Experimenting Different Jawi Spelling Conditions to Gauge their Cognitive Complexity

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ABSTRACT

Although traditionally, Malay was predominantly written in the Arabic script (*Jawi*), the Roman script has become the standard script for the Malay language after the Second World War due to the relative complexity of *Jawi* in comparison to the Roman script. One factor that makes reading *Jawi* a cognitively complex process is the complex and confusing use of vowel letters in the spelling of Malay words in *Jawi;* hence, making the *Jawi* spelling system appear to be rather inconsistent. Currently, the vowel phonemes in Malay words in *Jawi* are represented differently in different syllables either using vowel letters or not represented at all. Two reading experiments on Malay bi-syllabic words written in *Jawi* were conducted with two groups of readers. In Experiment 1, 28 Malay native speakers and 13 Arabic native speakers read 200 Malay bi-syllabic words in *Jawi* as quickly and as accurately as possible to investigate the naming latencies of words written in *Jawi* with and without diacritics. In Experiment 2, 30 Malay 13- and 14-year-olds read 108 Malay bi-syllabic words in *Jawi* to investigate if adding vowel diacritics and/or vowel letters to represent Malay vowels facilitates reading *Jawi*. Both experiments were conducted using DMDX, a Win 32-based display system for psychological experiments that records reaction times to visual and auditory stimuli. Results are presented in terms of the subjects' reading accuracy (correct responses) and latency (reaction times). To a great extent, adding vowel diacritics to the *Jawi* spelling system does facilitate reading. This study also shows that two forms of permutations in the *Jawi* spelling system can help make reading *Jawi* a cognitively less complex process for readers.

Keywords: Arabic script of Malay; cognitive complexity; DMDX; *Jawi;* psycholinguistics

INTRODUCTION

Reading is one area within cognitive psychology (Plaut, 1997) that can be investigated from different angles including perceptual processing, memory processing, comprehension processing, and production processing (Rayner, Pollatsek, Ashby & Clifton, 2012). Reading is regarded as a "highly complex process" (Rayner et al., 2012, p. 7) because it involves many sub-processes that rely on each other for the process to take place. Cognitive psychologists typically utilise experiments to investigate specific mechanisms involved in the process of reading.

The more popular type of research conducted on reading within the Southeast Asian region today has been off-line experiments (e.g., Noorizah Mohd Noor, 2010).

These off-line experiments investigate the manner typically- or atypically-developing children or adults read. The off-line experiments include 1) truth value judgment tasks; 2) picture matching tasks; and 3) act-out tasks (Schmitt & Miller, 2010). These off-line experiments are the more popular type of experiments because they do not incur much cost and are practical for classroom readers. However, such a research does not give researchers the opportunity to investigate the reading processes in terms of time-related properties. Some of the information gathered from off-line tasks also can make the interpretation of data challenging (Marinis, 2010). This is because, for off-line tasks, participants' interpretation of certain stimuli (e.g., a sentence), can only be measured *after* the completion of the presentation of the stimuli (in this case, the completion of the sentence).

On-line tasks, on the other hand, enable researchers to evaluate participants' unconscious and automatic responses to language stimuli (Marinis, 2010). These types of tasks are particularly good for research that investigates time-related properties. In most cases, the latency, or reaction time (RT) towards a certain stimuli is recorded by a computer and the RT thus becomes the dependent variable for the experiment. RTs to certain stimuli can actually reflect participants' unconscious processes, which are something that off-line experiments cannot measure (Marinis, 2010).

This article presents results of a study that aimed to investigate if adding vowel diacritics or additional vowel letters to the Arabic script of written Malay (henceforth, *Jawi*) facilitates reading in terms of accuracy and latencies. Today, *Jawi* is a marginalised script among Malaysians due to its cognitive complexity (Salehuddin, 2012). One of the reasons why *Jawi* is cognitively complex is the fact that the way Malay words are spelled in *Jawi* appear to be done rather unsystematically due to the number of rules to be memorised and applied. Bi-syllabic words, for example, are spelled with four different variants: 1) a vowel letter present in both syllables; 2) a vowel letter present in the first syllable, but absent in the second syllable; 3) a vowel letter absent in the first syllable but present in the second syllable; and 4) a vowel letter absent in both syllables. Although guidelines are available (e.g., Ismail Dahaman, 1991), the number of rules that users have to adhere to makes it rather confusing and complex, particularly to novice Jawi readers. Hence, in order to make the process less complex, Salehuddin (2013) proposed some innovative transformations to the script which includes the addition of vowel letters and vowel diacritics in the script.

