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CAN THE EYE TRACKER REVEAL HOW THE QUR'AN CAN BE LEARNED BY HEART?¹

Khazriyati Salehuddin

Abstract

Memorization is a mental process that enables one to remember verbatim. This skill is important to Muslims as Muslims are encouraged to memorize the Qur'an regardless of what their first language is. Various researches have been conducted and published in describing the best techniques to memorize the Qur'an. Huffaz (i.e., individuals who have memorized all the 6236 verses of the Qur'an) also often share their strategies on how the Qur'an, which is in Arabic, can be memorized. These published works, however, are based on off-line information (i.e., information based on what the huffaz thought took place while they were learning the Qur'an by heart). On-line information, however, is equally important, particularly because it provides information even on the unconscious activities that the huffaz engage in when memorizing the Qur'an. One way of collecting on-line information from the huffaz and tahfiz students (i.e., students who are memorizing the Qur'an) is through the use of the eye tracker, a device that enables researchers to track the eye movements of those who read the Qur'an to memorize it. Hence, this manuscript illustrates how the eye tracker can be used to investigate the cognitive processes that tahfiz students go through when the act of memorizing the Qur'an is performed.

Keywords: Cognitive Processes, Eye Movements, Memorization, Psycholinguistics, Qur'an, Reading,

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INTRODUCTION

Memorization is a mental process that enables one to remember verbatim, (i.e., word for word). Linguistically, the word “memorize” derives from the word “memory”, the mental faculty of retaining and recalling past experience. The suffix “-ize” added to the root “memory” suggests the meaning of making the process of retaining and recalling past experience possible. Since the act of memorizing something refers to the act of getting that something into one’s memory, memorizing is clearly a conscious process. Also known as “learning something by heart”, memorization enables the human capacity to later recall whatever knowledge that has been acquired². Learning and memory, according to Lieberman, are “intimately, perhaps inextricably, intertwined”³ as humans can only learn new things if these new things are remembered; and the fact that humans can only remember things that they have learned holds true undoubtedly.

Memorizing is an essential act in everyone’s lives for it enables one to function effectively in his/her community. Young children memorize letters of the alphabet to enable them to spell and they memorize multiplication tables to enable them to perform mathematical problems; science students memorize periodic charts and scientific formulae; actors memorize lines from plays; musicians memorize music pieces; and the list goes on and on. Memorization takes place very early in the existence of Muslims – short verses of the Qur’an (all in Arabic) such as *The Basmalah* are memorized at a very young age to inculcate the remembrance of The All Mighty when carrying out daily activities like eating, sleeping and travelling. As the Muslim children grow older, longer verses of the Qur’an such as the entire chapter of *al-Fatihah* and verses from the hadith such as the *Tahiyyat* (all in Arabic) are memorized so that the obligatory and optional prayers can be performed. The pillars of Islam, the pillars of *Iman*, the rules in *fiqh* are memorized in the languages that Muslims are most comfortable with so as to shape righteousness among the Muslims.

² David A. Lieberman, *Human Learning and Memory*. (Cambridge: Cambridge University Press, 2012), 291.

³ *Ibid*.

For Muslims, memorization goes beyond what is listed above. All Muslims are encouraged to memorize the Qur'an and practise the teachings that come with the revealed knowledge. Those who have completely memorized the Qur'an are called *huffaz*, which literally means "the guardians". The title *hafiz* (for singular male) and *hafiza* (for singular female) is given to the Qur'anic memorizers because their act of memorizing the entire Qur'an (all 6236 verses, comprising around 80,000 words) "guards" the Qur'an from any forms of modification, distortion or loss. The *huffaz* are able to recite the entire Qur'an from verse 1 to verse 6236 in the right sequence, continue the recitation of verses taken randomly from the Qur'an, and recite verses that contain specific words or phrases. The act of memorizing the Qur'an from the day of the first revelation some 1,430 years ago has preserved these words of The All Mighty, verbatim, up till today. This is one form of manifestation of HIS promise, that the Qur'an is preserved, and the translations of this promise are in the following:

Indeed, it is We who sent down the Qur'an and indeed, We will be its guardian⁴.

Indeed, it is a noble Qur'an. In a Register well-protected. None touch it except the purified. [It is] a revelation from the Lord of the worlds⁵.

But this is an honoured Qur'an. [Inscribed] in a Preserved Slate⁶.

Because of the status of the *huffaz* in this life and The Hereafter, many children have been sent to *madrassas* (Islamic schools) or *tahfiz* schools (i.e., schools specifically dedicated to teaching the memorization of the Qur'an). Such a practice is also common for individuals to become *huffaz* in Malaysia. In such schools, Arabic is taught formally, perhaps, as a second or a third language to the learners. Hence, those who memorize the Qur'an are typically those who have quite an extensive knowledge of the Arabic

⁴ *Al-Qur'an*, 15:9.

⁵ *Ibid.*, 56:77-80.

⁶ *Ibid.*, 85:21-22.

language. However, the memorization of the Qur'an is not exclusively for Arabic speakers. The act of memorizing the Qur'an is also inclusive of non-Arabic speakers. Non-Arabic speakers should also memorize the Qur'an and not being an Arabic speaker should not stop one from memorizing the words revealed by The All Mighty. A'aishah (*ra*) reported that the Prophet (*saw*) said: The likeness of the one who reads the Qur'an and memorizes it is that he is with the righteous honourable scribes. The likeness of the one who reads it and tries hard to memorize it even though it is difficult for him, he will have (at least) a double reward⁷.

The memorization of the Qur'an involves two modalities, namely, oral and written. For the visually impaired and those who have not developed their literacy skills, most of the memorizing is done through listening and least likely through reading. For the others, they are done through reading.

