Effectiveness of a Phonological Awareness Training for Arabic Disabled Reading Children: Insights on Metalinguistic Benefits

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Abstract
We examined the effects of a phonological awareness (PA) training program on word reading and pseudo-word decoding in dyslexic children reading the Arabic language (n=10; mean age= 129.74 months) in comparison to normal readers (n=10; mean age = 126.90 months) from grades 4 and 5. Particular attention was paid to phonological training of two metalinguistic reading-related skills: morphological awareness (MA) and rapid automatized naming (RAN), underscored as main predictive metalinguistic factors in Arabic dyslexia (Layes, Lalonde, Mecheri, Rebaï, 2015). The PA training program focused on phoneme/syllable identification, phoneme matching, and word segmentation. The results indicate that the dyslexic group performed significantly better in all post-training measurements, increasing reading, phonological processing, and metalinguistic-related skills, which indicates a strong relationship between these variables. The normal group only improved in MA production. These findings are discussed in terms of metalinguistic insights of reading gained through training in phonological awareness.

Keywords: Arabic orthography, phonological processing, phonological awareness training, morphological awareness, rapid naming

Résumé
Nous avons examiné les effets d'un programme d'entrainement phonologique sur le développement de la conscience phonologique, la lecture des mots et le décodage de pseudo-mots chez les enfants dyslexiques arabophones (n= 10, moyenne d'âge = 129,74 mois) en comparaison avec des lecteurs normaux (n = 10; moyenne d'âge = 126,90 mois) en 4ème et en 5ème années primaires. Nous avons recherché l'effet de l'entrainement phonologique axé sur la manipulation et l'identification des phonèmes / syllabes et la segmentation des mots, sur deux habiletés métalinguistiques liées à la lecture: la conscience morphologique et la dénomination rapide automatisée (RAN), comme principaux facteurs prédictifs de la dyslexie en arabe (Layes, Lalonde, Mecheri, Rebaï, 2015). Les résultats ont montré que les dyslexiques ont nettement amélioré leurs performances dans toutes les mesures post-intervention y compris les compétences métalinguistiques, indiquant une forte association entre ces variables. Les normo lecteurs ont progressé uniquement dans la production morphologique.

Mots-clés: l'orthographe arabe, le traitement phonologique, l'entrainement phonologique, la conscience morphologique, la dénomination rapide

Resumen
Se examinaron los efectos de un programa de entrenamiento de conciencia fonológica en la lectura de palabras y decodificación pseudo-palabras en niños disléxicos leen la lengua árabe (n = 10; edad media = 129,74 meses) en comparación con los lectores normales (n = 10; edad media = 126,90 meses) a partir de los grados 4 y 5. Particular atención se prestó a la formación fonológica de dos habilidades relacionadas con la lectura metalingüística: conciencia morfológica y nombrar rápidamente automatizado (RAN), destacó como principales factores predictivos metalingüísticas en dislexia árabe (Layes, Lalonde, Mecheri, Rebai, 2015). El programa de capacitación se centró en fonema / identificación sílaba, juego de fonemas, y la segmentación de palabras. Los resultados indican que el grupo disléxico un desempeño significativamente mejor en todas las mediciones posteriores a la formación, el aumento de la lectura, el procesamiento fonológico, y habilidades relacionadas metalingüísticas, lo que indica una fuerte relación entre estas variables. El grupo normal sólo mejoró en la producción de la conciencia morfológica. Estos resultados se discuten en términos de conocimientos metalingüísticos de la lectura obtenida a través de la formación en la conciencia fonológica.

Palabras clave: ortografía árabe, procesamiento fonológico, entrenamiento fonológico, conciencia fonológica, de denominación rápida

Introduction

The most acknowledged causal factors underlying dyslexia are the ability to reflect on and manipulate structural features of language (phonological processing and morphological awareness) and naming speed (Ellis, 2002; Wagner et al., 1997). Phonological awareness (PA) is the more widely known factor, which refers to the individual's implicit and explicit sensitivity to the sub-lexical structure of oral language and the ability to decode and manipulate the alphabet (Abu-Rabia, Share & Mansour, 2003). Given that learning to process printed words represents the major challenge for school-age children, there is a vital need to promote phonological awareness in the classroom. The current study examined the effectiveness of a phonological awareness-based intervention in disabled and normal Arabic children in 4th and 5th grades on concurrent metalinguistic factors in reading acquisition, i.e. morphological awareness (MA) and rapid automatized naming (RAN), identified as core metalinguistic predictors of reading ability beside the phonological decoding measured by pseudo-word identification examined in a previous study (Layes et al., 2015).