In order to investigate if the transformations proposed to the script facilitate the reading process, on-line experiments were conducted. Readers' RTs can provide information on how fast or slow the proposed transformation affects the readers' reading. Hence, it was assumed that if the transformations do facilitate reading, the number of correct responses will increase and the RT will decrease. A decrease in the RT will inform researchers that readers take less time to process the transformed spelling than its original spelling. In contrast, if the transformations do not facilitate reading, the number of correct responses will decrease; however, an increase in the RT will be observed.

Up till now, the *Jawi* spelling system has gone through various transformations, presumably to make it easier for readers to read *Jawi* and hence, to regain its popularity among Malaysians. Words like "*bumi*" (/bumi/ 'earth'), for example, used to be spelled without a vowel in the second syllable (i.e., "بوم"). As a result, the word was often misread as "*bom*" (/bom/ 'bomb'). However, more recently, a vowel letter has been added to the second syllable of the word (i.e., "بومي") so that the word is now read correctly as /bumi/. Similarly, words such as "*topi*"

(/topi/ 'hat') and "*tupai*" (/tupai/ 'squirrel') were often misread when they appeared in written form as they were both homographically spelled as "توڤي" (Ismail Dahaman, 1991). Hence, for readers to read sentences such as " ساي نمڤق توڤي" correctly, they would have to strongly rely on the numeral classifier "سايكور" (*seekor* "NumCl – animate, non-human") that preceeds the noun to disambiguate the word "توڤي" semantically (See Salehuddin (2014) for more information on Malay numeral classifiers). In 1986, a modification to the Jawi spelling system was made and this modification involved the inclusion of another vowel letter in the second syllable of words with diphthongs (e.g., changing "توڤي" "*tupai*" (/tupai/ 'squirrel') to "توڤاي" (Ismail Dahaman, 1991)). As a result of this change, readers no longer had to disambiguate certain homographs through the context as they previously had to.

However, despite the various forms of changes that *Jawi* has experienced up till now, the spelling has yet to be made fully consistent and less complex. As mentioned earlier, for bi-syllabic words alone, four different types of spelling can be observed.

1. A vowel letter is present in both syllables (/ju.ri/ →جوري)
2. A vowel letter is present in the first syllable, but is absent in the second syllable (/ki.ta/ →كيت)
3. A vowel letter is absent in the first syllable, but is present in second syllable (/har.ta/→هرتا)
4. A vowel letter is absent in both syllables (/d͡ʒi.ka/ →جک)

Vowel letters in *Jawi* do not perform the same role as those in the Arabic language. This is because the vowel letters in the Arabic language function as long vowels – vowels whose length is equivallent to two beats (*harakat*) which are often manifested either in the letter "ا", "و" or "ي". Short vowels, on the other hand, are either manifested in the form of *Tashkeel* (◌َ ◌ِ ◌ُ) or not manifested at all. To illustrate, words like "جمل", for example, are bi-syllabic words that are pronounced with two short vowels (i.e., /d͡ʒamal/ 'camel', as in "جَمَل"). The presence of a vowel letter in the second syllable "جمال" changes the meaning of the word (i.e., /d͡ʒamaːl/ 'beauty', as in "جَمَال") although the vowel sound in the second syllable of the two words are both low front vowels. This suggests that long vowels and short vowels in the Arabic language are indeed 'phonemes' which make "جمل" and "جمال" minimal pairs.

However, in Malay, the change in the length of the vowels in any of the Malay syllable does not change the meaning of the words. "Baju" (/bad͡ʒu/ 'clothes') is still perceived as "baju" even if a person extends the vowel length in any of the syllables (e.g., as in /baːd͡ʒu/ or /bad͡ʒuː/ or even /baːd͡ʒuː/). This is because, there are no long vowels in Malay and the use of vowel letters in *Jawi* does not make any syllable longer than the other. Because of this, if vowel letters appear in certain syllables in *Jawi*, they continue to be read as short vowels. As a matter of fact, the presence of vowel letters appears to be necessary as they may actually help readers in disambiguating ambiguous Malay words in *Jawi*.

Vowel diacritics ('*tashkeel*') have been used in the Arabic language to assist novice readers in reading the Arabic language more accurately, particularly in determining the vowel sounds (i.e., /a/, /i/, /u/) that should accompany particular consonants. Since in the Arabic language, the manifestation of vowels in syllables is dependent on context, the use of vowel diacritics (or "pointing") helps novice readers, who may not be familiar with Arabic syntactic structure, to read Arabic words accurately (Abu-Rabia, 2002).

