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Effectiveness of Our New Right-to-Left English Transcription on Arabic Learning Using the Reversed Image -Support in Arabic E-Learning System for the Beginners-

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Abstract- Arabic language differs from other languages in some features such as right-to-left writing, unfamiliar letters and sounds, using one of the letter's forms depending on the letter's position in a word, and attaching a diacritical mark to a letter to show how it is pronounced. It is important to provide a new transcription that follows Arabic direction and to help non-Arabic speakers to locate the letters corresponding to Arabic letters and their attached diacritical marks to read them. We invented a new transcription system for Arabic in which we transcribed every Arabic unit (an Arabic letter with an attached diacritical mark) by an English unit (an uppercase with a lowercase letter); we reversed the images of all English units horizontally. The new reversed transcription matches the direction of the Arabic writing. Our main aim is to apply this transcription in our new Arabic e-learning system as an on-demand support which let the learners read Arabic text itself at their own pace. This paper shows how our reversed image transcription works, especially for the beginners.

Keywords: *reversed image, arabic learning, transcription, e-learning.*

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Abstract- Arabic language differs from other languages in some features such as right-to-left writing, unfamiliar letters and sounds, using one of the letter's forms depending on the letter's position in a word, and attaching a diacritical mark to a letter to show how it is pronounced. It is important to provide a new transcription that follows Arabic direction and to help non-Arabic speakers to locate the letters corresponding to Arabic letters and their attached diacritical marks to read them. We invented a new transcription system for Arabic in which we transcribed every Arabic unit (an Arabic letter with an attached diacritical mark) by an English unit (an uppercase with a lowercase letter); we reversed the images of all English units horizontally. The new reversed transcription matches the direction of the Arabic writing. Our main aim is to apply this transcription in our new Arabic e-learning system as an on-demand support which let the learners read Arabic text itself at their own pace. This paper shows how our reversed image transcription works, especially for the beginners. We compared the effectiveness of using our reversed transcription with that of using a conventional left-to-right transcription, through a workshop and questionnaire. The results show that our reversed transcription helps the participants of the workshop in locating the English unit in the transcription correctly for any Arabic unit in any word in a feasible time. Moreover, the participants read the reversed transcription correctly and they preferred the reversed transcriptionthan the conventional one. The participants reported that the reversed transcription is helpful, convenient and easy in self-training. The results suggest that the reversed image transcription is a helpful support for the beginners to start reading Arabic text in a short time compared with the conventional transcription.

Keywords: reversed image, arabic learning, transcription, e-learning.

I. Introduction

Any learning system of Arabic has the great challenge to let the learners get used to Arabic script, read Arabic letters one by one with it sattached diacritical mark, and read Arabic words. Arabic, as a matter of fact, differs from other languages especially in its script.

The Arabic way of text is as follows. There are 29 letters and 10 diacritical marks. A sentence is a sequence of words arranged right-to-left. A word is a sequence of letters with attached diacritical marks arranged right-to-left and connected to each other. Each Arabic letter has four forms. One form is an independent, original or single form and the other three forms are dependent. Dependent forms change according to the position of a letter in a word, as exemplified in Table 1withletter "س" which is pronounced "s".

Each letter shows a syllable with an attached diacritical mark. Basically each letter itself designates the leading consonant of a syllable. An attached diacritical mark indicates how to read a syllable with the leading consonant: (1) the consonant with a vowel, (2) the consonant only, (3) the consonant twice with a vowel, and (4) leading consonant with a vowel ending with "n", as shown in Table 2. There are three vowels "a", "i" and "u" used in Arabic language [1, 2, 3 and 7].

Table 1 : Example of the four forms for the letter "س"

Dependent form-positions			Independent form
End form	Middle form	Beginning form	
ـس	ـسـ	سـ	س

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Table 2 : Example of the diacritical marks with letter"س"

	سٌ	سٍ	سً	سَّ	سِّ	سَّ	سْ	سُ	سِ	سَ
Transcription	sun	sin	san	ssu	ssi	ssa	s	su	si	sa

Fig. 1 shows the Arabic greeting " السلام عليكم" which means "Peace be upon you" or simply means "Hello". This text is as an example of the informal Arabic text in which there are no diacritical marks attached to the Arabic letters. Fig. 2 shows an example of the formal Arabic text in which diacritical marks are attached to the Arabic letters. This form is used in the Quran book. And this form is basically used in the Arabic learning text books, since beginners in Arabic learning cannot read Arabic syllables without attaching diacritical marks.

Fig. 1 : Arabictext without diacritical marks

السلام عليكم

Fig. 2 : Arabic text with diacritical marks

اَلسَّلامُ عَلَيْكُمْ

Each Arabic letter and its attached diacritical mark look as a unit of script. Fig.2 shows that Arabic text is written in units. There is a property that once the beginner can identify, read and remember every Arabic unit one by one, he/she can read any Arabic script. In Arabic learning for children, usual way is repetitive lessons to read and remember every Arabic unit, but it is not good for the adults. It is not endurable for them to repeat pronouncing lessons only for remembering Arabic units. Arabic learning for the adultsshould start with teaching sample sentences, phrases, and expressions until they get used to Arabic text and start readingit. Transcription should be used to help the learners to read Arabic units. Transcription must have a property of locating the letter(s) that is corresponding to every Arabic unit in a word.