The Key Role of Phonological Processing and Morphological Awareness in Reading

Learning to read is fundamentally metalinguistic, such that children must find out what linguistic units are represented by the elements of written language, whether phonemes,

syllables, or morphemes. Accordingly, phonological processing refers to the sounds of one's language in processing written and oral language (Wagner, Torgesen, & Rashotte, 1994). There is convergent evidence showing that children with dyslexia exhibit problems in all aspects of phonological processing including PA, RAN, and phonological memory (Torgesen, Wagner, Rashotte, Burgess & Hecht, 1999), leading to impairments in transcoding written words into correct pronunciation via the application of grapheme-phoneme conversion rules (e.g. Ramus, Rosen, Dakin, Day, Castellote, White & Frith, 2003).

A huge body of research has established that phonological processing predicts reading success and applies to all languages so far studied (Anthony & Francis 2005; Castles & Coltheart, 2004), including Arabic (Al Mannai & Everatt, 2005; Elbeheiri & Everatt, 2007; Saiegh-Haddad, 2005). Thus, phonological processing deficits seem to be a universal marker of reading difficulties across orthographies (e.g. Zeigler, Pech-Georgel, Dufau, & Grainger, 2010). However, MA, the internal organization of words, has recently emerged as an important metalinguistic factor associated with PA and reading skills in alphabetical systems and seems to be critical in reading development (Casalis & Colé, 2009; McBride-Chang, Tong, Shu, Wong, Leung, & Tardif, 2008), comprising Arabic since it basically uses morphological orthography (Boudelaa & Marslen-Wilson 2005; Saiegh-Haddad & Geva, 2007).

The second significant component of phonological processing skills emanates from speed of lexical access, the best known form being RAN (Wolf & Bowers, 1999; Wolf & Katzir-Cohen, 2001). RAN depends on the subject's ability to retrieve phonological information and is linked to reading development in different orthographies (Layes et al., 2015, Manis, Seidenberg, & Doi, 1999; Swanson, Trainin, Necoechea &, Hammill, 2003). While RAN and reading require many of the same processes, particularly the connecting of orthographic and phonological representations (Norton & Wolf, 2012), the former is considered a universal predictor of reading fluency across all known orthographies (Georgiou, Parrila, & Papadopoulos, 2008).

As reviewed and given the recognized correlations among PA, rapid naming, and MA as core prerequisites for learning to read across languages (Hulme & Snowling, 2013), research to date underscores the importance of investigating the contribution of these metalinguistic reading-related skills on reading efficiency. Tijms (2011) suggest that it is imperative to understand whether such factors operate in the evaluation of phonological training effectiveness.

Arabic Phonological Structure

Arabic is an alphabetic orthography with 28 letters that represent consonants of the Modern Standard Arabic (MSA) read from right to left. Arabic has six vowel phonemes: three long vowels / ā /, / ū /, and / ī / and three short vowels /a/, u/, and /i/ represented through an optional system of superscripted diacritics. Short vowels are represented as extra-diacritical marking, while patterns that include vowel letters are inserted between the root consonants (Taha, 2013). Moreover, Arabic writing is syllabic where, unlike English, the sound symbol association is almost entirely one-to-one and words always begin with a single consonant followed by a vowel (Aaron & Joshi, 1989).

Arabic orthography has two optional forms, vowelized (fully or partially) and un-vowelized. Vowelized orthography includes letters and diacritics that represent all consonants and vowels (shallow orthography). Unvowelized forms, which include only consonants so that short vowels are not represented, are considered as less transparent (Abu-Rabia, 1997). For example, the unvowelized word /KTB/, supports several alternatives as /KaTaBa/ (he wrote) , /KiTaB/ (book), or /KaTiB/ (writer). Hence, there is a variety of syllable structures, the most common being short syllables (Balasubramanian, 2011), in associations of consonant and vowel (CV), typical syllables in the form of closed syllables (CVC), and open syllables (CVV) as well as long syllables with different end structures (e.g. CVVC; CVCC).