Jawi, however, has never been written with diacritics. Hence, readers of Malay who are not familiar with Malay words or those who are not familiar with the

semantics and syntactic structures of Malay may not be able to read *Jawi* accurately. Therefore, it was hypothesised that the use of vowel diacritics in *Jawi* will help readers to read words in *Jawi* more accurately with faster RTs than to read words in *Jawi* without diacritics. It was also hypothesised that the use of vowel letters in syllables that currently do not have vowel letters in them would also assist readers in reading words written in *Jawi* more accurately with faster RTs than reading words written in *Jawi* that have missing vowel letters in certain syllables.

Based on the above-mentioned hypotheses, the current study investigated the effect of these modifications to *Jawi* in two different reading experiments. The on-line method was used as participants' unconscious and automatic responses to language stimuli can be recorded. Two reading experiments were conducted for this purpose. Experiment 1 investigated the naming latencies of words written in *Jawi*, with and without diacritics, by Malay and Arabic native speakers. Experiment 2 investigated the optimal manipulation in *Jawi* that facilitates reading. Both experiments were conducted using DMDX (Forster & Forster, 2003), a Win 32-based display system for psychological experiments that records reaction times to visual and auditory stimuli to capture the participants' on-line processes.

EXPERIMENT 1

METHOD

PARTICIPANTS

Twenty-eight Malay native speakers (27 females, 1 male) and 13 Arabic native speakers (3 females, 10 males) participated for payment in the experiment. The Malay participants were first year undergraduates at the School of Language Studies and Linguistics, Universiti Kebangsaan Malaysia. They were between 19 and 22 years old. Seventeen of them reported that they started reading *Jawi* before they were 7 years old. However, only two of them reported that they read *Jawi* on daily basis. Twenty-one of the Malay native speakers read the Qur'an, the Holy Scripture that is written in the Arabic script with diacritics, before they were seven and 19 of them reported that they read the Qur'an everyday.

The other group of participants were native and first language (L1) speakers of Arabic. They were selected solely for their ability to read the Arabic script. All of them were studying at the postgraduate level in Malaysia. They had been in Malaysia for between 1 and 3 years, and all of them regarded Malay as a foreign language. Despite the fact that they had lived in a country that has Malay as its national language for more than a year, their contact with the Malay language was limited because they rarely communicate with the locals. As a result, they had to learn the Malay language formally in language classrooms. Despite the formal Malay instructions, their proficiency in the spoken and written Malay was still very low. They also reported that they even had difficulty in constructing simple Malay sentences. None of them had the experience of reading *Jawi* prior to this experiment.
All participants (i.e., Malay and Arabic native speakers) had normal or corrected-to-normal vision and none of them reported having any reading disability. Table 1 summarises the Malay and Arabic native speakers' background information for reading *Jawi*.

TABLE 1. Background of the Malay and Arabic native speakers

	Age start reading *Jawi* / Arabic (years)				Frequency reading *Jawi* / Arabic				Age start reading the Qur'an (years)				Frequency reading the Qur'an			
	<7	7-12	13-17	>17	daily	weekly	monthly	yearly	<7	7-12	13-17	>17	daily	weekly	monthly	Yearly
Malay	17	10	1	0	2	8	9	9	21	7	0	0	19	9		
Arabic	10	3	0	0	10	3	0	0	6	7	0	0	6	7	0	0

STIMULI

The stimuli were 100 Malay words written in *Jawi* presented in its original form (i.e., without diacritics) and in its permutated form (i.e., with diacritics). Each word was presented in both conditions, that is, either with diacritics or without diacritics, in a random order for each individual participant. The words selected were bi-syllabic words and ranged in length from 3 to 6 letters (M = 4.78) for Roman script and 2 to 6 letters (M = 4.19) for *Jawi*. The mean word-frequency was 136 words per million and ranged from 0 to 10466 words per million (Dewan Bahasa dan Pustaka Corpus for Books & Magazine).

PROCEDURE

The naming task was run using DMDX (Forster & Forster, 2003). Participants were tested individually in a quiet room. Each of the participants sat approximately 50 cm in front of a *Multi-touch Full HD All-in-One* computer. Prior to the experimental session, each participant was briefed that Malay words written in Arabic script (printed in cursive) would be presented on the computer monitor and their task was to read the words aloud. They were instructed to name the words displayed on the screen as quickly and as accurately as possible. Presentation of the stimuli and recording of reaction times were controlled by DMDX software (Forster & Forster, 2003). Each participant received a total of 18 practice trials prior to the experimental phase.