Currently, English transcription is the most common one all over the world for Arabic in textbooks, dictionaries and e-learning systems, since English is used and learned worldwide. In English transcription, as shown in Fig. 3, letters are arranged left-to-right [5, 19, 20, 21, 23 and 24]. There is a conflict in direction between Arabic text and its transcription. Learners tend to read the transcription itself left-to-right as they read English text and rarely take care of Arabic script.

Fig. 3 : Example of conventional transcription for Arabic

اَلسَّلامُ عَلَيْكُمْ

assalamualykum

Moreover, the number of English letters in the transcription is not equal to the number of Arabic units in a word, as shown in Fig. 3, for various reasons. Some consonantsin the Arabic units are transcribed bya single English letter and others are transcribed by two English letters. Also, some diacritical marks in the Arabic units are transcribed bya single English letter, others are transcribed by two English letters and one diacritical mark is not transcribed by English letters. Moreover, both Arabic letters and their attached diacritical marksin the units are transcribed by lowercase letters [6, 8, 15, and 16].This difference in the numbers makes beginners find difficulty to locate the English letter(s) in the transcription corresponding to the Arabic unit [11].

We invented a new transcription system for Arabic script. It uses English letters because English letters are familiar to learners worldwide. We chose some English letters from the IPA transcription system and others from the LC system [22].

Our transcription consists of units; a unit transcribing an Arabic unit consists of two English letters: one in uppercase that corresponds to the Arabic letter, and the other in lowercase that corresponds to the attached diacritical mark.

In our transcription, we reversed the image of all English units horizontallyas "Through the Looking-Glass" and connected them to each other [4, 9 and 12]. Reversing the image of all English units shows the whole transcription as it is arranged right-to-left to match Arabic direction, and shows each English unit itself in reversed form to match its Arabic unit in direction. Reversed transcription allows readers' eyes to move in the direction of Arabic script, lets readers read each transcription unit automatically right-to-left, and make them remember how to read the Arabic unit. When we showed our reversed English units to some non-Arabic speakers, they understood that these reversed units are arranged right-to-left and they read it in that order without any explanation [13].

Table 3 shows an example of the Arabic word "بَـــيْـــتُ". It means "Home" and it is pronounced as "ba-y-tu". It consists of three units. These units, in independent form, are "بَ", "يْ" and "تُ" right-to-left. Each of these units is transcribed by our English unit as "Ba", "Y." and "Tu". Note that "Y." means "Y" without avowel. The English units are "BaY. Tu" left-to-right, and learnersread them left-to-right, since English letters are used in this direction. Learners find it difficult to locate the transcription unit for a given Arabic unit because of the conflict of direction especially when a word consists ofmany units. If we arranged the English units right-to-left, transcription became "TuY.Ba" and learner might read it left-to-right as "tuyba" [13]. Thus, we decided to

reverse all the images of English units and connected them, as shown in the table.

Table 3 : Developing the reversed image transcription system

Arabic word of three units right-to-left	بَـيْـتُ
Three Arabic units right-to-left English units left-to-right	بَ يْ تُ BaY.Tu
Three Arabic units right-to-left English units right-to-left	بَ يْ تُ Ba Y. Tu
Three Arabic units right-to-left Reversed image of all English units	بَ يْ تُ ɒB .Y uT
Arabic word of three units right-to-left Reversed image right-to-left English transcription	بَـيْـتُ ɒBY.Tu

We call our reversed image right-to-left transcription system "RIT". RIT reflects the mechanism of the Arabic unit and the direction of the Arabic script. When we used RIT, we found that non-Arabic speakers did not need training to read the units of RIT, they became accustomed with RIT, and they welcomed it [11, 12, and 13].Our expectationis that RIT supports the beginners to start reading Arabic units in a short time, and that therefore, beginners read Arabic text easily.

II. Objectives

We will show, by data, how RIT supports the non-Arabic speaking begin nerstoread Arabic text by locating the transcription unit for any Arabic unit in a wordeasily and correctly, and supports them in reading the located unit correctly. We will show also how the beginners preferred RIT.

III. Workshop and Questionnaire

It is important to compare the results of using RIT with the results of using one of the traditional left-to-right English transcription systems. Therefore, we chose BATR (Bikdash Arabic Transliteration Rules) [19].BATR does not use any special marks and it is expected that the beginners read BATR script easily.

We designed a workshop to compare how well the beginners read an Arabic unit by locating and reading an English unit corresponding to it in the transcription. Either in RIT or in BATR.

And we designed a questionnaire to ask the beginners which transcription they prefer in reading Arabic units, RIT or BATR. We asked volunteers for our workshop and questionnaire. We conducted the workshop and the questionnaire with some of those volunteers; we call them "participants". All participants had no experience in Arabic.

a) The participants

The participants were non-Arabic speaking beginners in Arabic learning. Most of them were students in the YUAI School for Arabic language learning in Tokyo. They were of different nationalities. They covered a wide range of profiles, including cultural backgrounds, ability of foreign languages learning, age, gender, studying majors, jobs, and experience in Arabic, as shown in Table4. Some of them were students of high school, students of university, or graduates of university. We tested all the participants before applying the workshop and they did not read Arabic units,. There were two groups of the participants, group1 was of 14 participants: $G_1 = \{G_1, G_2, ..., G_{14}\}$ and group2 was of 20 participants: $G_2 = \{G_{15}, G_{16}, ..., G_{34}\}$. All participants were 34: $G = \{G_1, G_2, ..., G_{34}\}$.