So how is the Qur'an memorized? According to Fathima Manaar Zuhurudeen⁸, memorizers of the Qur'an who are able to read must first learn to read Arabic and recite the text, before making attempts to memorize the Qur'an, part by part, over a period of time. For Arabic speakers, memorization is done with knowing the meaning of the words in the Qur'an; but for non-Arabic speakers, memorization is usually done without knowing the meaning of the words. Although Arabic plays a major role in the daily lives of Muslims regardless their native language due the recitation of the Qur'an in the daily prayers, according to Zuhurudeen, "Parents of young [non-Arabic-speaking] children do not prioritize the ability to understand the Qur'an, as they do the ability to read and memorize it"⁹. Instead, once their children are able to associate the Arabic phonemes with their respective graphemes (i.e., read the Qur'an) and master the Qur'anic phonological rules (i.e., the *tajweed*), they can proceed to the act of memorizing the Qur'an. Hence, non-Arabic

⁷ Al Bukhari, cited in Ibnu Hajar al-Asqalani, *Fathul Bari bi Sharh Sahihul Bukhari*. (Cairo: Dar AlBayan Litturath, 1988), 8/4937.

⁸ Fathima Manaar Zuhurudeen, Fathima Manaar, "Effects of Statistical Learning on the Acquisition of Grammatical Categories through Qur'anic Memorization: A Natural Experiment." Master thesis, University of Maryland, 2013.

⁹ *Ibid.*, 9.

speakers who learn to memorize the Qur'an are those who are able to at least recite (i.e., read, phonetically and phonologically) the Qur'an rather fluently; only a small portion of these memorizers may learn Arabic to study the Qur'an in greater depth later in life.

Unlike non-Arabic-speaking learners, Arabic-speaking learners are familiar with the meaning of the words in the Qur'an as they read and try to memorize them. This potentially helps in the memorization process because in processing words whose meanings are known, the new information at the sensory register is sent to the working memory and at the working memory, the new information (i.e., the words to be memorized) is associated with information (i.e., the meaning of those words) that is already (and permanently) available in the Long Term Memory¹⁰.

Although the process of memorizing the Qur'an varies, most learners usually begin by reading a verse of the Qur'an and repeating the verse several times to themselves until they are able to recite the verse without looking at the verse in print (i.e., the *mushaf*, or the manuscript that is bound between two boards). The memorized verses are usually reviewed with the presence of a teacher or a peer, or through a recording of the memorized verse, to identify and rectify mistakes, if any¹¹. Zuhurudeen added that even if the learners who are memorizing the Qur'an do not have the printed version of the Qur'an (the *mushaf*) in front of them to review the previously memorized verses, they can still passively acquire the memorized verses just by listening to the recordings of the recitation of the Qur'an, provided that the verses are presented as "continuous streams and exist in a diverse abundance"¹².

Several strategies of memorizing the Qur'an have been identified in Malaysian tahfiz schools^{13,14}; yet, these strategies are

¹⁰ Jane Oakhill, Kate Cain, and Peter E Bryant, "The dissociation of word reading and text comprehension: evidence from component skills." *Language and Cognitive Processes* 18 (2003): 443-468.

¹¹ Bill Gent, "The World of the British Hifz Class Student: Observations, Findings and Implications for Education and Further Research." *British Journal of Religious Education* 33, (2011): 3-15.

¹² Zuhurudeen, "Effects of Statistical Learning," 12.

¹³ Azmil Hashim, Ab Halim Tamuri, and Jemali, Misnan. "Latar belakang guru tahfiz dan amalan kaedah pengajaran tahfi alQuran di Malaysia." *The Online Journal*

applicable mainly to those who have knowledge of the Arabic language. What many people are not aware of is the fact that there are also non-*tahfiz* school-goers who aspire to memorize the Qur'an at their own initiatives, at their own pace. They include those who attend public schools where Arabic is not part of their school curriculum and those who already have an established career but would like to start memorizing the Qur'an on their own. As suggested by Zuhurudeen¹⁵, there are two types of memorizers among non-Arabic speakers. The first type is categorized as “memorizers with classrooms” and they are those who learn to recite and memorize the Qur'an while taking Arabic language classes (i.e., learning to write and speak Arabic at a public or private institution). This type of memorizers receives semantic cues of Arabic grammar both from the language classes as well as distributional cues from memorization. The second type is categorized as “memorizers without classrooms” and they are those who have never taken lessons of the Arabic language. This type of memorizers receives distributional cues of Arabic grammar through memorization and receives no explicit knowledge or semantic cues through any language classes¹⁶.

Indeed, the memorization of the Qur'an is difficult for someone who does not know the Arabic language. According to Wagner and Spratt¹⁷, the lack of the Arabic vocabulary and syntactic knowledge affects the process of memorizing the Qur'an. So how can Muslims who have knowledge of the Arabic language memorize the words of The Creator?

of Islamic Education 1, (2013): 28-39.

¹⁴ Sedek Ariffin, Mustafa Abdullah, Ishak Suliaman, Fauzi Deraman, Faisal Ahmad Shah, Mohd Yakub Zzulkipli Mohd Yusoff et al. “Effective Techniques of Memorizing the Quran: A Study at Madrasah tahfiz Alquran, Terengganu, Malaysia.” *MiddleEast Journal of Scientific Research* 13, (2013): 45-48.

¹⁵ Zuhurudeen, “Effects of Statistical Learning,” 12.

¹⁶ Zuhurudeen, “Effects of Statistical Learning,” 12-13

¹⁷ Daniel A. Wagner, and Jennifer E. Spratt, “Cognitive consequences of contrasting pedagogies: The effects of Quranic preschooling in Morocco.” *Child Development* 58, (1987): 1207-1219.

MEMORIZING – A COGNITIVE PROCESS

The act of memorizing is psychological in nature as it involves consciousness. The very first scientific experimental study of memory was conducted by Hermann Ebbinghaus, a German psychologist, in the 19th century, through the memorization of a list of nonsense syllables by reading aloud the list and trying to repeat the list in a correct order. This study, that did not involve the memorization of known words, shows that the memorized syllables faded over time; yet, the more repetitions he made in the process of memorizing the nonsense syllables, the fewer number of relearning of those syllables were required after forgetting took place¹⁸.