The participants read 200 bi-syllabic Malay words in *Jawi* aloud; 100 were bi-syllabic Malay words written without vowel diacritics whereas the other 100 were the same bi-syllabic Malay words but written with vowel diacritics. The presentation of Malay words in *Jawi* with diacritics was based on the proposition put forward by Salehuddin (2013). The presentation of stimuli was randomised and mixed for both with and without diacritics, with different order for each participant. After the 100th stimulus, each participant was given a break and was instructed to resume the experimental trial by pressing the 'space bar' key. Naming latencies (RTs) were measured and recorded by DMDX via a microphone. After the experiment, naming responses were analysed using CheckVocal (Protopapas, 2007). The naming task session lasted approximately 20 minutes.

RESULTS

Incorrect responses and response times less than 300 ms or greater than 1600 ms (10.94% Malay data and 28.23% Arabic data) were excluded from the latency analysis. The mean reaction times and proportion of correct responses (accuracy) are presented in Table 2.

TABLE 2. Mean latencies (in milliseconds) and accuracy for naming words with and without diacritics. Standard deviations are in parentheses

	Without Diacritics		**With Diacritics**	
	RT	**Accuracy**	**RT**	**Accuracy**
Malay (L1)	794	.93	793	.97
	(20)	(.08)	(21)	(.05)
Arabic (L1)	743	.66	839	.79
	(29)	(.07)	(30)	(.09)

Two repeated measures analyses of variance (ANOVA) were conducted for reaction times and accuracy (proportion correct). Word type (without diacritics, with diacritics) was a within subjects factor and native language (Malay, Arabic) was a between subjects factor.

The ANOVA on the latency data showed a main effect of word type ($F(1, 39) = 84.45$, $p<.001$, $\eta_p^2=.684$). Native language spoken was not significantly different ($p>.9$) but there was a significant interaction effect between word type and native language ($F(1, 39) = 87.83$, $p<.001$, $\eta_p^2=.693$). Post hoc comparisons were conducted. For the Malay speakers, there was no significant difference in reaction times when naming words with or without diacritics ($p>.8$). However, for the Arabic speakers, naming latencies were significantly faster (96 ms) when reading words without diacritics than with diacritics ($t(12) = 7.92$, $p<.001$).

The ANOVA on the accuracy data showed a main effect of word type ($F(1, 39) = 57.42$, $p<.001$, $\eta_p^2=.596$) with greater accuracy when naming words with diacritics than without diacritics. There was also a significant main effect of native speaker ($F(1, 39) = 115.75$, $p<.001$, $\eta_p^2=.748$) with the Malay speakers being more accurate and making less mistakes than the Arabic speakers. There was also a significant interaction effect between word type and native speaker ($F(1, 39) = 17.99$, $p<.001$, $\eta_p^2=.316$). Post hoc comparisons were also conducted. Malay speakers and Arabic speakers were both more accurate when naming words with diacritics than without (Malay speakers: $t(27) = 3.21$, $p<.01$, Arabic speakers: $t(12) = 6.19$, $p < .001$).

DISCUSSION

Experiment 1 has revealed a number of findings. First, the Malay native speakers did not differ in their latencies for reading words with diacritics (e.g., رِيَا, كِيتَ) or without diacritics (e.g., ريا, كيت). However, they were more accurate in reading the words with diacritics in comparison to reading words without diacritics. Thus, there was a facilitatory effect of the diacritics on their accuracy of visual-word recognition although not on naming latencies. In interpreting these results, it is important to note that these participants were reading words in their native language, but reading the words in a less familiar script. Malays are more familiar with reading the Malay language using *Rumi* or Roman script than Arabic script, particularly because the Roman script is currently the standard script for the Malay language. The diacritics appear to facilitate accurate lexical retrieval as they effectively help in narrowing down the plausible lexical candidates in comparison to words without diacritics, which leads to greater naming accuracy. Although a majority of the Malay participants rarely read *Jawi*, their daily contact with the Qur'an does help them in achieving accuracy in reading *Jawi* with diacritics. The Qur'an is written with vowel diacritics to ensure accuracy in reading the Holy Scripture. *Jawi* with diacritics

resembles the Qur'an and hence, the presence of diacritics helps Malay readers to read the Malay words in *Jawi* more accurately.