Table 4 : The participants

Number of participants		G_1	G_2
		14	20
Nationalities	Bangladesh	-	2
	China	-	1
	India	-	2
	Indonesia	-	1
	Japan	14	13
	USA	-	1
Foreign languages	No foreign language	2	6
	1 foreign languages	7	10
	2 foreign	2	3

	languages		
	3 foreign languages	2	1
	5 foreign languages	1	-
Ages	11 - 20 years	-	3
	21 – 30 years	-	7
	31 – 40 years	9	5
	41 – 50 years	2	5
	51 – 60 years	2	-
	61 – 70 years	-	-
	71 – 80 years	1	-
Gender	Male	4	7
	Female	10	13
Interested in Arabic	Yes	13	20
	No	1	-

b) Preparing word sets for the workshop

We prepared two sets of Arabic words: $\boldsymbol{X} = \{X_1, X_2, \dots, X_5\}$ and $\boldsymbol{Y} = \{Y_1, Y_2, \dots, Y_5\}$, as shown in Table 5. Hereafter we write the index set as $I = \{1, 2, \dots, 5\}$. Each word in *X* and *Y* has a designated Arabic unit in it. This unit is called a sample unit for the word. In Table 5, each sample unit is marked red. For convenience of readers, each Arabic word in Table 5has a transcription in BATR and RIT. In eachtranscription, colored red are English units correspond to the sample Arabic units.

The number of Arabic units in a word *w* is called length of the word and denoted by *l*(*w*). Each Arabic unit in a word is numbered starting from 1 right-to-left. The number given to the marked unit in a word *w* is called the Arabic sample position of *w*and denoted by*p*(*w*). Note that $1 \leq p(w) \leq l(w)$ holds by definition. We chose words as $l(X_i) = l(Y_i) = L(i)$ and $s(X_i) = s(Y_i) = S(i)$ hold for $i \in \boldsymbol{I}$ where *L* and *S* are defined by the Table 6.We chose those length values because Arabic words are of a single unit of different lengths up to 10 units in the usual Arabic learning materials for beginner [1, 2, 3 and 6]. Note that both of X_1 and Y_1 is special case indicating a single Arabic unit.

It was difficult to ask the participants to locate, read, and show their preference in all positions in all words. We decided to ask the participants about only one sample position for an Arabic unit in each word of *X* and *Y*.

Table 5 : *X*and *Y*word sets

Words sets			BATR	RIT
X_i	X_1	رُ	ru	uЯ
	X_2	قُفْلُ	qeflu	uL.ꟻiϘ
	X_3	كَتِيبَة	kateepate	uTɒBiYiTɒꓘ
	X_4	مَنْظُومَاتٌ	manzuumaatun	ūTɒÅɒM uWuZ.ͶɒM
	X_5	إِلِكْتُرُونِيَّاتُ	ilekturuuneyaatu	uT ɒÅ ɒY iͶ uЯ uT .ꓘ iL il
Y_i	Y_1	كَ	ka	ɒꓘ
	Y_2	كَنْزُ	kinzu	uZ.Ͷiꓘ
	Y_3	كَثِيرَةٌ	katheeratu	uTɒЯiYiθɒꓘ
	Y_4	مَقْطُوفَاتٌ	maqtuufaata	ūTɒÅɒꟻ uWuT.ϘɒM
	Y_5	مُسْتَخْلَصَاتُهُمْ	mostakhlassaatahum	.MuHɒTɒÅɒƧ ɒL.ꓘ ɒT.ƧuM

Table 6 : Functions *L* and *P*

I	1	2	3	4	5
L(*i*)	1	3	5	7	10
S(*i*)	1	2	4	5	8

Table 7 shows Arabic letters of the sample units of *X* words and *Y* words. *Y* words are slightly more difficult than *X*words in some points. *X*covers 15 letters and *Y* covers 18 letters. There are same 12 letters included in both *X* and *Y*. *X* contains only 1 letter of Arabic specific sound; whereas *Y* contains 3 letters of Arabic specific sounds. Each of *X* and *Y* contains most of the 10 diacritical marks. Table 8 lists all the sample Arabic units in *X* and *Y*. No Arabic letters of Arabic specific sound is included there and anybody can read those transcriptions easily.

Table 7 : States of words in X and Y

	Letters	Transcription	X	Y
Usual Sounds	ت	t	4	3
	م	m	2	3
	ر	r	2	2
	إ	i	1	2
	ف	f	1	2
	ك	k	2	1
	ل	l	2	1
	ن	n	2	1
	و	w	2	1
	ي	y	2	1
	ة	t	1	1
	ق	q	1	1
	ا	a	2	
	ب	b	1	
	ز	z		1
	س	s		2
	ه	h		1
Specific Sounds	ظ	zz: like "z" sound but stronger	1	
	خ	kh: no similar English sound		1
	ص	ss: like "s" sound but stronger		1
	ط	tt: like "t" sound but stronger		1