Subsequent memory researchers found that humans look for relationships between the items they have memorized and use the relationships to reorganize the items “into a more coherent and easily remembered structure”¹⁹. Unless they form such relationships, memorizing tends to end up in forgetting. According to Miller²⁰, human beings are only able to memorize between five and nine items (or 7 +/- 2) after a single exposure because of the limited memory span. Despite this limited memory span, human beings are able to store infinite number of facts and experiences in their memory. How is this possible?

The Atkinson-Shiffrin Model

Earlier studies have shown that newly-formed memories are more “fragile” than older memories. Unless attention is given to these newly-formed memories, they are easily forgotten. Because of the difference in the ability to retain newly-formed memories compared to older ones, psychologists proposed two separate compartments in our cognition for storing memories. Atkinson and Shiffrin²¹ are

¹⁸ Lieberman, *Human Learning and Memory*, 291.

¹⁹ *Ibid.*, 302.

²⁰ George A. Miller, George A. “The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information.” *Psychological Bulletin* 63, (1956): 81-97.

²¹ Richard C. Atkinson and Richard M. Shiffrin, “Human Memory: A Proposed System and its Control Processes.” In *The Psychology of Learning and Motivation: Advances in Research and Theory*, edited by K.W. Spence, and J.T. Spence, 89-195.

among those who proposed a model that explains how memories are formed and retained. According to them, “Human memory is divided into a short-term working memory and a long-term permanent memory. Control processes act within the short-term working memory to make decisions and regulate information flow, thereby controlling learning and forgetting”²².

Based on their 1968 model, Atkinson and Shiffrin suggested that memories of items that are perceived through the sensors and are passed through the sensory register decay within 0.2 and 4 seconds if no attention is given to them. If attention is given to those items, the items are transferred to the short-term memory storage, or also known as the working memory compartment. The memory stored here will decay within 20 and 30 seconds (which is equivalent to 7 +/-2 chunks of items) unless maintenance work is done here. Maintenance is usually done through rehearsal, (i.e., by repeating the items) to refresh the item’s trace in the short-term memory compartment. This is why, according to Randall²³, repetition has always been used to get automated responses.

Association between the items stored in the short-term memory and the long-term memory results in more meaningful learning and facilitates the transfer of items in the short-term memory storage to the long-term memory storage to enable items from the new memory to become more permanent (Figure 1)

New York: Academic Press, 1968.

²² Richard C. Atkinson, and Richard M. Shiffrin, “The Control Processes of Short-Term Memory” (Technical Report, Stanford University, 1971), 1.

²³ Mick Randall, *Memory, Psychology and Second Language Learning* (Amsterdam: John Benjamins Publishing Company, 2007).

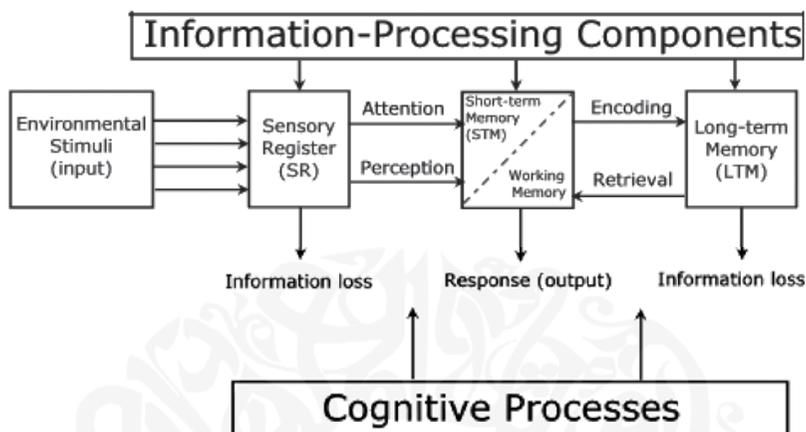


Figure 1: An information-processing model developed from Atkinson and Shiffrin's (1968) model²⁴.

One variable that has been claimed to affect retention of items, particularly words, is the frequency of exposure²⁵. Although it is not known how many times and how often learners should be exposed to the words before they are remembered, in new vocabulary learning among first language readers, for example, Saragi, Nation, and Meister²⁶ showed that incidental vocabulary learning takes place when the first language readers are exposed to the words for about 10 times in their reading process. The same frequency was also found to be true among relatively advanced second language readers²⁷.

²⁴ "An Information Processing Model of Learning", accessed August 1, 2015, http://www.oerafrica.org/FTPFolder/guyana/CCTI%20CD/CCTI%20CD/ukzncore1a/document/s/core1.inf_proc_model.htm

²⁵ Rolf Palmberg, "Patterns of vocabulary development in foreign-language learners," *SSLA* 9, (1987): 201-220.

²⁶ T. Saragi, Paul Nation, and G.F. Meister, "Vocabulary learning and reading," *System* 6, (1978): 72-78.

²⁷ Ana Pellicer-Sánchez and Norbert Schmitt, "Incidental Vocabulary Acquisition from an Authentic Novel: *Do Things Fall Apart?*" *Reading in a Foreign Language* 22, (2010): 31-55.

READING – A COGNITIVE PROCESS

Reading is also a cognitive process as the process begins with sensory input in the form of visual stimuli and ends with encoding and retrieval at the Long-Term Memory storage. When reading takes place, images in the form of visuals become iconic memory (as opposed to echoic memory for auditory images) at the sensory register (or also known as sensory store²⁸) before they are passed to the Short-Term Memory storage.

The neural receptors in the eyes are regarded as “a part of the brain that has extended outside of the cortex”²⁹. When reading a line of text is taking place, the vision falls under three regions: foveal (2 degrees of visual angle around fixation point, i.e., where they eyes are centred on, hence, the clearest vision); parafoveal (10 degrees of visual angle around fixation point); and peripheral (anything on the line of text beyond the parafoveal region, hence, the worst vision). Hence, words are easily recognized (about 60 milliseconds) when they fall under the foveal region, although words can already be recognized even when they fall under the parafoveal region³⁰.