These linguistic characteristics infer that lexical accesses developed by Arabic literate children operate via phonological representations based on a perfect discrepancy between consonants and their positions (root) and vowels (pattern). Roots and phonological patterns are abstract entities and only their joint combinations forms specific words, so that the former convey the core meaning of the word whereas the later convey the phonological pattern of word class information. Furthermore, many letters have a similar or even identical structure and are distinguished only on the basis of location and number of dots, e.g. the Arabic letters /t/ (ت) ; /th/ (ث) and /b/ (ب). Every letter can be made into different shapes depending on its position in the word, for example the phoneme /m/ is represented as ﻢ, ﻤ, ﻣ (Ibrahim, 2009). Thus, learning to read Arabic relies on a precise distinction between graphemic characteristics which may be ensured by further visual processing.

Phonological Awareness Training

Systematic and explicit instruction in PA by matching letters with sounds is reported to serve as a remedial procedure for reading disabilities (e.g. Ehri, et al., 2001). This sort of instruction

seems beneficial for normal and disabled readers, so that children who received PA training get higher scores on reading achievement than children who did not. However, the expected positive effect of phonological training on reading in the literature was permanently studied without seeking potential benefits of such intervention on supplementary related metalinguistic skills (i.e. MA and RAN).

In Arabic-based studies, little research is available to support the usefulness of PA on reading skills in disabled reading children. Tibi (2010) conducted PA training on 140 typical readers from the first three elementary grades. The results showed a developmental progression across all three grade levels on all four tasks tested (identification of initial sounds, rhyme oddity, syllable deletion, and word segmentation). More recently, Ibrahim (2013) examined the effects of an intervention program for improving PA in kindergarten Arabic children. Children trained in phonological skills attained higher scores on tests of PA than the control group and had superior reading abilities in the first grade. It seems that effective training in developing awareness in Arabic may involve the implementation of various phonemic patterns combined with roots, rather than focusing on single phonemes reported as the main method leading to the emergence of alphabetic skills in other orthographies (Lyster, 2002).

Practical consideration concerns the optimal strategy for training children to link their emerging PA to print. In contrast to opaque orthographies (e.g. English), there is significantly more regularity at the level of grapheme–phoneme correspondences than at the level of the orthographic rhyme (Treiman, Mullenix, Bijeljac-Babic, & Richmond-Welty, 1995). Therefore, it may be better to teach children to focus on links between phonemes and letters (or letter strings), rather than to emphasise the linkage between rhymes and print, because at this level they will be faced with consistency in spelling–sound correspondences.

The current study aimed at assessing the effectiveness of PA training based on the use of phoneme and syllable identification, blending and segmenting, in improving the reading of words and pseudo-words along with RAN and MA skills in 4th and 5th grade dyslexic and non-dyslexic children. A number of variables mediating program implementation and literacy outcomes may demonstrate how well the PA based intervention can be useful for the targeted population in the classroom environment.

The following main research questions were addressed:

1. Does phonological training enhance PA measured by phoneme blending and phonological decoding (pseudo-word identification) in all participants?

2. Does phonological training improve reading accuracy in all participants?

3. Does phonological training assist in advancing MA and RAN as concurrent outcomes in post-training reading achievement?

We predicted significant effects of PA training on dyslexic children relative to typical readers on all measures.

Method

Participants

All participants were readers of Standard Arabic and enrolled in regular classes. Twenty children took part, including normal readers (n=10) with a mean age of 126.9 months (SD=7.18) and dyslexics (n =10) aged 129.74 months (SD=9.35) taken from those available to continue on the training program (n=13). An additional criterion was their adequate performance on the Raven Standardized Matrices. Normal readers were exempt from any learning or language disabilities. Independent t-tests showed no difference between the two groups on IQ and age (Table 2). Both groups received the same phonological intervention program with the consent of parents informed about its general aim.

Design and Procedure

Unlike previous Arabic studies (Dallasheh-Khatib, Ibrahim, & Karni, 2014; Taha, 2013; Tibi, 2010), the present one focused on investigating the effects of PA intervention on dyslexics and normal readers from grades 4 and 5 at pre-training and post-training periods. Both groups were exposed to a similar reading condition in the classroom.