Table 8 : Sample units of X and Y

Sets		Arabic letter	Transcription	
			BATR	RIT
X	X_1	رُ	ru	uR
	X_2	فْ	f	.F
	X_3	بَ	pa	aB
	X_4	مَ	ma	aM
	X_5	يَ	ya	aY
Y	Y_1	لُ	lu	uL
	Y_2	نْ	n	.N
	Y_3	سَ	sa	aS
	Y_4	فَ	fa	aF
	Y_5	تَ	ta	aT

c) Preparing card sets for the work shop

We prepared two sets of cards: $\boldsymbol{B} = \{B_1, B_2, \ldots, B_5\}$ and $\boldsymbol{R} = \{R_1, R_2, \ldots, R_5\}$, as shown in Fig.4. B_i contains X_i with its transcript in BATR for $i \in I$ and R_i contains Y_i with its transcript in RIT for $i \in I$. Words on cards are marked red on their designated position. We apply functions l and s to those cards by defining $l(B_i)=l(R_i)=L(i)$ and $s(B_i)=s(R_i)=S(i)$ for $i \in I$. Each word has its transcription printed below it. Each sample unit is marked by red color, as shown in Fig. 4. We write all the cards as $\boldsymbol{C} = \boldsymbol{B} \cup \boldsymbol{R}$.

d) Applying the workshop

We started the workshop by telling the participants the aim of the workshop. We explained the introduction of the Arabic to the participants. We showed an example of the Arabic text with the transcription in BATR and in RIT by a panel like Fig. 5 to tell them how each transcription is used to locate the English unit corresponding to an Arabic unit and to read it.

To each participant, we showed $\boldsymbol{B}$ cards one by one and then we showed $\boldsymbol{R}$ cards one by one, and on each card, we asked him/her to locate the English unit corresponding to the marked Arabic unit, point to the located English unit, and read the located English unit. For G_1, we showed the cards sequentially in the order of Fig. 4, but for G_2 randomly.

The time spent for both locating the English unit and pointing to it in each card was measured by seconds using a wrist watch and there is a measuring error of -0.5 to +0.5 second. We call this measured time "locating time". The accuracy of the pointing out in each card was judged as 1 if it is correct and as 0 if it is wrong. We call this value "locating accuracy". The accuracy of reading the pointed unit in each card was

judged as 1 if it is correct and 0 if it is wrong. We call this value "reading accuracy".

Fig. 4 : Workshop cards B and R

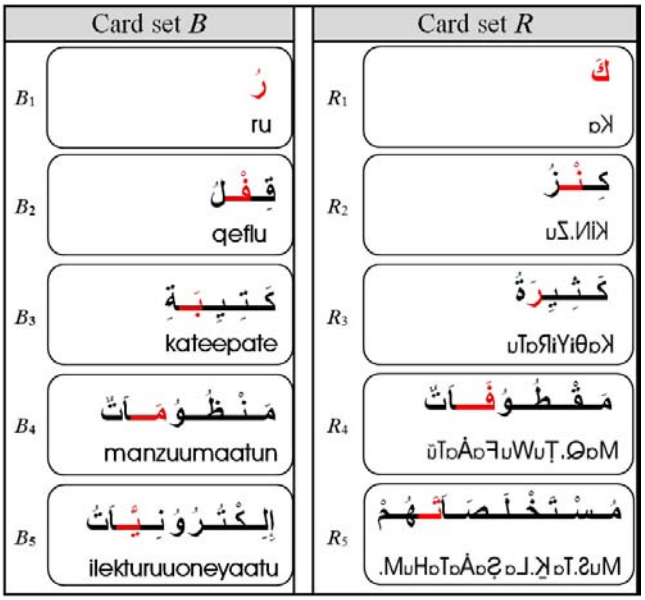
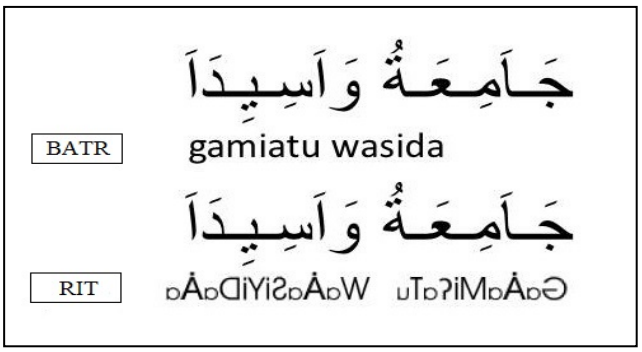


Fig. 5 : An example of BATR and RIT



e) Applying the questionnaire

We applied the questionnaire after the workshop. At first, we told the participants the aim of the questionnaire. To each participant, we showed a card pair (B_i, R_i) for $i \in \boldsymbol{I}$ in order. During showing every card pair, we pointed out the correct English unit. Then, we asked him/her "which one do you prefer, RIT transcription or BATR transcription, to locate the English unit for the marked Arabic unit?".We recorded each preference as 1 if R_i is preferred and 0 if B_i is preferred.We call this value "preference".We write the card pair as $\boldsymbol{D} = \{D_1, \dots, D_5\}$and $D_i = (B_i, R_i)$for $i \in \boldsymbol{I}$.

IV. The Results

Data obtained are (1) locating time $t(c,g)$ for $c \in \boldsymbol{C}, g \in \boldsymbol{G}$: integer, (2) locating accuracy $a(c,g)$ for $c \in \boldsymbol{C}, g \in \boldsymbol{G}$: 1 or 0, (3) reading accuracy $r(c,g)$ for $c \in \boldsymbol{C}, g \in \boldsymbol{G}$: 1 or 0, and (4) preference $f(d,g)$ for $d \in \boldsymbol{D}, g \in \boldsymbol{G}$: 1 or 0. We may consider all the data and subsets of them. We write the name t, a, r or f itself to represent all the data, and subscripted names to represent subsets of the data. For example, $t_{\boldsymbol{B}}$for $\{t(c,g) | c \in \boldsymbol{B}, g \in \boldsymbol{G}\}$, a_{R_2} for $\{a(R_2,g) | g \in \boldsymbol{G}\}$ And $r_{\boldsymbol{R},\boldsymbol{G}_2}$ for $\{r(c,g) | c \in \boldsymbol{R}, g \in \boldsymbol{G}_2\}$.