At the sensory register, which is the initial stage of information-processing model, the physical information obtained from reading and registered by the sense organs (i.e., the neural receptors in the eyes) remains available temporarily (even after the display has gone off) and becomes iconic memory for about 0.25 second³¹. However, this information has to be processed further into a more permanent representation, i.e., in the Short-Term Memory. However, not all iconic memory is transferred to the Short-Term Memory, and the capacity of the Short-Term Memory itself is limited. In reading, the “7+/-2 items” does not specifically mean seven words, or seven letters, or seven digits; the word “items” here refers to “chunks”. Hence, for some, a chunk may be a sequence of 3 characters; yet, for others, it may be a sequence of 2 or even 4 or 5 characters. To hold the iconic memory longer in the Short-Term

²⁸ Keith Rayner, Alexander Pollatsek, Jane Ashby, and Charles Clifton Jr. *Psychology of Reading. 2nd Edition*. (New York: Psychology Press, 2012).

²⁹ Ibid.

³⁰ Ibid.

³¹ Ibid.

Memory, other than chunking, repeating the items over and over again (through rehearsal) has been found to be successful. Although the memory here is stored in the form of images, for linguistic stimuli, “short-term memory is primarily acoustic, as evidenced by the fact that we try and remember phone numbers from the telephone book by rehearsing them subvocally”³². Since there are evidence that the “Short-Term Memory works actively to retain information and does not merely function as “a storage”, the Short-Term Memory is also known as “Working Memory”, particularly in reading activities.

Although the transfer of information from the Short-Term Memory to the Long-Term Memory is the slowest in the information-processing model and that not all information in the Short-Term Memory gets to be transferred to the Long-Term Memory, information that enters the Long-Term Memory will be stored permanently. However, retrieval can be difficult if the information is not properly organized and if new information interferes with previously stored information.

The type of Long-Term Memory that is more relevant to reading is “Semantic Memory” (i.e., memory to understand the meaning of what is read, as opposed to “Episodic Memory”, i.e., memory of events in life). One important aspect of semantic memory that is most important for reading is the lexicon (i.e., the dictionary stored in the head) because usually, the aim of reading is to understand new information³³.

The shapes of letters or characters that are arranged in certain spatial relationship perceived by the sensory memory enable the recognition of letters or characters regardless of the way the letters or characters are presented. Typically, three linguistic levels of encoding take place when reading: phonological encoding, semantic encoding, and syntactic encoding. This is followed by linguistic decoding, where orthographic representation is transformed into phonological and semantic representation. The term “decoding” was coined by Gough and Tunmer³⁴ to refer to human’s ability to encode

³² Ibid., 15.

³³ Ibid.

³⁴ Philip B. Gough and William E. Tunmer, “Decoding, reading, and reading disability,” *Remedial and Special Education* 7, (1986): 6-10.

visual word recognition to emphasize the importance between the phonemes and the graphemes. Hence, good readers will be able to read the various manifestations of the letter “A”, for example, in any language, regardless of what the letters look like.

Studies³⁵³⁶ have shown that the semantic processing of words speeds up the reading process; understanding the meaning of words makes it easier for the words to be read. Decoding, or word recognition, is said to be influenced by several factors, including lexical fluency, familiarity, context effects, word superiority, word length, and regularity. Reading becomes much easier (i.e., faster with more accuracy) if the words are high frequency words and if the readers are familiar with the meanings of those words³⁷. Stroop effect tests demonstrate that names and the meaning of the word are simultaneously processed by skilled readers despite their attempt not to process them³⁸.

Reading takes place the moment attention is given to prints. Reading cannot take place if no attention is given to the text. Once attention is obtained, associated learning begins to take place. At this stage, readers will relate whatever that is read with whatever knowledge that is available in their cognition.

READING AND THE MOVEMENT OF THE EYES

When reading takes place, the eyes do not make very smooth progresses, as many may think. Instead, the eyes make a lot of complex but rather systematic movements: they jump from one point to another for a duration of 20-35 millisecond (*saccade*, or, very rapid ballistic movements, for the length between 1-18 characters), they make stops in between those jumps (*fixations*, or pauses, for an average duration between 66 and 416 milliseconds), and they reread

³⁵ Marcel Adam Just and Patricia A. Carpenter, “A Theory of Reading: From Eye Fixations to Comprehension,” *Psychological Review* 87, (1980): 329-354.

³⁶ Kate Nation and Margaret J. Snowling, “Semantic Processing and the Development of Word-Recognition Skills: Evidence from Children with Reading Comprehension Difficulties,” *Journal of Memory and Language* 39, (1998): 85-101.

³⁷ Alan D. Baddeley, Neil Thomson, and Mary Buchanan, “Word Length and the Structure of Short Term Memory,” *Journal of Verbal Learning and Verbal Behaviour* 14, (1975): 575-589.

³⁸ Rayner, Pollatsek, Ashby and Clifton, *Psychology of Reading*, 58.

earlier parts of texts (*regression*)³⁹. Visual information is not gathered throughout the reading process; instead, visual information is only gathered during fixations.

In reading studies using the eye tracking machine, reading is defined as “the ability to extract visual information from the page and comprehend the meaning of the text”⁴⁰. The eye movement recording has been used to “infer moment-to-moment cognitive processes during reading” because such recordings give information on “where readers look, and how long they look there” and provide “information about the mental processes associated with understanding a given word or set of words”⁴¹. Typically, among skilled readers, oral reading rate is around 150-200 words per minute whereas silent reading rate is around 300 words per minute⁴². Interestingly, a person’s silent reading can also be influenced by the author of the text’s speed of reading the same passage earlier. This happens because Short-Term Memory is usually acoustic in nature⁴³.

Reading process is not the same in all conditions. Tongue twisters, for example, are also said to slow reading process and interfere with the comprehension of sentences and memory for sentences and word lists. This is because of the fact that “the overlap of the phonemic representations is automatically activated during reading”⁴⁴. Phonemic similarity effect also has a great effect on memory span. Sentences with phonemically similar words are more difficult (i.e., takes longer) to be processed than those that are not phonemically similar and this is because “inner speech is solely a post-lexical process involving holding words in working memory”⁴⁵. Liberman et al.⁴⁶ found that more errors are made by good readers

³⁹ Ibid.,

⁴⁰ Ibid., 19.

