development skills and decoding and spelling development has been the subject of much scholarly research. The link between spelling and the reading skills has been established (Curtin, Manis & Seidenberg, 2001; Ellis, 1993). Frith (1985) argues that spellers first go through the alphabetic stage where they heavily rely on phoneme-grapheme mapping and then reach the orthographic stage where they are able to spell irregular words. Still there is a need for the development of a lexical route to enable the retrieval of specific orthographic chunks of phonological pronunciation (Lennox & Siegel, 1998). The development of this lexical route for spelling is the stage of skilled spellers. A rich lexicon enables the correct spelling of irregular words with deep orthographic chunks.

This ability develops as a result of experiencing reading and acquiring good reading skills (Snowling, 1987), which strengthens the relationship between reading and spelling skills (Ellis, 1993).

Thus, according to the above literature, an efficient orthographic lexicon enables efficient spelling processing because it contains the specific knowledge about the different orthographic chunks. This is in addition to the spelling rules of the specific writing system. Different orthographies are usually characterized by different spelling rules. The Arabic language has a unique orthography with unique spelling rules (Abu-Rabia & Taha, 2004, 2006, in press).

In sum, the question that underlies this study is: are there any gender differences in spelling error types as a result of phonological and lexical processing? Our hypothesis is that female will make fewer phonological processing based errors(i.e. Semiphonetic errors & Dysphonetic errors) and fewer lexical processing based errors(i.e. Phonetic errors & Irregular spelling rules), because the phonetic errors aren't directly a phonological processing based errors.

Method

Participants. Two hundred and eighty-eight Arabic-speaking students participated in this study, 119 females and 169 males. They were all students from grade 1 to grade 9 (see Table 1). All the students came from ideal socioeconomic status and from normal populations. All students who were known to be reading or learning disabled and students with special learning problems were dropped from this sample.

Table 1: The Distribution of Males and Females

Grade	Male	Female	Total
1	14	18	32
2	9	20	29
3	14	17	31
4	12	19	31
5	17	14	31
6	12	21	33
7	14	21	35
8	16	20	36
9	11	19	30
Total	119	169	288

Materials

Nine lists of words were composed for testing the spelling skills of these students from grade 1 to grade 9. For each grade, the list of words was based on the basal reader of the Ministry of Education. Each list of words was built according to gradually increased difficulty, also considering low and high frequency words. All the lists were judged by the teachers of those classes for frequency and difficulty level. Each list represented the words and their complexity in Arabic the way they are presented in the basal reader. The list of words consisted of a different number of words(cronbach alpha is parenthesized) ; grade 1, 24($\alpha = 0.911$); grade 2, 25($\alpha = 0.88$); grade 3, 35($\alpha = 0.91$); grade 4, 35($\alpha = 0.943$); grade 5, 40($\alpha = 0.922$); grade 6, 40($\alpha = 0.82$); grade 7, 40($\alpha = 0.906$); grade 8, 40($\alpha = 0.93$) and grade 9, 45 words($\alpha = 0.912$). These lists were presented in pilot studies on regular classes and teachers were asked to comment on the difficulty level and the level of frequency of each word. Ten teachers were asked to comment on frequency and level of difficulty. Almost 15% of the original list was dropped or revised to raise the level of reliability of each list.

Procedure

All lists of words were administered to the participants in their regular classes at their schools. Instructions in Arabic, their mother tongue, were given to all the students. They were instructed to write down as fast as they could words which dictated to them by the tester. The Arabic teacher of each specific grade level attended the testing in each class. The whole testing procedure took 9 days, one for each grade. They were tested for spelling accuracy.

Results

The spelling errors across all grades (from grade 1 to grade 9) were qualitatively analyzed according to the spelling error analysis paradigm of Abu-Rabia and Taha (2004). Furthermore, for statistical analysis the ANOVA was applied to test the significant variance between the categories as a result of gender. The dependent variable was defined as the mean number of spelling errors made by each gender group and the independent variable was the groups, boys and girls. The girls made significantly fewer spelling errors than the boys $F(1,286) = 18.721, p < 0.001$ (Table 2).