Before the intervention, all participants were tested on criterion-referenced reading tests. The children of the two groups then completed phonological training at the same time. The training lasted 12 weeks, in three sessions of 40 minutes per week. The duration and frequency of intervention sessions are relevant to the age group (Griffiths & Stuart, 2011).

The Phonological Training program: Background and content

Phonological training was designed as an explicitly delivered intervention focusing on phoneme identification as well as segmenting and blending sounds in spoken words as highly inter-correlated sub-skills (e.g. Gillon, 2004). The tasks in the PA program were based on those reported in the literature at word and syllable levels (e.g. Taha, 2013; Tibi, 2010). Particular consideration was given to word segmentation, systematic and explicit instructions of speech sound–letter mappings based on a small group model, and integration of letter-sound knowledge (Schneider, Kuspert, Roth, Vise, & Marx, 1997). These activities were

rotated from easiest to hardest throughout training. The author moved throughout the continuum of PA skills as indicated in the content program below. The children participated by listening, answering questions, and following directions. The following tools were used:

a) Pictures: ten cards, each composed of 12 pictures, in that different letters of the Arabic alphabet in initial and final positions of the words are represented. The pictures are ranged in cards illustrating animals and objects of everyday life and serve as visual support for phonological activities. Each participant was given a copy so that he/she could execute the tasks individually.

b) A large format card including all Arabic letters with short and long vowels.

Unlike the reviewed phonological training interventions, the main characteristics of the present program are related to:

- The syllabic-based activities, combining consonants and (short) vowels as basic units in all phonological tasks (identification, segmentation, blending).

- The exclusive use of images as visual support.

Program implementation

To ensure the homogeneity of group training procedures, the 10 children in each group were trained collectively with identical timing. During training sessions, each child were questioned in turn, and the children's errors were discussed with the experimenter. If a child encountered difficulties, he/she received further explanations and a few minutes of each training session were specifically devoted to those needing them. The objective was that all children get the same amount of information and to follow the progression exactly. The training period was broken down into 3 phases:

First phase: To reinforce the child's knowledge of phoneme-grapheme relations (*alphabetic awareness*)**,** three weeks of exercises were devoted to learning letter identification with different diacritics marks and thereby enhance familiarity with letter names leading to recognition and identification of letters and sounds *(phoneme-grapheme knowledge)*. *Participants were initiated to* letter formations with three short vowels (diacritics) and three longs vowels *(sound-letter association activities)*, and to differentiate between similar letters in terms of shape (letters in different positions).

Second Phase: during weeks 4 to 6, we targeted developing the ability to discriminate graphemes by their vocal forms. Implementation of tasks requires detecting the first and the last phonemes alternatively corresponding to the name of objects illustrated on the cards, with increasing implication of syllable segmentation. This includes the following activities:

- *Picture to syllable matching*: The child was told to point to the corresponding picture chosen on the card (the phonemes are randomly presented) for the identifiying the picture through the first or last phoneme of the object's names.

- *Words segmentation:* To analyse words at the phonemic level, children were asked to segment words presented orally into syllables (CV). Two sets of words were used: 10 bi-syllabic and 10 di-syllabic words. As an introduction, participants performed the segmentation mentally by mean of manual taps. Example: /tawila/ (table) = three syllabes.

Third phase: This section lasting 6 weeks targeted the development of PA and phonological memory via the recognition of visual items. The instructor chose a set of pictures on the card and asked the participant to identify as rapidly as possible the pictures whose names begin with a pronounced phoneme. The child responded by placing sticks on the chosen pictures. This includes:

- Syllable deletion: After the identification of the initial sound of the word, the child deletes the first sound of the word heard and then pronounces the remained segment.

- Syllable blending: After assembling the first phonemes of the three names of pictures randomly arranged on the card, participants were asked to pronounce the result of the three assembled first phonemes.

- Rapid phoneme identification (recognition).

Pre and Post Training Measures

Reading tasks

A set of 80 words (α = .83) was given to be read aloud (40 frequent words and 40 infrequent words). The words varied for length (disyllabic and trisyllabic) and frequency (high and low). In addition, 20 pseudo-words (α = .94) controlled for orthographic length (Layes, et al., 2015) were used. Frequency was determined by consulting the Aralex lexical database for Modern Standard Arabic (Boudelaa & Marslen-Wislon, 2010), over 25 appearances per million being frequent.