⁴¹ Ibid., 20.

⁴² Keith Rayner and Chuck Clifton Jr. “Language Processing in Reading and Speech Perception is Fast and Incremental: Implications for Event-Related Potential Research,” *Biological Psychology* 80, (2009): 4-9.

⁴³ Rayner, Pollatsek, Ashby and Clifton, *Psychology of Reading*, 189.

⁴⁴ Rayner, Pollatsek, Ashby and Clifton, *Psychology of Reading*, 202.

⁴⁵ Ibid, 203.

⁴⁶ I.Y. Liberman, Donald Shankweiler, Alvin Meyer Liberman, Carol A. Fower, and F.W.Fischer. “Phonetic Segmentation and Recoding in the Beginning Reader. In

when the letters are presented on rhyming sequences than non-rhyming sequences.

The recording of the eye movements is usually done using a device called “the eye tracker”. The recording of the eye movement involves,

Shining a beam of invisible (infrared) light onto the eye that is reflected back from the cornea or retina to a sensing device, or using an infrared camera to form an image of the pupil whose location is determined by a computer. With this methodology readers are free to look at any part of the text for as long as they wish... the technique also has a great deal of ecological validity in that participants in the eye movement experiments are actually engaged in the task we wish to study, namely reading⁴⁷.

Salehuddin & Ho⁴⁸ (2014), for example, in an eyetracking experiment, found that when reading Malay in Arabic script, readers rarely look at the vowel diacritics (i.e., the *tashkeel*). It is interesting to find out what *tahfiz* students look at when they read the Qur’an to memorize the verses.

FROM READING TO MEMORIZING

In a study that examined the relationship between the memorization of new words and teaching techniques involving different modes of vocabulary presentation, Laufer and Shmueli⁴⁹ found that retention (i.e., the process of remembering the words tested) varied depending on the presentation of the items to be tested. New vocabulary of words in learners’ target language was presented to learners in four

Towards a psychology of reading: The Proceedings of the CUNY Conference (Hillsdale, NJ: Lawrence Erlbaum Associates Inc., 1977), 207-225.

⁴⁷ Rayner, Keith, Alexander Pollatsek, Jane Ashby and Charles Clifton Jr. *Psychology of Reading. 2nd Edition*. New York: Psychology Press. (2012): 20.

⁴⁸ Khazriyati Salehuddin and Hong-Fa Ho, “An eye movement study to investigate the cognitive complexity in reading Jawi,” Paper presented at SEAPSIL3, Kuching, Malaysia, 2014.

⁴⁹ Batia Laufer and K. Shmueli, “Memorizing New Words: Does Teaching Have Anything to Do with it?” *RELC Journal* 28, (1997): 89-108.

different presentations namely 1) in isolation; 2) in 'a meaningful sentence'; 3) in text context; and 4) in the original text context supplemented by clarifying phrases and sentences. Their studies show that new words were better retained when they were glossed (explained) in their first language; and that words presented in lists and in sentences are remembered better than words presented in text and elaborated texts⁵⁰.

As mentioned earlier, Palmberg⁵¹ claims that the frequency of exposure affects the memorization of words. In a study conducted to investigate the learning of Russian words through reading among English native speakers, Saragi et al. suggest that "the minimum number of repetitions for words to be learned in a reader should be somewhere around 10"⁵² and the same frequency was proposed by Wodinsky and Nation⁵³. However, the quantity (i.e., the frequency of repetitions) alone is not adequate in the retention of new words. The quality of word processing (i.e., the ability to link "the new words with other words associated with it, in terms of form, meaning, or context") helps in retaining the new words⁵⁴. In addition, Laufer and Shmueli suggest that distractions, which may be in the form of elaborated texts, may interfere in word memorizing.

Why is repetition important in learning the meaning of new words, especially those that are not from one's native language? To answer this question, we will have to look back at the psychology of learning. Among the behaviourist psychologists, learning takes place when there is a change in behaviour, and this is usually a result of proceduralization. Proceduralization refers to a process of converting declarative, factual knowledge (e.g., riding a bicycle), into a more procedural representation through memorization and rehearsal before the skill is learned. Through lots of practice, the skill becomes automatic.

In learning a second language, repetition is often used to

⁵⁰ Ibid.

⁵¹ Palmberg, "Patterns of Vocabulary," 201-220.

⁵² Saragi, Nation, and Meister, "Vocabulary learning and reading," 76.

⁵³ M. Wodinsky and Paul Nation, "Learning from Graded Readers," *Reading in a Foreign Language* 5, (1988): 155-161.

⁵⁴ Laufer, Batia, and Shmueli, "Memorizing New Words," 90.

automatize desired responses and this results in ‘learning’. The items to be learned are usually broken into smaller units to enable repetition to take place more easily. Through such language drilling of individual language items and by chaining the learned routines into larger units, the process of proceduralization can eventually take place⁵⁵. This method of language teaching is clearly evident in the audio-lingual method and reflects the behaviourists’ stimulus-response habit formation (as the behaviourists view language as a verbal behaviour⁵⁶, and that learning is a change in a behaviour). Despite being an old method, the audio-lingual method is still found to be successful in some language classrooms, and is particularly useful in learning pronunciation, words, and structures, because learning a new language, to a certain extent, involves some automated responses from the learner. “The private, silent, inner rehearsal which characterizes rote learning approaches also functions to provide the repetition needed for proceduralisation to take place”⁵⁷.

According to Randall, there are two types of learning that involves memorization: superficial learning, and deep learning. In superficial learning, memorization is done without associating new items (which are in the form of sensory information) with learned items. Since attention is only given to surface forms only (e.g., the sound of the words, which involves making neural connections at only one level) the new items are not processed deeply and are easily forgotten. This is because, according to Randall, such an act of memorization merely involves the activation loop, and results in “a highly inefficient means of learning”⁵⁸. Such an act of memorizing is known as “rote memorization” in which learning that does not focus on understanding, but on memorization through repetition. Learning of words through surface learning is done, for example, by repeatedly speaking those words aloud or repeatedly writing those words down. In contrast, in deep learning, memorization is done by associating

⁵⁵ Randall, *Psychology and Second Language*, 2007.