In contrast, the Arabic native speakers were significantly faster when reading words without diacritics than with diacritics. Yet, they were more accurate when naming words with diacritics than without diacritics. There are a number of possible explanations for these conflicting results. These results reflect the Arabic speaker's low proficiency levels in Malay and lack of experience in reading *Jawi*. An additional contributing factor is that as their first language is Arabic, they are used to reading Arabic without diacritics, and hence are faster at reading the words in Experiment 1 without diacritics although not as accurate. This is because, they are reading a script that they are very familiar with but retrieving words in Malay, a language they are less familiar with. Malay has a larger number of vowels represented than Arabic and so when consonants only are available, as occurs in *Arabic script* without diacritics, accurate lexical retrieval is more challenging in their second language, Malay. In Arabic script, when diacritics are not available there is greater reliance on top-down processing, which is dependent on knowledge of the language. This is why beginner readers and second language learners, when they first start learning to read Arabic (and the same with Hebrew), are given texts with diacritics; once they become more experienced at reading, the diacritics are removed (Abu-Rabia & Siegel, 2003). In addition, the naming latencies were slower, also probably because of the fact that *Jawi* with diacritics resembles the Qur'an. Muslims are taught to recite the Qur'an slowly and clearly, as stated in verse 4 of surah al-Muzzammil, the translation of which is "and recite the Qur'an in slow, measured rhythmic tones" (Ali, 1934, 1977). Because of the resemblance between the Qur'an and the *Jawi* with diacritics in terms of their presentation, readers who are native speakers of Arabic tended to read the latter slowly as a result of the conditioning process in the recitation of the Qur'an.

IMPLICATIONS

In Experiment 1, there was only qualified support for the prediction that diacritics would have a facilitatory effect on the reading of words in *Jawi*. For the Malay readers, there was no difference in latencies for reading words with or without diacritics, but they named the words with greater accuracy when diacritics were present. In relation to the Arabic speakers, there was a facilitatory effect of diacritics on the accuracy of naming the words when diacritics were present, but not on naming latencies.

Experiment 1 shows that to a certain extent, the presence of diacritics in *Jawi* does help readers to read the script more accurately. This suggests that the presence of diacritics in *Jawi* can, to a certain extent, help in reducing the cognitive complexity of Jawi, supporting the proposition made by Salehuddin (2013).

Vowel diacritics, as mentioned earlier, represent short vowel sounds in the Arabic language. Vowel letters, on the other hand, represent long vowel sounds in the Arabic language. Malay does not have long vowels; yet, vowels letters are pervasive in *Jawi*. Nevertheless, they appear to be used rather inconsistently in *Jawi*. As mentioned earlier, some syllables within a word are written with vowel letters whereas some syllables within a word are written without vowel letters (see Salehuddin, 2012 for further description). Despite the use of these vowel letters, the duration of the syllables, with or without vowel letters, are the same. Hence, syllables with vowel letters are read in the same length with those without vowel letters. It can be assumed that vowel letters in *Jawi* play the same role as vowel diacritics do in Arabic scripts.

With this in mind, based on Salehuddin's (2012) argument, it can be assumed that there can be four possible ways of spelling a Malay bi-syllabic word in *Jawi*. This includes 1) maintaining the current *Jawi* spelling, i.e., the latest spelling system by Dewan Bahasa dan Pustaka (see Ismail Dahaman, 1991); 2) adding vowel diacritics to the current *Jawi* spelling; 3) adding vowel letters to the current *Jawi* spelling; and 4) removing all vowel letters from the current *Jawi* spelling, but adding vowel diacritics to all syllables.

EXPERIMENT 2

Experiment 2 was conducted to investigate if readers who are native speakers of Malay are able to read *Jawi* with greater ease in all the four different spelling conditions mentioned in the preceeding paragraph. If there is a difference in the facilitatory effect of the spelling conditions in reading *Jawi*, it would be important to find out which manipulation is the most effective.

METHOD

Thirty (16 Male, 14 Female) Malay native speakers who were able to read *Jawi* participated in this study. They were thirteen- (12) and fourteen-year-old (18) students of SMK Seafield, USJ 2, Subang Jaya, Selangor Darul Ehsan. All participants had normal or corrected-to-normal vision. They participated based on the invitation circulated to them through one of their school's English teachers.

Prior to the session, the participants answered a questionnaire designed to investigate their ability to read *Jawi* and the Qur'an. A majority of them started to learn to read *Jawi* even before they were 7 years old while quite a number of them started reading the Qur'an between 7 and 12 years old.

Participants were tested individually. Each of them sat approximately 50 cm in front of a Toshiba laptop. Prior to the experimental session, each participant was briefed that they would be presented with Malay words written in Arabic script (printed in a cursive form) and their task was to read the words aloud. Eighteen (18) bi-syllabic Malay words were presented to the participants as practice trails using the DMDX software and once they have read the 18 trials, they proceeded to the experimental trials by pressing the "space bar" button. All instructions were given to the subjects in Malay.

