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An Interventional Study Comparing the Memory Retention of Verbal & Pictorial Materials among MMMC Students

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Authors' contributions

This work was carried out in collaboration between all the authors. Author KJH designed the study, wrote the first draft of the manuscript and analysed the study. Authors MKAMY and FNZ managed the literature searches and wrote the protocol. Authors GS and NAA managed the analyses of the study. Author NKS performed the statistical analysis and wrote the final draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To compare the effectiveness of pictorial against verbal materials in memory retention among medical students.
Study Design: Crossover randomized controlled trial.
Place and Duration of Study: This study was conducted in Melaka-Manipal Medical College, Muar, Johor, Malaysia in April 2016.
Methodology: 38 right-handed medical students of Melaka-Manipal Medical College were volunteers and participants were divided into two groups equally via simple random sampling. One group of participants were to recall pictures shown first followed by words while the other group of participants were to recall words first followed by pictures. All the pictures and words shown were of everyday objects. Data were analysed using Epi Info version 7.

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Results: There was a significant difference of memory retention between pictures and words (P-value =; $p < 0.05$) and of memory accuracy (P-value; $p < 0.05$). For memory retention, both groups were found to have higher scores for pictures than words as both groups obtained a mean score of 11.3 and 13.4 respectively for the pictures and 9.7 and 11.1 respectively for words. For memory accuracy, pictures were found to be recalled better than words as the mean scores for the pictures are higher than words in both groups.
Conclusion: Information in the form of pictures should be more utilized in medical schools so that medical students can have better memory retention which in turn will lead to better academic performances.

Keywords: Memory; pictures; words; medical students; Malaysia.

1. INTRODUCTION

Medicals students all over the globe are subjected to high volume of information which has to be learned in a short time. Hence, it is vital to establish the proper way they encode information in their mind [1]. This enables us to refine our techniques for encoding information while coming up with systems that allow us to memorize and recall much more information than we otherwise could [2]. Normal memory involves acquisition and retrieval. Acquisition of memory is the recognition, registering and cataloguing of a stimulus while retrieval involves the skill of appropriate recall. Verbal memory refers to material presented in the verbal form whereas visual memory refers to material presented without words or verbal mediation [3].

Over the past few decades, investigations regarding difference in memory for words and pictures have been conducted with the general conclusion being pictures are better remembered than words [4-7]. Psychologists have also studied the differences between the encoding and processing of words with the processing of pictures, and the most extensively investigated difference is known as the picture superiority effect [7-9].

Allan Paivio [10,11] proposed a theory regarding dual encoding process which assumes that there are two cognitive subsystems; one specialized for the representation and processing of nonverbal objects or events (example given: imagery) and the other specialized for dealing with language. For instance, one can think of a rose by thinking of the word 'rose', or forming a mental image of the rose [12].

Generally, there have been extensive researches regarding difference between memory for pictures and words. Although most of these studies of revealed that pictures were better recalled than words which supported the theory on picture superiority effect, there are also evidences that suggested verbal materials were better in memory retention compared to pictorial materials [13-15]. In another study of picture-words effect on memory by Lutz and Luts (1977), the results showed that pictures were better remembered than words only in cases of interactive pictures [16]. It is hoped that this study will further solidify the superiority of pictorial memory over verbal memory.

There were also no crossover studies done about the picture superiority effects amongst the medical students [4-6]. Crossover study is when two groups of participants acted as their own control and were assigned to recall pictures and words in an order determined by randomisation, with a washout period between the two exposures [17]. Therefore, this research helps us to determine the effectiveness of pictorial against verbal material in memory retention among medical students in MMMC, whilst analysing the students' preferences between pictorial and verbal materials. Medical students have to learn about different pathophysiology and complications of hundreds of diseases, as well as the indications, contraindications and adverse effects of the drugs used to treat those diseases. Therefore his provides us an opportunity to explore the applicability of picture superiority effect in medical school in order to learn and retain information better (example given: Problem-based learning slideshows, community poster presentations and clinical examination demonstrations).