We ascertained statistically that, on each measurement item, the data obtained from $\boldsymbol{G}_1$ and the data obtained from $\boldsymbol{G}_2$ share a common population. We applied Mann-Whitney test on $t_{c,\boldsymbol{G}_1}$ vs. $t_{c,\boldsymbol{G}_2}$for $c \in \boldsymbol{C}$ and Pearson's chi-squared test on $a_{c,\boldsymbol{G}_1}$ vs.$a_{c,\boldsymbol{G}_2}$for $c \in \boldsymbol{C}$,$r_{c,\boldsymbol{G}_1}$ vs. $r_{c,\boldsymbol{G}_2}$for $c \in \boldsymbol{C}$ and $f_{d,\boldsymbol{G}_1}$ vs. $f_{d,\boldsymbol{G}_2}$for $d \in \boldsymbol{D}$. All tests failed to deny the null hypotheses with $p<.01$. And we decided to merge the data into a group of 34 participants, namely as $\boldsymbol{G}$, and then investigate it.

There are two cases that have rather small p-value, whereas $p>0.18$ in the others. One case is $t_{B_3,\boldsymbol{G}_1}$ vs. $t_{B_3,\boldsymbol{G}_2}$ at $p=.086$, and another $t_{R_4,\boldsymbol{G}_1}$ vs. $t_{R_4,\boldsymbol{G}_2}$ at $p=.013$. It looks rather delicate to say that the hypnosis seems to hold for the latter case, which we will look into in 5.

a) Locating time (t)

B_1 card and R_1 card contains a special word that consists of a single Arabic unit, and basically there is no need for long time to locate the English unit corresponding to the single Arabic unit. Table 9 summarizes stats of $t_{B_1}$and t_{R_1}.

Table 9 : t_{B_1} and t_{R_1}

	Minimum	Maximum	Average
t_{B_1}	1	2	1.9
t_{R_1}	2	3	2.3

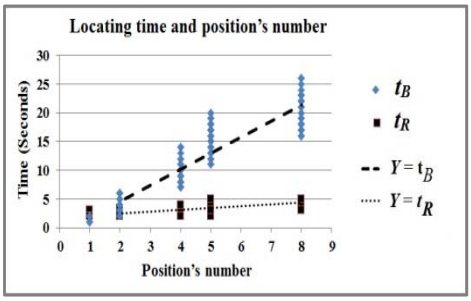
We consider the general cases, namely, the subsets of the data $\breve{\boldsymbol{B}} = \{B_2, \dots, B_5\}$ and $\breve{\boldsymbol{R}} = \{R_2, \dots, R_5\}$ to investigate how locating time $t_{\breve{\boldsymbol{B}}}$and $t_{\breve{\boldsymbol{R}}}$ changes depending on the sample position by the linear regression and obtained are the equations (1) and (2) by taking x for sample position and y for locating time.

$$y = -1.2 + 2.8x \quad (1) \text{ for } t_{\breve{\boldsymbol{B}}}$$

$$y = 1.8 + 0.3x \quad (2) \text{ for } t_{\breve{\boldsymbol{R}}}$$

The correlation coefficient is $+0.96$ with $p<.001$ for $t_{\breve{\boldsymbol{B}}}$, and $+0.70$ with $p<.001$ for $t_{\breve{\boldsymbol{R}}}$. On Fig. 6, plotted are the data $t_{\boldsymbol{B}}$ and $t_{\boldsymbol{R}}$, and drawn are the lines of Equation (1) and (2).

Fig. 6 : Locating time on Arabic sample position



b) Locating accuracy (a)

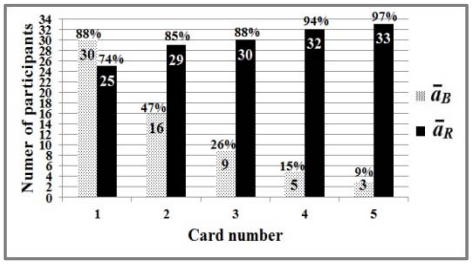
On each cardof $\boldsymbol{B}$and $\boldsymbol{R}$, we count the participants who located correctly as follows.

$$\bar{a}_{\boldsymbol{B}}(i) = \sum_{g\in\boldsymbol{G}} a(B_i, g) \text{for } i \in \boldsymbol{I},$$

$$\bar{a}_{\boldsymbol{R}}(i) = \sum_{g\in\boldsymbol{G}} a(R_i, g) \text{for } i \in \boldsymbol{I}.$$

We call them "locating accuracy count" or "accuracy count" for short. The results of accuracy counts are shown in Fig.7.

Fig. 7 : Accuracy counts



c) Reading accuracy

On each card in $\boldsymbol{C}$, we count the participants who read correctly the English units that they located, no matter correctly or not. All the participants read the located units on all cards correctly except those located units on R_2, on which 30 among 34 participants read the located units correctly.