A total of 108 bi-syllabic Malay words were presented to the participants in four different conditions: Condition 1: 27 bi-syllabic words written in the current *Jawi* spelling; Condition 2: 27 bi-syllabic words written in the current *Jawi* spelling with the inclusion of vowel diacritics in all syllables; Condition 3: 27 bi-syllabic words written in the current *Jawi* spelling with the inclusion of vowel letters in all syllables, and Condition 4: 27 bi-syllabic words in Condition 3 but with vowel letters replaced by vowel diacritics in all syllables (Table 3 for illustrations). The bi-syllabic words were 27 of the 100 words used as stimuli in Experiment 1. The presentation of the stimuli was randomised with a different order for each participant. The experimental session lasted about 20 minutes/participant.

TABLE 3: Four spelling conditions for the bi-syllabic Malay words in *Jawi*

	Condition 1	Condition 2	Condition 3	Condition 4
Mua	موا	مُوَا	مووا	مُوَ
Jua	جوا	جُوَا	جووا	جُوَ
Salam	سلام	سَلَام	سالام	سَلَم
Kahwin	كهوين	كَهوِين	كاهوين	كَهوِن

RESULTS

Analysis of correct reading responses given by each participant shows that there was a significant effect of the four spelling conditions on the mean number of correct response, $F(1, 116) = 4.07$, $p<.01$, $\eta_p^2= .116$. Posthoc analysis shows that the difference between conditions 1, 3 and 4 was not significantly different from each other and neither was the difference between conditions 4 and 2. Condition 2, however, was significantly different from conditions 3 and 1.

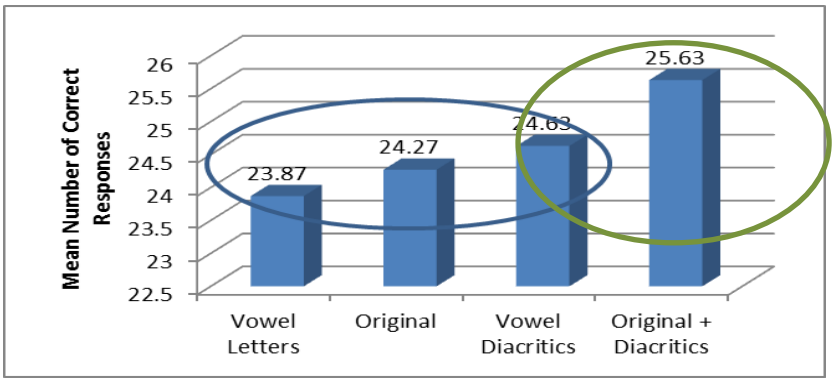

FIGURE 1: Mean number of Correct Responses for the different *Jawi* spelling conditions

Analysis of the Reaction Times on all correct responses shows that there was no significant difference of spelling condition for reaction times, $F(3, 116) = .295$, *ns*, $\eta_p^2= .008$.

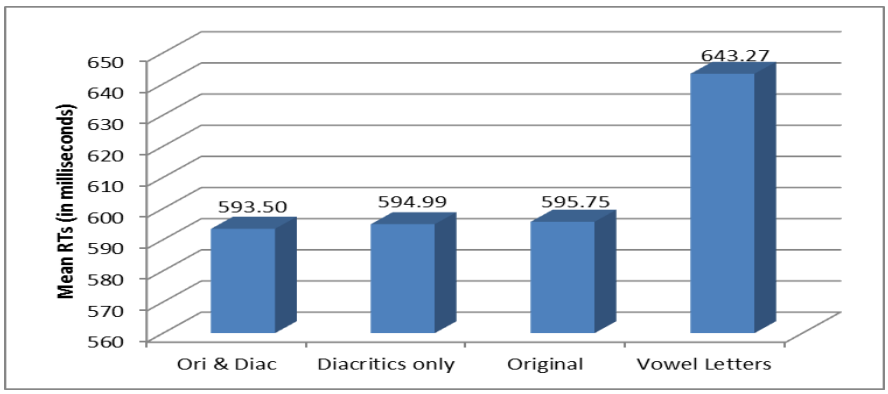

FIGURE 2: Mean reaction times (in milliseconds) for the correct responses in all spelling conditions

DISCUSSION

Experiment 2 has revealed some findings. Readers read with more correct responses in conditions when vowel diacritics are present, regardless of whether there were vowel letters in the syllables or not. The presence of additional vowel letters in syllables did not help readers in reading words in *Jawi* more accurately. However, in terms of reaction times, none of the conditions appear to facilitate readers in reading the words.