Phonological awareness: Syllable manipulation. (α = .66)

This refined skill including phoneme deletion, segmentation, extraction and retention, represents the ability to manipulate sounds to support the flexible use of knowledge (Konza, 2011). Twenty pairs of words were presented orally and participants asked to isolate the initial syllables from each word and then to pronounce the new combination of these isolated segments. Words include consonantal clusters (CVCVC), since Arabic words are trilateral

consonantal roots. Two practice trials were given to make sure that the participants understood the task.

Morphological awareness test (α = .86)

Adapted from the Arabic Morphological Awareness test described by Taha and Saiegh-Haddad (submitted), this measure assesses a child's implicit morphological awareness, and consisted of two tasks:

-   Recognition of morphological patterns.

To evaluate children's ability to recognize the morphological relationship between words (derivational morphology knowledge), twenty pairs of words were orally presented either related morphologically (example: /3amal/ (work) /3amel/ (worker)), or semantically (example: /mahkama/ (tribunal), /3adala/ (justice)). Participants were instructed to decide whether the two words were morphologically related (i.e. from the same family or not).

-   Morphological production.

This timed task was conceived to examine the participants' ability to generate morphologically related words. Ten vowelized verbs were presented to participants to generate as quickly as possible four derived forms in five minutes. The expected responses follow various patterns commonly used in Arabic (e.g. /ka:teb/ [writer]; passive adjective /maktu:b/ [written], etc.).

Rapid naming tasks

- Rapid Automatized Naming: RAN objects.

Prior to timed naming, participants named as quickly as possible recurring objects (scissors, cat, book, pen, hand) in a practice trial. They then named objects arranged semi-randomly in five rows and repeated 10 times (Layes et al, 2015). The time needed to name all stimuli was measured.

-   Rapid Alternating Stimulus (RAS).

This test was based on previous studies (Wiig, Zureich, & Chan, 2000). The present version consisted of three sets of letters: five Arabic digits (2, 4, 6, 7, 9) and six geometric shapes (triangle, square, rectangle, circle, star, new moon) repeated in a randomized pattern. Participants were asked to name the items as fast as possible. Cronbach's alpha coefficient was .65, and Pearson coefficients between test-retest reliability was adequate (r=.51 to .56).

Validation of the Instruments

To determine the underlying dimensions of the multi-task measurements, an exploratory factor analysis was undertaken (KMO = .645; Bartlett's test of sphericity $p < .000$). The

dimensions of the subtests were examined by principal component analysis with Varimax rotation, with 8 items indicating that the initial Eigen values of the first factor (frequent words, infrequent words, pseudo-words, and PA) explained 43.49% of the variance with factor loadings of 0.87 to 0.88. The second factor (morphological awareness) explained 20.58 % of the variance with factor loadings of 0.50 and 0.84. The third factor (rapid naming) explained 13.89 % of the variance with factor loadings of 0.54 to 0.88.

Statistical Analyses

One-way MANOVA with "Group" of readers as a fixed factor was performed to evaluate group differences in the pre-training period. Dependent variables included reading words, pseudo-word decoding, PA, RAN, RAS, and MA. A within-group comparison with a paired sample t- test was conducted to assess whether the training program was effective in enhancing phonological processing and reading as well as metalinguistic reading-related skills (MA and rapid naming). In addition, a t-test for independent samples was performed for comparing dyslexics and typical readers on all measures during pre-training and post-training periods.

Results

Pre-Training Period

Sample characteristics of dyslexic and normal readers are presented in Table (1). As expected, significant differences emerged on all the measures. A one-way MANOVA with seven dependent variables (word reading, pseudo-word decoding, PA, MA, RAN, RAS) and "group" (dyslexic / normal readers) as the fixed factor was run. The omnibus effect for groups was significant (Wilks'λ =.200, $F_{(7.12)}$ = 6.86, $p < 0.002$), partial eta squared = .800 and the power to detect an effect.985 and so univariate effects were examined. Significant main effects on ANOVAs were obtained for RAN, $F_{(1.18)}$ = 6.833, $p <.01$, partial eta square =.275, power = .696 , PA, $F_{(1.18)}$ = 4.568, $p <.04$, partial eta square =.202, power = .525, word reading, $F_{(1.18)}$ = 26.819, $p <.000$, partial eta square =.598, power = .998; and pseudo-word decoding, $F_{(1.18)}$ =31.605 , $p <.000$, partial eta square = .637, power =1 .000.