⁵⁶ Burrhus F. Skinner, *Verbal Behaviour* (New York: Appleton Century Crofts, 1957).

⁵⁷ Randall, *Psychology and Second Language*, 168.

⁵⁸ *Ibid.*, 169.

new items with learned items. Since attention is given to a variety of features (involving neural connections made at several levels), new items will not be easily forgotten. Hence, although memorization is regarded as “an important pre-requisite for successful learning”⁵⁹, the act of memorizing should only come after understanding.

In the process of memorizing the Qur'an among non-Arabic speakers, there is no doubt that there are countless number of papers, books, and diaries produced by individuals and Qur'anic memorizers on the strategies used in memorizing the Qur'an. Among the strategies that have been identified in Malaysian tahfiz schools includes *Sabak* (repeat reading of verse for 40 times), *Para Sabak* (recalling memorized items), *Ammokhtar* (reciting larger parts of memorized items by heart), and *Halaqah Dauri* (reciting as much as 150-pages of memorized items by heart). All these are being used in the process of getting the students to memorize the Qur'an⁶⁰. Hashim et al.⁶¹ on the other hand found that in some Malaysian *tahfiz* schools, the *tahfiz* teaching and learning framework proposed by al-Qabisi in 1955 has been adopted and this includes *talqin* (teaching), *takrar* (drilling), *almail* (loving the Qur'an), and *alfahm* (understanding). al-Qabisi also suggests an integration of various sensory modes to reinforce understanding (namely, listening (through teaching), speaking (through drilling), reading and writing). Based on *off-line* reports, both studies by Ariffin et al. and Hashim et al. suggest that the process of memorizing the Qur'an among Malaysians, involve a lot of repetition.

However, is the repetition that takes place in the process of memorizing the Qur'an considered as deep learning or superficial learning? What seems obvious is the fact that in memorizing the Qur'an, deep learning has obviously taken place, as forgetting is not permissible among the *huffaz*. If they had memorized the Qur'an as superficial learning, they would have forgotten the verses they memorized earlier. How then do non-Arabic speaking *tahfiz* learners actually memorize the Qur'an?

⁵⁹ Ibid.

⁶⁰ Ariffin et al. “Effective Techniques of Memorizing,” 45-48.

⁶¹ Hashim, Tamuri and Jemali, “Latar belakang guru tahfiz,” 28-39.

TRACKING THE EYE MOVEMENTS WHEN MEMORIZING

Apart from identifying the strategies that *tahfiz* learners used in memorizing the Qur'an through *off-line* reports, the memorization strategies obtained from *on-line* reports through eye movement studies can be used to complement past findings obtained from *off-line* reports. *On-line* reports using the eye tracking machine can be regarded as reliable because of the fact that the eyes are regarded as the “window” to what happens in the cognition. Hence, reports on eye movement experiments can include information on any unconscious processes that *tahfiz* learners engage in when they are memorizing the Qur'an.

The eye tracking machine has several features that can be used to investigate *on-line* processes, particularly in reading. First and foremost, gaze points are likely to be the most used terms in discussing research using the eye tracking machine. Gaze points allow researchers to investigate elements of visual stimulus that the eyes are looking at. Between fixations (i.e., the period where the eyes are fixated towards a particular point), the eyes move in ballistic-like movements called *saccade* and these saccades allow researchers to see the gaze plots.

In conducting research using the eye tracking machine, there are specific parameters that researchers investigate and these include features (or metrics) that are made available in eye tracking machines such as the Total Fixation Count, Time to First Fixation, Fixation Duration, and Total Fixation Duration, just to name a few. All these are analysed after specific Areas of Interest (henceforth, AOI, i.e., the sub-regions of displayed stimuli that are to be investigated) are identified⁶².

Fixation Count measures the number of times the participants fixate on an AOI whereas Time to First Fixation measures the amount of time (i.e., how long, in seconds) taken by participants to look at a specific AOI from the onset of a stimulus (i.e., the first display of the AOI). Fixation Duration (also known as Fixation Length), measures the duration of individual fixation within an AOI whereas Total Fixation Duration measures all fixations within an

⁶² *Tobii Studio User's Manual*, 2016.

AOI. Total Fixation Duration also includes those fixations after the participants have left the AOI.

Figure 2 shows a visualization of the metrics mentioned earlier. The largest box refers to the visual stimuli and the two smaller boxes in the largest box (marked AOI 1 and AOI 2) are the Areas of Interests, indicating there are two AOIs to be investigated for the given visual stimuli. The three circles in AOI 1 suggest there are 3 fixation points in that AOI, namely 2, 3 and 6 whereas in AOI 2, there is only 1 fixation point, namely 5. As seen in Figure 2, the fixation count for AOI 1 is three (i.e., fixation points 2, 3 and 6), and the Time to First Fixation is 0.25 seconds. Fixation duration for Fixation 2 is 0.175 second (i.e., 0.425-0.25) whereas the fixation duration for Fixation 3 is 0.1 second (i.e., 0.55-0.45). The Total Fixation Duration in AOI 1 includes Fixation Durations of 2, 3 and 6.