2. METHODOLOGY

2.1 Study Design and Population

This is a cross-over randomized controlled trial comprising two different groups of participants in an effort to determine any difference between the retention ability for pictorial and verbal materials.

The study was conducted from 4th April 2016 to 13th April 2016 at Melaka Manipal Medical College, Muar Campus, in Muar district of the Johor state of Malaysia. The participants were 38 fourth year medical students at the Melaka Manipal Medical College (MMMC), Muar Campus, consisting of 19 male and 19 females, who volunteered to take part in the study. All the 38 students were divided into two groups, namely Group A and Group B. Both groups were of the same proportion because there were 9 males and 10 females in each group. Participants of Group A consisted of 8 Malay, 5 Chinese, 3 Indian and 3 others, whereas Group B consisted of 5 Malays, 4 Chinese, 8 Indians and 2 others. Group A were to recall pictures first followed by words, while Group B were to recall words first, followed by pictures. Group A and Group B acted as each other's control as each group had to recall both pictures and words. MMMC is a tertiary education centre based in Bukit Baru, Melaka, which offers courses for twinning MBBS and BDS program, in Melaka, Muar Campus in Malaysia and the Manipal Campus in India. MMMC was established in 1997 through the vision of Dr.RamdasPai, Chancellor of Manipal University, and the instrumental efforts of the late Datuk K Pathmanaban, former Malaysian Deputy Minister of Health. They recognized that the problem of a shortage of doctors in the country at the time could be effectively addressed if more Malaysian students were given the opportunity to achieve their aspirations of becoming doctors and healthcare professionals. Ever since, MMMC has become the leading medical education provider that is the single largest contributor of doctors to the Malaysian healthcare system.

2.2 Sample Size and Sampling Method

We calculated the appropriate number of sample size from reviewing the research done by William E. Hockley [18]. The minimum sample size required was 31 and we had included 38 participants into the study. The 38 participants were volunteers for the study and we had assigned identification number to all participants in the database and utilized computerized program to perform probability block sampling. In order to distribute the participants equally into those that were going to be given words first and those that were going to be given pictures first, the simple random sampling method using Microsoft Excel's random number generator was done. By this method, all participants had equal chance to be selected into either group. Each group acted as the control of the other group because each participants were to recall both pictures and words. We performed single blinding, in which the participants did not know whether they will be given words or pictures first. However, double or triple blinding was not performed.

None of the participants have history of learning disability or visual impairment. In addition, all the participants were right-handed and have good command of English [6]. Those who were left-handed were excluded from the study as they may have an advantage in this study compared to right-handed participants [19].

2.3 Experiment Procedure and Data Collection

The experiment commenced at 5pm on 22nd April 2016 in two booked classrooms equipped with overhead LCD projector and ended at 6pm. The demographic data was collected by our group members using a questionnaire before the commencement of the experiment. The stimuli were lists of 20 words and 20 pictures that were projected onto a large overhead LCD screen to the students sitting in a lecture theatre [18]. The stimulus material covered mostly everyday objects and the names of which are easily understood [6]. The words and pictures were presented against a white background on each slide using Microsoft PowerPoint [14]. There were two groups of participants, one labeled as PW group which receives pictorial intervention first followed by words intervention and another group labeled as WP group which receives words intervention first then pictorial intervention. PW group is assigned as Group A, and WP group as Group B in the results portion to ease discussion. Both slides of words and pictures are displayed for 1 minute, with 3 seconds allocated for each word and picture respectively. After the stimuli were displayed, 2 minutes were given as a washout period and the participants were shown a 2-minute video clip unrelated to the study. Then, the participants were asked to recall as much as words or pictures that they could, and list them on a paper given within 1 minute. Following the recall session, we distributed another set of questionnaire to acquire data on the perceptive aspect of their recalling performance. We did not require any follow up.