According to Salehuddin (2012), a syllable that contains the vowel /a/, for example, can be manifested in *Jawi* in two forms; the first with the vowel letter "alif" (ا), and the second without any vowel letter. When the first takes place, the script can be considered as a "shallow orthography", because the presence of the letter "alif" can signal readers that the vowel /a/ should be manifested out loud in reading the syllable. When the second takes place, the script can be considered as a "deep orthography", because the absence of the letter "alif" may leave readers guessing as to how the syllable should be read. This is because the absence of vowel letters in particular syllables may mean that the syllables can be read with many other vowel sounds. But what appears to have caused *Jawi* to be cognitively complex is the fact that *Jawi* is a "shallow" orthography and a "deep" orthography at the same time. Vowel /a/ in the Malay word "mama" is manifested in *Jawi* using the vowel letter "alif" (ا) in both syllables (i.e., ماما); yet, the vowel sound is not manifested in *Jawi* in the first syllable of "harta" (i.e., هرتا), in the second syllable of "jasa" (i.e., جاس), and in neither syllable of "jika" (i.e., جك).

However, when vowels are manifested in the form of diacritics in *Jawi*, readers felt that their reading was more "guided"; the presence of the diacritics help them to decide which vowel should be used to make up a particular syllable. Participants' incorrect responses in the reading aloud task indicated that they did have problems in deciding which vowels should be filled in reading words. Hence, the use of the vowel diacritics does help them in deciding which vowels to choose when reading.

DISCUSSION AND CONCLUSION

It is common knowledge that scripts that are cognitively complex are relatively more difficult to read than those that are cognitively less complex. When scripts are easier to read, accuracy will be higher and reaction times will be faster. In other words, readers will make more mistakes and spend more time reading when the scripts are cognitively complex.

Jawi has become a marginalised script presumably due to it being a relatively more complex script in comparison to the Roman script. The script is cognitively complex not only because of its physical attributes, but also because of the complexity in its spelling system (Salehuddin, 2012). Hence, some transformations have been proposed with the aim of reducing the complexity of the current *Jawi* script (Salehuddin, 2013).

The effectiveness of the proposed transformation to reduce the cognitive complexity of *Jawi* can only be known if what happens in the cognition of the readers can be understood. Hence, two experiments which investigated the on-line processes in reading *Jawi* were conducted. The number of correct responses and the reaction times from both experiments suggest that to a certain extent, some permutations in the *Jawi* spelling system do help in making the process of reading *Jawi* a less complex process for readers.

Experiments 1 and 2 have shown the effect of adding and removing vowel letters and/or vowel diacritics to and from the existing *Jawi* spelling system. Both experiments show that the use of vowel diacritics in *Jawi* increases readers' accuracy in reading. However, no significant difference in latency was observed.

It is not surprising that participants read more accurately when reading words with diacritics. This is because diacritics help readers to make quick decisions on which vowel sounds to manifest in certain syllables. Yet, the presence of vowel letters, however, does not result favourably in terms of accuracy. Although vowel letters, like vowel diacritics, can give readers clue as to which vowel sound to manifest in certain syllables, the addition of vowel letters in syllables where they were absent in the original *Jawi* spelling does not help readers in reading the word accurately. Why does this happen?

Readers read less accurately when vowel letters were added to the original *Jawi* spelling probably because the additional letters interfere with the typical shape of certain words. To illustrate, readers may be familiar with the physical shape of the word "سلام" ("salam" *peace*) in what they see on signboards and posters; this results in them giving the correct response upon seeing the word. The presence of "ا" (i.e., the Arabic letter *alif*) in the second syllable, however, may hinder word-recognition processing, and hence, results in inaccurate word production. However, removing vowel letters from the existing spelling does not have the same effect. Although the removal (e.g., "سَلَم") does not make the same word look similar with the original shape, the diacritics does help readers in deciding how to pronounce the words they see. In other words, adding vowel letters into the *Jawi* spelling disrupts the reading process; but adding vowel diacritics, to a certain extent, helps ease the process of reading *Jawi.*

It was discussed earlier that readers' reaction times in reading *Jawi* is longer with the presence of diacritics because of readers' previous experience in reading the Qur'an. If this were true, adding vowel letters to the original *Jawi* spelling would also give a longer reaction time, as vowel letters in the Arabic script represents long vowels. However, in Experiment 2, the RT for long vowels was not significantly longer than the other conditions. This is an interesting finding that needs to be explored in the future.

The current study has shown that the inclusion of vowel diacritics can, to a certain extent, make *Jawi* an easier script to read. In terms of accuracy, the act of removing vowel letters from the current *Jawi* spelling and concurrently adding the vowel diacritics so that all syllables have vowel diacritics in them result in no significant difference from adding vowel diacritics to the current *Jawi* spelling. This suggests that vowel diacritics do facilitate reading. Because of this, there are two permutations that can be considered in making a change to the current *Jawi* spelling system: 1) adding vowel diacritics to the current *Jawi* spelling; and 2) removing all vowel letters from the original *Jawi* spelling, but adding vowel diacritics to all syllables.