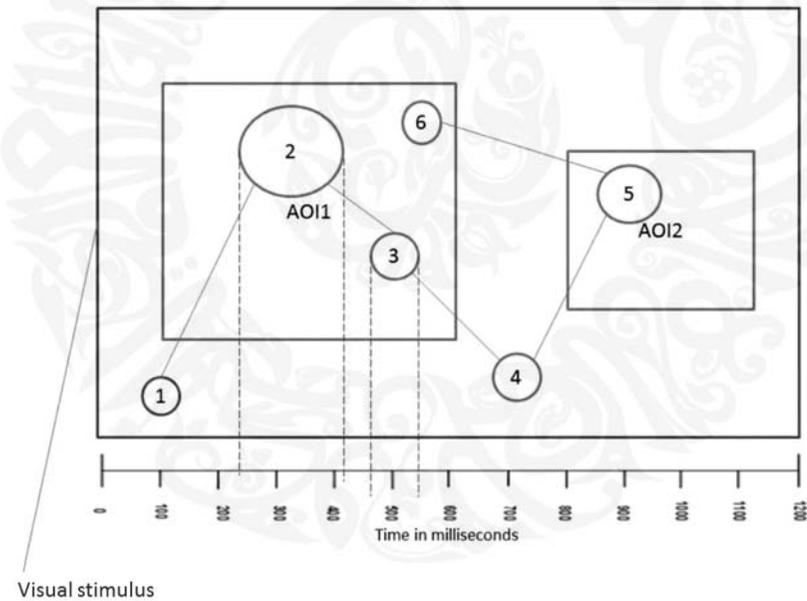


Figure 2: A hypothetical gaze plot to explain the terms used in this study

Apart from that, the eye tracker also provides another form of visualized presentations through heat maps and scan paths. The heat

map is a form of visualization that shows the distribution of gaze points and fixations in general, to indicate attention to certain visual stimuli. The heat map shows the density of participants' attention; the higher the density (usually indicated by the color "red", the higher the frequency of the gaze is to the particular area.) The scan paths is another form of visualization that contains a series of fixations and saccades. Scan paths can be used to analyse cognitive intent, interest and salience. Although both heat maps and scan paths do not provide quantitative data, they provide qualitative information on the participants' gazing behaviours.

Apart from the two metrics, namely, heat maps and scan paths, some eye tracking machines are also equipped with a user camera video (and audio) to enable basic qualitative analysis of participants' behaviour (e.g., their facial expression, their gestures, their voice, etc.) during tests to be conducted. Hence, when readers' reading is replayed, researchers will be able to see other conscious or unconscious observable behaviours that the participants engage in when reading a given stimulus.

Based on the mentioned features above, the eye tracking machine definitely has features that can be used to investigate the process of memorizing the Qur'an. To begin with, past *off-line* studies on the memorization of the Qur'an have indicated that repetition plays a very important role in the process of memorization. Although '40' has been mentioned as the number of repetitions needed in memorizing a particular verse, whether or not all good *tahfiz* students repeat their readings 40 times in all contexts is still unknown. The fixation count metric available in the eye tracker enables the number of fixations that good *tahfiz* students employ in the process of memorizing the Qur'an to be tracked. In addition to the fixation count, the total fixation duration can also be used to measure the attention that good *tahfiz* students give to specific items in their process of memorizing the Qur'an.

Apart from repetition, past *off-line* studies also suggest that understanding the meaning of the words that are to be memorized facilitates the act of memorizing the Qur'an. Hence, by analysing the fixations, investigation on whether or not understanding the meaning of the Arabic words help the *tahfiz* students in memorizing the

Qur'an helps. This can be done by inserting the translations of words and verses in each of the stimulus given. In addition, it is clear that although the Qur'an is in Arabic, some of the words are familiar words to the Malay speakers as they are Malay words that are originally derived from Arabic (e.g., *solat* (prayer), *zakat* (Tithe), *ilm* (knowledge)). Hence, analysis of the fixations (e.g., the fixation count, fixation duration etc) will also enable researchers to investigate if good *tahfiz* students look at the meaning of these words as well in the process of memorizing the Qur'an.

Past *off-line* studies on memorization also suggest chunking as a means to facilitate the memorization process, particularly in long verses. The scan paths (as shown in Figure 2) enable researchers to follow the paths good readers take in the process of memorizing long verses in the Qur'an. For example, if long verses are presented to the *tahfiz* students, scan path analysis can show if learners memorize these long verses all at one go or if they break these verses into smaller chunks as described in past studies. If they do break these long verses into smaller chunks, scan path analysis will also allow researchers to identify the typical size of each chunk for the *tahfiz* students.

For such an experiment on memorizing the Qur'an using the eye tracking machine, the visual stimuli in Figure 3 can be proposed.

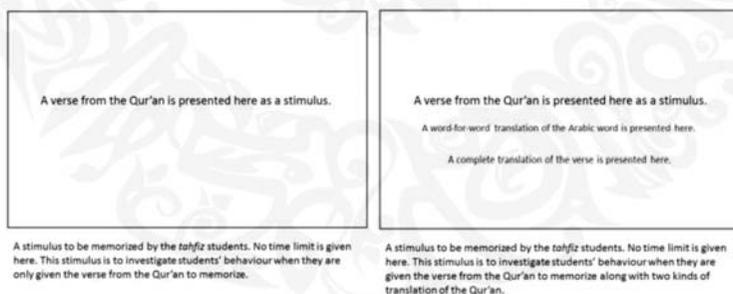


Figure 3: Two types of visual stimuli: One with no translation (left) and one with word-for-word and a complete translation of a verse from the Qur'an. Translation is provided in the right stimuli to investigate if learners do look for meaning of certain words in the process of memorizing the Qur'an and if they do, which type of translation.

The AOI for the stimulus with the verse from the Qur'an (Figure 3, left) could be the individual Arabic words printed in the *mushaf*. Hence, for a nine-word verse, there could altogether be 9 AOIs to be investigated. The AOI for the stimulus with the verse together with the two kinds of translations (Figure 3, right) should have more AOI than the left. Hence, for a nine-word verse, there should be a total of nineteen AOIs altogether: nine AOIs on individual Arabic words, another nine on the word-for-word translation of the individual Arabic words, and one for the complete translation of the verse. Once all these are identified as AOIs, the fixation count, fixation duration, and total fixation duration can all be calculated and analysed quantitatively. Apart from the quantitative data that can be obtained, the heat maps and scan paths can also be obtained from the same experiment. These qualitative data enable researchers to investigate particularly the paths *tahfiz* students take in memorizing the Qur'an verses. The user video (an audio) function in the eye tracking machine also enables researchers to investigate other observable (conscious and unconscious) behaviours that *tahfiz* students engage in when memorizing the given stimuli, particularly, where they look at when no eye movements are recorded by the eye tracker, and what their facial expressions and gestures are like when they are memorizing the stimuli.