2.4 Data Processing and Data Analysis

We processed the data regarding demographic data in relation to the memory performance by using Epi Info 7 software. The data of age,

gender and ethnicity against the frequency of group members in both PW and WP groups were tabulated and compared. Then we utilized Microsoft Excelto calculate the mean and standard deviation scores of memory retention and memory accuracy in both PW and WP groups for descriptive statistics. The memory retention was determined by the words being able to be recalled by the participants, which includes those with wrong spelling and those which are not the actual object shown but were similar. The memory accuracy was determined by the exact words recalled by the participants. Following that, we used the same software to compare the mean scores between PW and WP groups, and determined the t-value for cross over effect and t-value for the overall effect for inferential statistics. We processed the data obtained by utilizing the software Epi Info. The frequency, mean and standard deviation were tabulated. We did the confirmatory statistical analysis of crossover trials on Microsoft Excel to check if our cross-over study was valid, which the p value should be more than 0.05 [20]. Then, we proceeded to check if our result was significant by utilizing Microsoft Excel as well. A p value of <0.05 was considered statistically significant. We did not calculate any measures of association.

2.5 Ethics

The participants volunteered for the study. The participants were asked to sign a consent form after the nature of the procedure involved had been explained to them and confidentiality was also assured [15].

3. RESULTS

Table 1 and 2 show the socio-demographic characteristics of this study sample. In Table 1, a mean age of 22.8 years was obtained with a standard deviation of 0.5 years in group A and in group B, a mean of 22.7 years was obtained with a standard deviation of 0.7.

Table 2. showed that in terms of gender, females were larger in number accounting for 52.6% in both groups. In terms of ethnicity, Malays were the largest in proportion at 42.1%, followed by Chinese, Indian and other ethnicities accounting for 26.3%, 15.8% and 15.8% respectively in group A. In group B, Indians account for 42.1% which is the largest, followed by Malays at 26.3% and Chinese at 21.1%. Other ethnics made up the remaining 10.5%. In terms of birth order, first and middle children were in equal in proportion of 36.8% each with last child forms the remaining 26.3% in group A. In group B, middle child was the largest in number accounting for 42.1% and followed by first child at 36.8% and last child at 21.1%.

Table 3 showed the differences of memory retention and memory accuracy of pictures and words between the two groups. For memory retention, both groups were found to have higher scores for pictures than words as both groups obtained a mean score of 11.3 and 13.4 respectively for the pictures and 9.7 and 11.1 respectively for words. The standard deviation was greater for the memory retention of words in both groups compared to pictures. Pictures are retained significantly better than words in both groups.

For memory accuracy, pictures were found to be recalled better than words as the mean scores for the pictures are higher than words in both groups. The standard deviation was greater for the memory accuracy for words than pictures in both groups. Pictures are recalled significantly better than words in both groups.

Table 4 described the affective domains of this study obtained from the questionnaires done by participants from both groups. Score more than 2.5 indicates that the participants prefer pictorial materials over verbal materials. From the table, it can be found that there is no significant difference in the mean score for the preference for the material types between the two groups. Both groups showed preference towards pictorial materials compared to verbal materials.

The following Fig. 1 shows the questionnaire responses on selected affective domains of pictures and words in memory recognition. The comprehension and the preference of participants are displayed in the bar chart to show the inclination towards different materials. Participants that chose ‘strongly agree’ and ‘agree’ responses for the affective domains indicate inclination towards pictorial materials while ‘disagree’ and ‘strongly disagree’ responses indicate that participants are more inclined towards verbal materials. From the chart, it can be seen that the participants have better comprehension and prefer pictures compared to words.