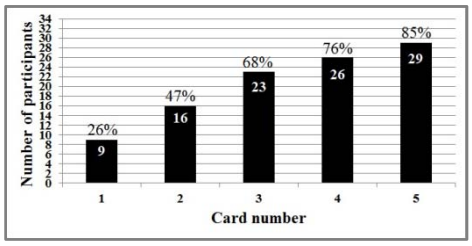
d) Preference (f)

For each card pair in $\boldsymbol{D}$, we count the participants who preferred RIT, namely who got preference value 1, as follows.

$$\bar{f}(i) = \sum_{g\in\boldsymbol{G}} f(D_i, g) \text{for } i \in \boldsymbol{I}.$$

We call them "preference count". The results of preference counts are shown in Fig. 8.

Fig. 8 : Preferencecounts



e) Looking into personal behavior

We have treated the participants only as a group and we have not looked into the personal behavior in 4.1 - 4.4. Now we look into some of the properties that may depend on personal difference.

i. *Accuracy score*

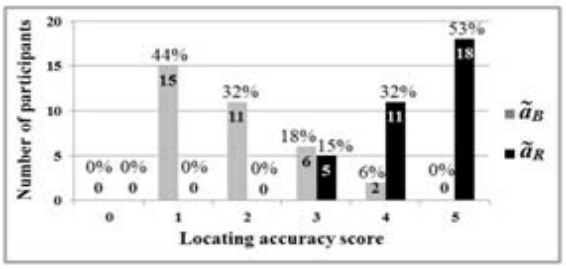
For each participant$g \in \boldsymbol{G}$, we count how many cards he/shegot locating accuracy value 1 as follows.

$$\tilde{a}_{\boldsymbol{R}}(g) = \sum_{c\in\boldsymbol{R}} a(c, g) \text{ for } g \in \boldsymbol{G},$$

$$\tilde{a}_{\boldsymbol{B}}(g) = \sum_{c\in\boldsymbol{B}} a(c, g) \text{ for } g \in \boldsymbol{G}.$$

We call them "locating accuracy score", or "accuracy score" for short, for $\boldsymbol{R}$ and $\boldsymbol{B}$, By definition $0 \le \tilde{a}_{\boldsymbol{R}}(g) \le 5$ and $0 \le \tilde{a}_{\boldsymbol{B}}(g) \le 5$for $g \in \boldsymbol{G}$. Fig. 9 shows the histograms of participants on their accuracy score.

Fig. 9 : Histogram of participants on accuracy score



We count the participants on each pair of accuracy scores for $\boldsymbol{B}$ and $\boldsymbol{R}$. Table 10 shows these counts.

Table 10 : Number of participants on each pair of accuracy scores

Accuracy score for *B* \ Accuracy score for *R*	0	1	2	3	4	5
0						
1				2	5	8
2				1	5	5
3				1	1	4
4				1		1
5						

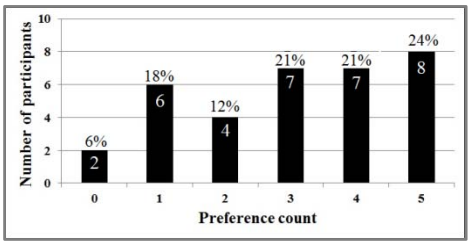
ii. *Preference score*

For each participant $g \in \boldsymbol{G}$, we count how many card pairs he/she got preference value 1 as follows.

$$\tilde{f}(g) = \sum_{c\in\boldsymbol{D}} f(c, g) \text{ for } g \in \boldsymbol{G}.$$

We call them "preference score". By definition, $0 \le \tilde{f}(i) \le 5$. Fig. 10 shows the histogram of participants on their preference score.

Fig. 10 : Histogram of participants on the preference score



iii. *Accuracy scores and preference score*

For each participant $g \in \boldsymbol{G}$, we consider the difference of the two accuracy scores for $\boldsymbol{R}$ and $\boldsymbol{B}$ as follows:

$$z(g) = \tilde{a}_{\boldsymbol{R}}(g) - \tilde{a}_{\boldsymbol{B}}(g) \text{for } g \in \boldsymbol{G}$$

We call them "accuracy score difference". The difference $z(g)$ ranges -5 to 5 by definition, but actually it ranges only $-1 \le z(g) \le 4$ for $g \in \boldsymbol{G}$.

We count participants on each pair of their preference score and accuracy score difference. Table 11 shows those counts.

Table 11 : Number of participants on each pair of preference score and difference of two accuracy scores

		accuracy score difference					
		-1	0	1	2	3	4
Preference score	0					2	
	1		1	1	2	1	1
	2				3	1	
	3				1	3	3
	4	1		1	4		1
	5			1	1	3	3

We count participants on each pair of their preference score and accuracy score for *R*. Table 12 shows those counts.

Table 12 : Number of participants on each pair of preference score and accuracy score for *R*

		Accuracy score for *R*					
		0	1	2	3	4	5
Preference score	0					1	1
	1				2	2	2
	2					3	1
	3					1	6
	4				3	1	3
	5					3	5

V. Discussion

Though G_1 and G_2 were different groups of participants, and showing the cards were applied in different orders, sequentially and randomly, the results showed that there were no significant differences detected by the statistical testing between the data obtained from G_1 and the data obtained from G_2. So that, we merged the data of G_1 and G_2 to gether and we analyzed them as data of one group. These results also showed that the difference of showing the cardsis regarded as having a little effect on the measured data.