CONCLUSION

Psycholinguistics is an inter-disciplinary research area that investigates the cognitive processes involved in performing language activities. Since the act of memorizing the Qur'an is a psycholinguistic activity, research using methods used in psycholinguistic studies would be a good platform to scientifically investigate what actually happens in the cognition of the memorizers when they memorize the Qur'an.

The memorization of the Qur'an, to most people, particularly visual learners, involves the process of reading the Qur'an *mushafs*; hence, the eye movement patterns can be utilized as the window to understand the cognitive processes that *tahfiz* students engage in when they read, memorize, and recall the verses of the Qur'an.

This manuscript starts out with a question on whether the eye

tracking machine can be used to investigate how the Qur'an can be learned by heart. By comparing the features of eye tracking machines that are available now with post *off-line* reports on how the Qur'an is memorized, this manuscript concludes that the eye tracking machine can indeed be used to investigate how the Qur'an is learned by heart and all these can be supported both quantitatively and qualitatively from the data collected by the eye tracking machine.

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TRANSLITERATION TABLE

CONSONANTS

Ar=Arabic, Pr=Persian, OT=Ottoman Turkish, Ur=Urdu

Ar	Pr	OT	UR	Ar	Pr	OT	UR	Ar	Pr	OT	UR	
ء	'	'	'	ز	z	z	z	گ	—	g	g	g
ب	b	b	b	ژ	—	—	ʀ	ل	l	l	l	l
پ	p	p	p	ژ	—	zh	j	م	m	m	m	m
ت	t	t	t	س	s	s	s	ن	n	n	n	n
ث	—	—	ṭ	ش	sh	sh	ʃ	ه	h	h	h'	h'
ث	th	th	th	ص	ṣ	ṣ	ʃ	و	w	v/u	v	v/u
ج	j	j	c	ض	ḏ	ḏ	ḏ	ی	y	y	y	y
چ	—	ch	çh	ط	ṭ	ṭ	ṭ	ة	-ah	—	—	-a ²
ح	ḥ	ḥ	ḥ	ظ	ẓ	ẓ	ẓ	ال	al ³	—	—	—
خ	kh	kh	kh	ع	'	'	'					
د	d	d	d	غ	gh	gh	ğh					
ڈ	—	—	d	ف	f	f	f					
ذ	dh	dh	dh	ق	q	q	k					
ر	r	r	r	ك	k	k/g	k/ñ					

¹ – when not final
² – at in construct state
³ – (article) al - or l-

VOWELS

	Arabic and Persian	Urdu	Ottoman Turkish
Long	ا	ā	ā
	آ	Ā	—
	و	ū	ū
	ي	ī	ī
Doubled	ي	īy (final form ī)	īy (final form ī)
	و	uww (final form ū) uvv (for Persian)	uvv
Diphthongs	و	au or aw	ev
	ی	ai or ay	ey
Short	ا	a	a or e
	ا	u	u or ū
	ی	i	o or ö
	ی	i	i

URDU ASPIRATED SOUNDS

For aspirated sounds not used in Arabic, Persian, and Turkish add h after the letter and underline both the letters e.g. چ jh گ gh

For Ottoman Turkish, modern Turkish orthography may be used.

Contents

ARTICLES IN VOL. 23 No. 1, 2018

THE PHENOMENON OF <i>IRHĀB</i> (TERRORISM): MEANING, HISTORY AND CAUSES <i>Thameem Ushama</i>	1
FORM AND CONTENT: A HISTORICAL AND ARTISTIC ASSESSMENT A 17TH CENTURY ILLUSTRATED SHAHNAMEH FROM S. M. N A. LIBRARY, MALAYSIA <i>Amir H. Zekrgoo</i>	41
SEPARATION OF CONJOINED TWINS FROM THE COMMON LAW AND <i>SHARI'AH</i> PERSPECTIVES: THE LEGAL AND ETHICAL CONUNDRUM <i>Puteri Nemie Jahn Kassim</i> <i>Fadhlina Alias</i>	67
THE CRITICS ON THE HISTORY OF ARABIC GRAMMAR <i>Solehah Yaacob</i>	97
CAN THE EYE TRACKER REVEAL HOW THE QUR'AN CAN BE LEARNED BY HEART? <i>Khazriyati Salehuddin</i>	125
THE RELEVANCE OF <i>WAQF</i> TO THE AUSTRALIAN SOCIETY FROM THE PERSPECTIVE OF <i>MAQĀṢID</i> <i>AL-SHARĪ'AH</i> (HIGHER OBJECTIVES OF <i>SHARĪ'AH</i>) <i>Rawaa El Ayoubi Gebara</i>	149
THE QUR'ĀNIC CONCEPT OF <i>QIWĀMAH</i> : A REVIEW OF COMMENTARIES ON THE VERSE: 4:34 <i>Nadzrah Ahmad</i> <i>Muhammad Abdul Rasheed</i>	169
THE ANTI-ISLAMIST DISCOURSE: THE CASE OF AL-BŪTĪ <i>Bachar Bakour</i> <i>Abdelaziz Berghout</i>	183
THE ROLE OF SHAYKH ABD AL-RA'UF AL-FANSURI IN THE RECONCILIATION OF SUFISM AND <i>SHARĪ'AH</i> OF 17 TH CENTURY THE MALAY WORLD <i>Abdul Salam Muhamad Shukri</i> <i>Ridwan Arif</i>	207
THE HISTORY OF ISLAM IN THE MALAY ARCHIPELAGO: AN ANALYTICAL STUDY OF ABDULLAH BIN NUH'S WORKS <i>Mohammad Noviani Ardi</i> <i>Fatimah Abdullah</i>	247
NOTES ON CONTRIBUTORS	269