Due to a significant group difference in "morphological recognition pattern" (Table 1), a separate MANOVA for MA tasks was conducted. Wilks'λ =.695, $F_{(2.17)}$ = 3.72, $p < 0.05$), partial eta squared = .305. The power to detect the effect was .602.

Table 1. Participant's characteristics and mean performance by group in all pre-training measures

	Normal Readers	Dyslexics		Mean Dif

Variables	M	SD	M	SD		t (2.00)
Age (months)	126.90	7.18	129.74	9.35	-2.10	-0.56 ns
Raven	20.10	4.77	18.00	4.59	2.10	1.00 ns
Total reading words	64.70	6.49	46.10	9.31	18.60	5.17***
Frequent words	35.20	3.73	27.40	5.60	7.80	3.66***
Infrequent words	29.50	3.10	18.70	5.87	10,80	5.14***
Pseudo-words	21.10	6.70	8.40	2.45	12,70	5.62***
PA	11.20	4.04	7.30	4.99	3,90	2.13*
Total M. A	26.60	4.16	24.00	3.80	2.60	1.45 ns
MA recognition pattern	13.00	2.16	9.70	3.02	3.30	2.81**
MA Production	13.60	3.09	14.30	3.80	-0.70	-0.45 ns
RAN	32.40	8.22	41.60	7.50	-9.20	-2.61**
RAS	49.60	16.85	51.50	14.99	-0.26	1. 90 ns

Note. PA= phonological awareness; M. A= morphological awareness; RAN= rapid automatized naming ; RAS= rapid alternate stimuli ; Mean Dif= mean difference
*P <.05; **P <.01; ***P <.001; n.s. = not significant.

Within Group Comparison: Effects of the Phonological Training Program

To test potential differences of the intervention program, we compared pre- versus post-training periods by paired t-tests (Table 2). Significant improvements were found in the dyslexic group (t (27) = 2.26, p < .05) for word reading (p < .000), pseudo-word decoding (p < .01), MA (p < .01 except for pattern recognition), and RAN (p < .01). Normal readers improved only for morphological production (p < .01).

Table 2. Pretest and post-test scores, mean differences, paired samples t–test and effect sizes (Cohen's d) for typical readers (n=10) and dyslexics (n=10).

Measures	Normal readers			Dyslexics		
	Mean Dif	*t* value	Cohen's d	Mean Dif	*t* value	Cohen's d
Total reading words	-1.20	-0.54 ns		-11.50	-4.04 ***	2.69
Frequent words	-1.30	-1.31ns		-4.30	-2.88 **	1.92
Infrequent words	-0.10	0.07 ns		-7.20	-2.73 *	1.82
Pseudo-words	3.80	-1.98 ns		-7.10	-3.17 **	2.11
PA	1.20	-1.47 ns		-6.20	-3.17 **	2.11
Total M A	-5.90	-3.98 **	2.65	-7.90	-3.47 **	2.31
MA Pattern recognition	-0.10	-0.12 ns		-1.90	-2.05 ns	
MA Production	-5.80	-4.22**	2.81	-6.00	-3.12 **	2.08

RAN	-4.00	-1.53 ns		-9.20	3.09 **	2.06
RAS	-8.00	-1.28 ns		5.70	0.76 ns	

Note. PA= phonological awareness; M. A= morphological awareness; RAN= rapid automatized naming ;
RAS= rapid alternate stimuli ; Mean Dif= mean difference
*P <.05; **P <.01; ***P <.001; n.s. = not significant