We will discuss the results based on the standpoint that the differences between *R* cards and *B* cards are due to the differences between RIT and BATR. As mentioned in 3.3, the workshop was applied by using *B* cards including *X* Arabic words with BATR and using *R* cards including *Y* Arabic words with RIT. So that *X* and *Y* are similar to each other and differences between them could not affect the results of the workshop. Therefore, only the difference between RIT and BATR affected the results.

a) Locating time

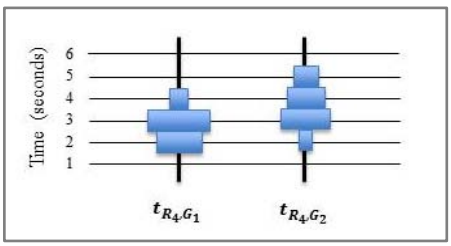
We designed RIT considering that reversing the image of all English units as a whole results in that the transcription units run right-to-left along with the Arabic units. The beginners in a previous trialeasily knew, by onlyan example like Fig. 5, how they could locate an English unit in RIT that corresponds to a given Arabic unit, namely, it is only to look at the English unit just below that Arabic unit [12]. We expected, therefore, that the beginners take just a short time in locating English units in RIT. And we measured, by sampling, how long the participants take for locating English units in RIT, to see that it is really a short time.

Fig. 6 shows that locating time on *R* cards, or cards transcribed in RIT, remains short even when cards contain longer words. Equation (2) tells us that locating time increases linearly on the Arabic sample unit position, and its increment is about 0.3 sec. per position, and, for example, the expected time in locating for the 10th Arabic sample positionis still less than 5 sec., which is surely said short or feasible to know how to read an Arabic unit either for first time or learned before but not recalled.

For locating time on *B* cards, or cards transcribed in BATR, Fig.6 shows that locating time increasesrapidly along with the Arabic sample position especially when cards contain longer words. Equation (1) tells us that the expected time is more than 25 sec. for the 10th Arabic sample position, which is far beyond a feasible time for finding out how to read a single Arabic unit.

We reported in section 4,that the test on the data of t_{R_4,G_1} and t_{R_4,G_2} resulted in $p=.013$. The actual data distributions are shown in Fig.11, on which blocks on each horizontal line have width proportional to the number of the participants who spent the time indicated for the line.

Fig. 11 : Distribution of t_{R_4,G_1} and t_{R_4,G_2}



Though the tow distributions look different, the difference is something at most 1 second. Our time measurements have errors of ± 0.5 second, and the results obtained thereof should be considered having the precision of 1 digit. Yet, the results clearly show the advantage of RIT in locating time. The difference of t_{R_4,G_1} and t_{R_4,G_2} does not affect this conclusion.

We conclude that in RIT, the beginners can easily locate each English unit for an Arabic unit in a short time, i.e. in a feasible time, but in BATR, they cannot do so.

b) Locating accuracy

We designed RIT considering that reversed units appear right-to-left in the direction of Arabic units, and then each Arabic unit has its English unit just under it. We expected, therefore, that the beginners can locate the correct English unit in RIT for an Arabic unit

regardless the Arabic unit position in a word. And we measured how surely the participants locate the correct unit in each card transcribed in RIT and confirmed that they were reasonably sure to locate correctly.

Fig. 7 shows that more than 74% of the participants correctly located the English unit on all the ***R*** cards, and more than 85% of the participants did so except for R_1 card containing a word of length 1. The participants are, therefore, expected to locate each English unit in RIT correctly in reasonably high success rate.

For locating accuracy on ***B*** cards, or cards transcribed in BATR, Fig. 7 shows that the percentage of the participants who located correctly rapidly decreases from 88% to 9% along the card number.

We conclude that in RIT, the beginners can locate each English unit correctly in reasonably high rate, but in BATR, they cannot do so.

c) Personal results on locating accuracy

According to the results of the locating accuracy, we expected that beginners can locate correctly in RIT in relatively high success rate, in another words, it is not the case that the beginners would be divided into two groups: onewhose members can locate correctly in very high success rate and the others whose members fail to do so in high failure rate. We studied on the obtained data of each participant to know how many ***R*** cards he/she located correctly, and how many ***B*** cards as well.

Fig. 9 shows that on ***R*** cards, all the 34 participants succeeded in locating correctly on 3 or more cards and more than half of them succeeded on all 5 cards. Fig. 9also shows that on ***B*** cards, only 8 among 34 participants succeeded on 3 or more cards, and no one succeeded on all cards.

We studied further on the difference of the two accuracy scores on each participant. Table 10 shows that almost all of the participants scored higher for ***R*** than for ***B***, one scored the same for both, and only one scored higher for ***B***. This result shows that RIT provides better support, than BATR, for the participants to locate the English unit and find how to read out an Arabic unit. We conclude that RIT supports the beginners to locate correctly in high success rate, but BATR does not.

d) Reading accuracy

We designed RIT considering that the reversed units are of English letters and then RIT is easy to read out. We expected, therefore, that the beginners can read out correctly the located units in RIT.

All the participants read out all the located English units on cards ***B*** as well as ***R***. Only the exception is the card R_2, on which 4 (12%) of participants did not read out correctly the located English unit.

R_2 is transcribed in RIT, and its English unit is "N." that represents to read only as "N" without any vowel. The participants must judge how to pronounce it, since it might be the first time to see "." in transcription. Others could guess it correctly but the 4 participants failed. This is good news for RIT that many of the participants could find how to pronounce it.