Table 1. Characteristics of independent variables via quantitative analysis among Group A (PW group) and Group B (WP group)

Independent variables	Group A mean (SD)	Group B mean (SD)	P-value
Age (years)	22.8 (0.5)	22.7 (0.7)	0.581

Significance level set at 0.05

Table 2. Comparison of independent variables via qualitative analysis among Group A and Group B

Independent variables	Group A (n=19) frequency (%)	Group B (n=19) frequency (%)	P-value
Gender			
Male	9(47.4)	9(47.4)	1.000
Female	10(52.6)	10(52.6)	
Ethnicity			
Malay	8(42.1)	5(26.3)	0.351
Chinese	5 (26.3)	4(21.1)	
Indian	3(15.8)	8(42.1)	
Others	3(15.8)	2(10.5)	
Birth Order			
First	7(36.8)	7(36.8)	0.915
Middle	7(36.8)	8(42.1)	
Last	5(26.3)	4(21.1)	

Significance level set at 0.05.

Table 3. Characteristics of outcome variables among Group A and Group B

Variables	Pictures Mean (SD)	Words Mean (SD)	T-stat for cross-over effect (P-value)	T-stat for overall effect (P-value)
Memory retention				
Group A	11.3 (2.4)	9.7 (3.3)	1.94 (0.06)	-4.83 (P-value<0.00***)
Group B	13.4 (2.7)	11.1(3.5)		
Memory accuracy			2.00 (0.05)	
Group A	10.7 (2.5)	9.6 (3.4)		-4.83 (P-value<0.00***)
Group B	13.1 (2.7)	10.8 (3.5)		

Significance level set at 0.05.

Table 4. Means for affective domain from questionnaires among group A and group B

Affective Domain	Group A	Group B	t-test	P-value
	Mean (SD)	Mean (SD)		
Quantity	4.0 (0.8)	4.1(0.9)	0.362	0.720
Speed	4.1(0.7)	4.1(1.0)	0.000	1.000
Preference	3.9(0.9)	4.0(1.0)	0.324	0.748
Comprehension	3.7(0.9)	3.8(1.0)	0.324	0.748
Retention period	4.0(0.6)	3.9(0.8)	0.436	0.666

Significance level set at 0.05.

4. DISCUSSION

The aim of this crossover study was to examine the effectiveness of pictorial materials against verbal materials in memory retention. The results demonstrated that the pictures were retained significantly better than words in the memory. Moreover, pictorial materials were found to be recalled more accurately compared to the verbal materials. These findings support the well-established picture superiority effect, which is based on Paivio – Dual Coding Theory [5]. However, the affective outcomes, which were derived from the questionnaires, did

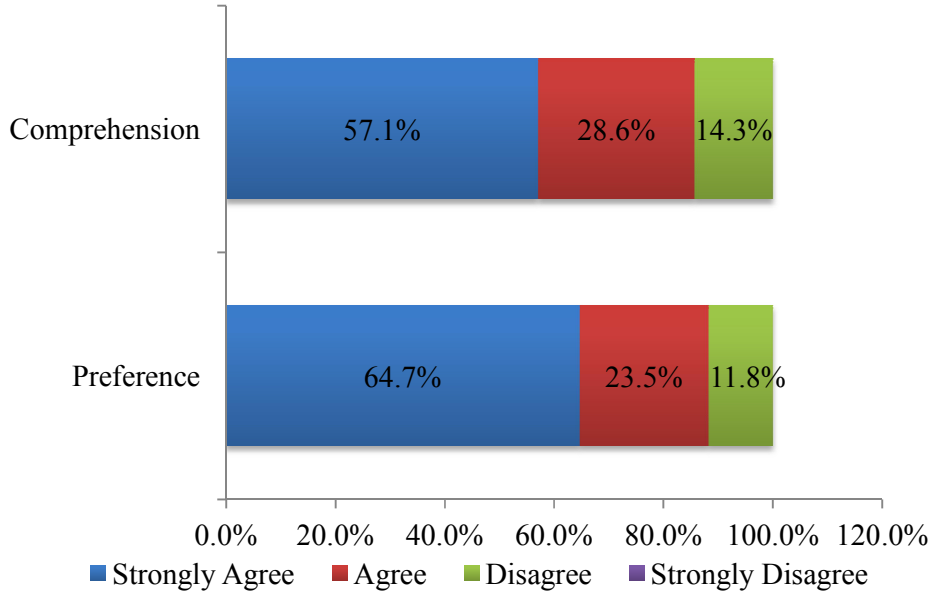

Fig. 1. Questionnaire responses on selected affective domains of pictures and words in memory retention