As presented in Figure 1, PA effects in the dyslexic group increased as a function of time for all measures and typical readers only for morphological production.
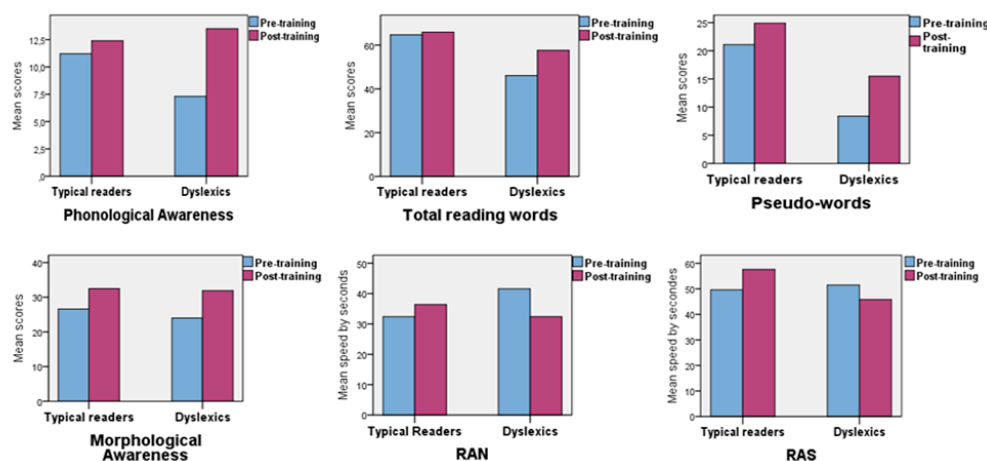

Figure 1. Performance comparisons between dyslexics and typical readers in Pre and Post- training measures.

Post-Training between Groups Comparison

As shown in Table 3, between-group comparisons in the post-training period revealed no significant differences between dyslexic and typical readers on any measure, including word reading, PA, MA, and rapid naming, except for pseudo-word decoding (t (2.00) = 2.88; p < .01).

Table 3. Participant's mean performance by group in post-training measures: reading, PA, MA, RAN, and RAS

Variables	Normal Readers n= 10		Dyslexics n= 10		Mean Difference	t (2.00)
	M	SD	M	SD		
Total reading words	20.10	4.77	18.00	4.59	2.10	1.00 ns
Frequent words	65.90	7.14	57.60	12.10	8.30	1.86 ns
Infrequent words	29.40	4.71	25.90	8.67	3.50	1.12 ns
Pseudo-words	24.90	7.14	15.50	7.44	9.40	2.88**
P.A	13.50	3.97	12.40	2.91	1.10	0.10 ns
Total M.A	32.50	6.81	31.90	5.75	0.60	0.18 ns

MA Pattern Recognition	13.10	2.55	11.60	2.41	1.50	1.34 ns
M.A Production	19.40	5.62	20.30	6.61	-0.90	-0 .45 ns
RAN	36.40	12.56	32.40	10.45	4.00	0.77 ns
RAS	57.60	20.05	45.80	13.39	11.80	1.54 ns

Note. PA= phonological awareness; M. A= total morphological awareness; RAN= rapid automatized naming ;

RAS= rapid alternate stimuli. *P <.05; **P <.01; ***P <.001; n.s. = not significant

Discussion

The Effects of Phonological Training on Reading Words and Pseudo-Words

The first research question was whether phonological training enhances phonological awareness and consequently improves word reading accuracy and pseudo-word decoding. Positive results of the present study replicate previous findings of PA and other decoding skills that benefit struggling readers (Snowling & Hulme, 2011; Torgeson, 2006). More particularly, our results show that phonological intervention improved phonological processing of blending and decoding, in line with previous results (Fälth, Idor, & Tomas, 2011; Lyster, 2002), including Arabic-based studies (Dallasheh-Khatib et al, 2014), indicating that the blending of phonemes, besides other subskills, are strong predictors of future reading success.

The results regarding pseudo-word decoding accuracy suggest that the phonological training program increased participants' knowledge of letter-sound patterns, whereby students effectively applied the strategy of sounding out unfamiliar words. Pseudo-word decoding is considered to be a rigorous test of competence for decoding in general and strongly correlated with reading acquisition (Castle & Coltheart, 2004). By the end of the program, dyslexic participants were competent in identifying pseudo-words and their accuracy improved in the post-intervention period (Table 3).

The Effect of Phonological Training on Morphological Awareness and Rapid Naming

The second research question was whether this intervention advances MA and RAN as concurrent outcomes in reading achievement. The present findings showed significant gains in MA in the dyslexic cohort, in line with correlational studies (Lyster, 2002), indicating that such participants developed morphological knowledge to a significantly higher level than typical readers. This finding demonstrates that the ability to manipulate the sound structure of words facilitated the development of MA and highlights a reciprocal relationship between

MA and PA, though scores of each contribute to an independent part of variance in learning to read.