We conclude that in RIT, the beginners can read out each English unit correctly as they can do so in BATR, which is essentially transcription in English.

e) Preference

We expected that the beginners prefer RIT to BATR when they recognize that RIT is a good support for locating the English unit to find how to read out any Arabic unit in text. And we studied their preference through the questionnaire.

Fig.8 shows that the preference of RIT was expressed by more than two thirds of the participants on every card pair No.3-5, by a half of them on the card pair No.2, and by only a quarter of them on the card pair No.1. The card pair No.1 contains a word of length 1, No.2 a word of length 3, and No.3-5 words of long length. Taking into account of Fig.7, it suggested a possibility that the more participants succeeded in locating on a card, the more of them expressed the preference of RIT.

We studied further the data on each participant. First study is on the preference score that is the number of card pairs on which a participant expressed his/her preference for RIT. Fig. 10 shows that the participants scattered over preference score values, or in other words that there were participants who definitely preferred RIT on every card pair, and at the same time there were those who definitely refused to prefer RIT, or equivalently, who definitely prefer BATR to RIT.

Second study is on each participant preference score for RIT and his/her accuracy score difference between RIT and BATR. Table 11 shows that the participants can be categorized into two groups, one enclosed in an oval, the other in a rectangle. The oval group consists of those who got low preference score for RIT, or unconsciously hate to read the reversed images, though they could get higher accuracy score in RIT than in BATR. The rectangle group consists of those who got high preference score for RIT on their getting high accuracy score difference.

We studied further and summarized the results in Table 12. Table 12 shows more clearly than Table 11 that the participants can also be categorized into two groups. The oval group consists of those who seem to dislike RIT, or unconsciously hate to read the reversed images, though they could locate well in RIT. The rectangle group consists of those who seem to express their preference for RIT straightly on their successes in RIT.

In discussion with those participants who did not prefer RIT, we asked them "why do not you prefer RIT even you can use it correctly?". They replied that they know that RIT works well, but they are not familiar with RIT.

We applied the questionnaire with 8 volunteers who have experience in Arabic and who did not join in the workshop. All of those 8 volunteers preferred RIT to BATR in all card pairs, since they found that RIT is helpful for the beginners to just locate English units corresponding to Arabic units in the text.

In discussion with the volunteers and the participants who preferred RIT, we asked them "why do you prefer RIT?". Most of them reported that although RIT is not familiar for them, RIT is convenient, helpful and better than BATR in locating English units corresponding to Arabic units in text.

We conclude that it does not necessarily hold, at least on personal level, that whenever a participant succeeds in locating and reading the English unit in RIT, he/she prefers RIT, though we see a general tendency that in a situation where many participants succeed in locating and reading out in RIT, many of them are expected to express their preference for RIT.

This result is a good news to RIT, since it means that RIT do not lure the participants to stay in its transcription and unconsciously pushes them to read out Arabic text directly without help of RIT. In this sense, RIT is a good support for the beginners to learn Arabic text reading.

f) Characteristics of the participants

The participants had a variety of the general characteristics, as indicated in Table 4, in terms of nationality, age, gender, and experience in Arabic. We assume that they are good representatives for almost all beginners who are grown-ups. The number of the beginners was rather small. We hope to conduct another workshop with a large number of beginners with an appropriate experimental design.

VI. Conclusion

RIT, our new system of reversed image English transcription supported the non-Arabic speaking beginners more than the conventional English transcription. Through the workshop, almost all the beginners used RIT to identify the units in the English transcription for the Arabic units correctly at any unit position in different words in a feasible time. They also read the located units correctly. Through the questionnaire, most of beginners who have no experience and those who have experience in Arabic language preferred RIT to the conventional transcription to identify the English unitsfor the Arabic units in Arabic words.

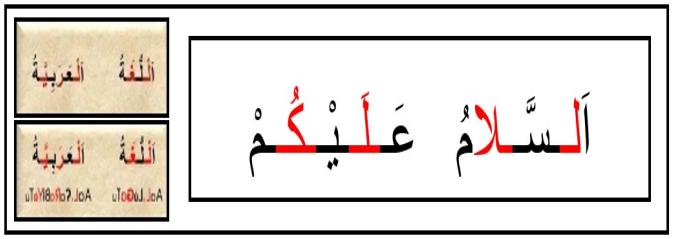
These results mean that RIT is ahelpful support for the beginners to read and/or remember any Arabic word in the text. RIT assists the beginners to read the Arabic text in a feasible time and correctly. And that therefore, the beginners are encouraged to read the Arabic textitself directly and avoid reading RIT even it appears with the Arabic text.

Therefore, RIT is the best support for the beginners to get accustomed to read Arabic text itself at their own pace. We need to conduct a long run workshop to confirm that RIT is a helpful support for the beginners to read Arabic text directly, especially in the e-learning system for the Arabic language.

a) Future work

We worked on a new version of RIT. In which, we colored the Arabic units and the reversed units in different two colors. Colored version relates to one of our previous works [14].Our aim is to apply RIT as an on-demand support in our new Arabic e-learning system, as shown if Fig. 12 [10 and 18]. This e-learning system shows our transcription only when the learner demands it, but that transcription will be hidden in an adequate time automatically. Then the learner has to train himself/herself to read the Arabic text at his/her own pace. We are in the process of testing how RIT supports the learners as an on-demand support in our new Arabic e-learning system (ETaJWa) to identify and read Arabic units/words/expressions and to recall them. The results will be reported in other paper.

Fig. 12 : Applying RIT in ETaJWa



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