** 'Strongly agree' and 'agree' responses indicate that the participants are more inclined towards pictures*
** 'Disagree' and 'strongly disagree' responses indicate that participants are more inclined towards words*

not reveal any significant difference between picture and words as the findings in both groups were more inclined towards pictures.

From Table 3, it is found that pictures were retained significantly better than words in the memory. This outcome supports the findings seen in other studies in which pictures are better retained in memory compared to words [8,9,18,22]. The most popular explanation for better retention of memory in pictures is Paivio's dual code theory [5]. This theory explains that there are two codes for pictures (visual information and verbal information) whereas there is only one code for words (verbal information) [21]. The presence of two codes adds to the strength of pictorial memory because there can usually be two methods to represent any one pictorial item. In another words, pictures automatically contain a "naming" advantage while the human brain, without any additional instruction and mental effort does not usually produce images for words [11]. Pictures are perceptually better than words and this visual distinctiveness gives people an added advantage in memory, as there are additional stimulus such as color, shape and texture. All these enrich the memory trace [22]. Words are visually scant, as the letters are normally presented in a single color (black) in a common font (e.g. Times New Roman and Comic Sans MS) [18]. These common fonts have been seen with thousands and millions of other words, leading to almost nil visual distinctiveness while causing the visual imagery of the word to be impoverished. Therefore, words rarely stimulate the generation of an image, which is different from a picture, which has the tendency to be automatically labelled.

The results from Table 3 also showed that there was a significant difference in recognition accuracy between pictures and words, with pictures being more accurately recalled than words. The result is consistent with the sensory-semantic model of picture superiority [9] and the levels of processing theory [23]. The theory explained that the memory is represented by stimuli that has three distinct features; Visual (sensory), phonemic (acoustic) and semantic (meaning or significance). It was assumed that these features are handled in different orders depending on the stimulus being either picture or words [24]. The human brain would process a

picture from its visual (sensory) features to accessing its meaning from memory (semantic), and then proceeds to add a phonemic (acoustic) feature which altogether, provide a name or label for that picture [25]. This is different when compared to word processing. They progress from a visual (sensory) feature then proceed to either phonemic (acoustic) feature or to meaning (semantic) feature. Therefore, a word may be labeled without accessing whereby a picture would have the need access to meaning (semantic) before assigning a nam [9].

Alternatively, theory of semantic activation [8]. also states that semantic links enable pictures to have a superior advantage to verbal labels. Based on this theory, pictures tend to activate memory cues much better than words itself. Stenberg et al. [26] provided his subjects with a certain number of pictures and words to be studied initially before testing their memory with a subsequent memory test. It was found that the level of accuracy and reaction times were high for the picture stimuli than the words. Hence, it was concluded that the processing of pictures have the potential to prime and activate analogous semantic nodes better than words contributing to a much accurate recall of memory [27].

The assessment of responses from questionnaires showed that affective domains of this study did not differ in a significant manner between the pictures-words and words-pictures groups. For instance, the result in Table 4 showed a non-significant difference in the mean score for the preference for the material types between the two groups when the significance level is set at 0.05. This indicates that subjects in both groups preferred pictures than words in terms of information recall. This preference for pictures over words was due to the influence of retrieval cues or environmental stimuli that enhanced the amount of information recalled by making it more accessible by activating previously stored information [28]. The retrieval cues can influence and cause bias in recalling by facilitating access to the information related to the cues or by preventing access to the associated items [29-31]. Hence, the participants were more likely to prefer recalling pictures using retrieval cues compared to the words.