Vowel diacritics, in studies on Arabic language, have been described as "perceptual noise" (Roman & Pavard, 1987). Whether this is also true for *Jawi* is still unknown. This study, from two on-line experiments, has found two spelling conditions that could ease the process of reading *Jawi.* To determine which one of the two would be the better change for *Jawi,* another on-line experiment, using the eye-tracking machine can be conducted for this purpose. A study he on the eye movement patterns when reading can also investigate if vowel diacritics are truly perceptual noise for *Jawi* as they are in the Arabic language.

The *Jawi* spelling system has gone through various phases of transformation. The transformation proposed in this study is not ultimately aimed at making *Jawi* the standard script of Malay. However, such a transformation is necessary today so that the efforts made by the Malaysian's government to encourage a widespread in the usage of the script at all levels will be fruitful.

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REFERENCES

Abu-Rabia, S. & Siegel, L. S. (2003). Reading Skills in Three Orthographies: The Case of Trilingual Arabic-Hebrew-English-Speaking Arab Children. *Reading and Writing: An Interdisciplinary Journal*. *16*, 611-634.

Abu-Rabia, S. (2002). Reading in a Root-Based Morphology Language: The case of Arabic. *Journal of Research in Reading*. *25*(3), 299-309.

Ali, A.Y. (1934, 1977). The Holy Quran: Translation and Commentary, 2nd edition American Trust Publication.

Dewan Bahasa dan Pustaka – Korpus Buku dan Majalah. http://sbmb.dbp.gov.my/knb/nb_login_pelanggan_web.aspx?konkordans=yes

Forster, K. I. & Forster, J. C. (2003). DMDX: A Windows Display Program with Millisecond Accuracy. *Behavior Research Methods, Instruments & Computers*. *35*, 116-124.

Ismail Dahaman. (1991). Pedoman Ejaan Jawi yang Disempurnakan (1986). (On line). Retrieved 31 May 2011, from http://www.astech.com.my/koleksi_digital/konvension/Display&f=jawi00031&s=1&t=toc.htm

Marinis, T. (2010). Using On-line Processing Methods in Language Acquisition Research. In Blom, E., & Unsworth, S. (Eds.). *Experimental Methods in Language Acquisition Research (pp. 139-162)*. Amsterdam: John Benjamins Publishing Company.

Noorizah Mohd. Noor. (2010). ESL Learners' Reading Approaches of an Academic Expository Text. *3L: Language Linguistics Literature®, Southeast Asian Journal of English Language Studies*. *16*(2), 19-46.

Plaut, D.V. (1997). Structures and Functions in the Lexical System: Insights From Distributed Models of Word Reading and Lexical Decision. *Language and Cognitive Processes*. *12*(5/6), 1-19

Protopapas, A. (2007). Check Vocal: A Program to Facilitate Checking the Accuracy and Response Time of Vocal Responses from DMDX. *Behaviour Research Methods*. *39*, 859-862.

Rayner, K., Pollatsek, A., Ashby, J. & Clifton, C. (2012). *Psychology of Reading*, New York: Psychology Press.

Roach, P. (2004). *English Phonetics and Phonology: A Practical Course (Third Edition)*. Cambridge: Cambridge University Press.

Roman, G., & Pavard, B. (1987). A Comparative Study: How We Read Arabic and French. In J. K. O'Regan & A. Levy-Schoen (Eds.). *Eye Movements: From Physiology to Cognition (pp. 431-440).* Amsterdam: North Holland Elsevier.

Salehuddin, K. (2013). Arabic Script of Written Malay: Innovative Transformations Towards a Less Complex Reading Process. *Pertanika Journal of Social Sciences and Humanities. 21*, 63-76.

Salehuddin, K. (2012). Penilaian ke atas Kerumitan Kognitif dalam Proses Membaca Jawi. *GEMA Online® Journal of Language Studies. 12*(4), 1181-1192.

Salehuddin, K. (2014). Malay Numeral Classifier Acquisition. In Winskel, H. & Padakannaya, P. *South and Southeast Asian Psycholinguistics* (pp. 71-78). Cambridge: Cambridge University Press.

Schmitt, C. & Miller, K. (2010). Using Comprehension Methods in Language Acquisition Research. using On-line Processing Methods in Language Acquisition Research. In Blom, E., & Unsworth, S. (Eds.). *Experimental Methods in Language Acquisition Research (pp. 35-56).* Amsterdam: John Benjamins Publishing Company.

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