Table 2: Mean Spelling Errors of Males and Females

Gender	M	SD	N
Male	12.88	8.55	119
Female	8.97	6.74	169
Total	10.59	7.77	288

Table 3 presents the mean of spelling errors of all boys and girls in all categories.

Table 3: Mean Spelling Errors on all Error Categories as a Function of Gender

Gender		Pho.	Dys.	S.Ph.	S.Rules	V.S.	O.W.	A.W.
Male	<u>M</u>	5.95	1.94	1.47	2.54	.29	.62	6.7
	N=119 SD	4.28	3.02	1.64	2.13	.76	1.61	.64
Female	<u>M</u>	4.41	.93	1.04	1.89	.29	.34	5.32
	N=169 SD	3.89	1.65	1.34	1.96	.78	1.37	.38
Total	<u>M</u>	5.05	1.34	1.27	2.16	.29	.46	5.90
	N=288 SD	4.12	2.37	1.48	2.05	.77	1.48	.50

Pho. = phonetic

Dys. = dysphonetic

S. Pho. = semiphonetic

S. rules = spelling rules

V.S. = visual similarities

O.W. = omission of words

A.W. = addition of words

Generally, the ANOVA 2(male/female) x 7(spelling error categories), revealed a significant effect for gender $F(1,286)=18.721$, $p<0.001$ and indicated a main effect for gender on the phonetic error categories $F(1,286) = 9.986$, $p < 0.05$. Further, there was also a significant effect for gender on the semiphonetic error category, $F(1,286) = 13.27$, $p < 0.05$). Similarly, there was a significant effect for gender on the disphonetic category $F(1,286) = 5.93$, $p < 0.05$ and on the spelling rules category $F(1,286) = 6.88$, $p < 0.05$. However, there was no significant effect for gender on the other categories: visual letter similarities and omission of words. The focus will be on the gender differences in the phonological and the lexical error categories (phonetic, semiphonetic, disphonetic& spelling rules category errors).

Discussion

The results of the present study indicate clearly that girls are better in spelling phonological and lexical processing than boys. The differences between males and females on language in general are not new (Halpern, 1992; Emanuelsson and Stevansson, 1990); however, such differences in phonological and lexical spelling processing based and reading are quite new. The results of our study support and expand previous results of Halpern (1992) and Emanuelsson and Svensson (1990) that females were superior on verbal skills. However, other researchers failed to find statistically significant gender differences on phonological processing although the females achieved better grades (Norrelgen, Lacerda & Forssberg, 2001).

The results of the current study indicate that girls are better processors of phonology than boys, which supports the notion that later, these girls may be equipped with better verbal abilities than the boys. This is because phonology is necessary for the development of reading and writing (Adams, 1990; Bradley & Bryant, 1983; Stanovich & Siegel, 1994; Share, 1995).

Neurocognitive studies indicated that the language areas in the brain that are responsible for processing reading and writing are located in different brain areas among males and females. Among males, these areas are located mainly in the left hemisphere and among females they are spread in both hemispheres (Coney, 2002; Levy & Heller, 1992; Pugh et al., 1996; Shaywitz, et al., 1995; Frith et al., 2001; Lambe, 1999).

These neurocognitive results fit nicely into the assumption of many reading and writing scholars that when spelling is significantly more efficient it is based on mental lexicon orthographic-direct retrievals than when it is based on phonology (Abu-Rabia & Taha, 2004, in press; Lennox & Siegel, 1998; Snowling, 1987, 2001; Snowling et al., 1996; Frith, 1985). It seems that females with their more widely developed brain areas for language become better processors of phonology and that this accelerates and enriches their orthographic mental lexicon with the orthographic combinations of writing. This enrichment of their mental lexicon may enable faster retrieval and more efficient lexical processing by the female skilled spellers whenever it is needed. The males may continue to struggle with spelling at the phonological stage due to less widely dispersed brain language areas.

In the current study we used only one spelling error paradigm across ages on one list of words for each age level. We found clear gender differences on phonological error categories favoring the females, but we still cannot be sure of the breadth of these gender differences until a wider variety of verbal tasks has been tested comparing the performance of males' and females' phonological, orthographic and mental processing.

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