Similarly, Dallasheh-Khatib et al. (2014) investigated the effects of MA and phonological intervention programs in kindergarten on the reading abilities of 1st grade Arab-speaking children. The phonological intervention group improved several phonological tasks including last phoneme match and phoneme count tasks as well as morphological tasks, including morphological synthesis and combined morphological scores. This may be ascribed to the development of morphology sensitivity underscored in Semitic languages that may hasten the decoding process and assist in the reading of complex words (Arnbak & Elbro, 2000).

In contrast to dyslexic subjects, normal readers improved only on the morphological production task, in agreement with previous results (Nelson, Benner, & Gonzales, 2005). Torgesen (2006) reported that the effects of phonological training are of particular importance for children with low initial levels of PA. The present findings provide evidence for a relationship between PA and MA abilities in learning to read, although no causal connection has yet been established (Mahony, Singson, & Mann, 2000). More particularly, Arabic disabled readers may be able to rely on phonological information provided by the presence of vowelisation signs (diacritics) in overcoming morphological processing difficulties. This reliance on phonological information may differ in the two groups of readers.

Furthermore, phonological awareness training was effective regarding RAN. This finding diverges from those reported in opaque orthographies (e.g. Norton & Wolf, 2012), indicating that RAN taps into a basic index of processing involved in phonological and reading processes (Plaza & Cohen, 2003). The present findings support the view that the slower speed in naming tasks on the part of dyslexic subjects is caused by deficits in using phonological information for lexical access, indicating shared processes underlying naming speed and PA (Torgesen, et al., 1997; Wagner, Torgesen, & Rashotte 1994). However, the difference in the extent of improvement between RAN and RAS may be due to the different stimuli used. The former includes only object representations, whereas the latter represents a heterogeneous set of elements (shapes, digits) that may require more attention and thereby tap abstract mapping abilities (Stainthorp, 2005). Hence, the presence of different items in rapid naming may require processes involved in saccadic eye movements and inhibition (Jones, Branigan, & Kelly, 2009), which may hinder rapid lexical access.

Implications

The most important finding of the current study was that improvements in phonological abilities were accomplished in a relatively short period of time. This research has implications for how practitioners and teachers understand the acquisition of literacy and the implementation of effective instruction procedures. One aspect of this is an understanding of phonological and phonemic awareness and the role they play in this development.

As phonological awareness is developed through reading (e.g. Griffiths & Stuart, 2011), the reading deficits in dyslexics may not allow them to develop PA, and thus it is vital to have other alternatives by implementing PA interventions to promote explicitly the children's ability to identify, segment, and manipulate the smallest units of one's own language.

Secondly, findings of the current study have important practical implications. Practitioners and teachers need to know which PA tasks are more suitable to younger children and necessary for them to be sensitive to the level of difficulty of the PA tasks to be taught. Our results showed that for Arabic speaking children, PA tasks that deal with segmentation and initial / final sound identification are more suitable than other PA tasks that require manipulation of the sounds in phonological memory. Therefore, one may argue that dealing with larger units in Arabic would be easier than dealing with smaller units because Arabic is considered a syllabic orthography. It should be easier for Arabic speaking children to break an Arabic word into syllables rather than single phonemes (Tibi, 2010).

Conclusions

Although the phonological intervention was applied to a small sample, we believe it is relevant in developing word reading and pseudo-word decoding in dyslexic Arabic children. Overall, the present study underscores the importance of PA beyond as a viable option for improving word decoding and phonological processing skills. We interpret this finding as evidence that PA training exerts qualitative changes on the underlying phonological representations which, in turn, make phonological processing and rapid naming processes more efficient. While these children were making some progress in learning to read with PA training, the developmental rate of PA skills may further increase by reading exposure via systematic instruction.

PA seems bi-directionally related to concurrent reading abilities such as MA and RAN as parts of key reading-related skills. These provide support to already available research in a

developmental perspective of a strong causal link between PA and reading acquisition, representing a powerful predictor of later reading success. Further monitoring is necessary to demonstrate maintenance effects by conducting follow-up investigations.

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