Another important affective domain investigated through questionnaire in this study is the extent to which comprehension is achieved through pictures compared to words. Based on the results in Table 4, there was no significant difference in mean score for the comprehension of pictures and words between the pictures-words and words-pictures groups. The subjects in both groups felt that they can comprehend pictures better than words and this supports the general consensus that pictures play a positive role in helping readers to comprehend a text [32]. Previous study showed that pictures provided readers with a new source of information in addition to what they could get from reading the text itself, and that the combination of this two sources of information facilitated reading comprehension [33].

However, not all kinds of pictures can facilitate in comprehending a reading text [34]. In other previous study done, the author had found that pictures with superfluous and distracting information, and pictures depicting information that could not be found in the corresponding text, to be not effectively useful in enhancing comprehension. Based on another previous studies, a picture facilitating reading comprehension was expected to meet several criteria such as not including too much information about the content of the reading text, depicting the information from the beginning paragraph(s) of the text, mirroring language complexity of the text and depicting the information that was invited to be processed in the text [35]. All these studies did not provide clear cut evidence to what extent pictures can be comprehend better compared to words, but there is a mutual relationship between these two sources where picture helps to enhance comprehension in a reading text [34]. Therefore, it is understandable why participants perceived that pictures were better comprehended than words.

One of the limitations of this study is that there was a possibility that Hawthorne effect may have influenced the outcomes of this study. Participants were aware that this study is a memory based study which will be evaluated through scores. Hence, some participants may put some extra effort than they normally do into concentrating and memorizing the pictorial and verbal materials. Also, some participants had interpreted the pictorial materials differently than others, leading to possible bias in recalling the pictures. Another limitation was the verbal materials presented were not of native language of most of the participants. But all our participants had a good command of English language and this limitation was not significant

enough to influence the outcomes. Moreover, the common limitation of any crossover study, which was the carryover effect, was not applicable to this study.

Based on the outcomes of our study, it is shown that picture superiority effect has a remarkable effect in the memory retention of pictorial and verbal materials. This effect can be utilized in medical school where lots of information in the form of pictures and text has to be learned and medical students should be encouraged to adapt this effect into their learning. This study can be expanded to find out other aspects of pictorial and verbal materials such as the type of pictures that facilitate reading comprehension and influence of colored text and pictures on memory retention.

This study can also be extended for application into neuropsychiatric field and neurodevelopmental pattern of development. A study conducted by Bill Gasparrini had shown that, patients who suffered left hemisphere cerebral vascular accidents had better memory retention with visual imagery technique [36]. Patients with Huntington's disease and right-hemisphere damage also showed better pictorial memory retention compared to patients with alcoholic Korsakoff's syndrome and Alzheimer's disease [37]. According to a study done by Maureen K. O'Connor and Brandon A. Ally in patients with mild cognitive impairment and Alzheimer's disease, it is found that the memorial familiarity remained intact and markedly better using pictures than words [38-39]. This shows that picture superiority effect is greater in both diseases [40]. A patient from Cambridge who suffered from limbic encephalitis was able to recall her autobiographical events 31% more effectively by viewing her personal events in the form of images recorded from her SenseCam (a wearable digital camera) rather than reading her personally written diaries [41]. According to these different studies, different level influences of pictorial component plays a role in different brain damage lesion, however more studies must be conducted to further strengthen this view.

5. CONCLUSION

This study shows that picture superiority effect has a remarkable effect in the memory retention of pictorial and verbal materials. Therefore, the results of this study support the need to implement and apply this theory in medical schools which require heavy memorization of informations in the form of pictures and text. Hence, the utilization of this method of study is essential for more efficient learning and improving academic performance.

CONSENT

All authors declare that all the participants volunteered for the study had signed a consent form after the nature of the procedure had been explained and confidentiality was assured.

ETHICAL APPROVAL

Approval to conduct the study was obtained from Melaka-Manipal Medical College Research Committee, Melaka-Manipal Medical College, Melaka, Malaysia [42].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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