

The Effect of Ground Colour on Memory Performance

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This study intended to examine the effect of ground colour on memory performance. Most of the past research on colour-memory relationship focus on the colour of the figure rather than the background. Based on these evidences, this study try to extend the previous works to the ground colour and how its effect memory performance based on recall rate. 90 undergraduate students will participate in this study. The experimental design will be used is multiple independent group experimental design. Fifty geometrical shapes will be used in the study phase with measurement of figure, 4.74cm x 3.39cm and ground, 19cm x 25cm. The participants will be measured on numbers of shape that are being recall in test phase in three experimental conditions, coloured background, non-coloured background and mix between coloured and non-coloured background slides condition. It is hypothesized that shape with coloured background will be recalled better than shape with non-coloured background. Analysis of variance (ANOVA) statistical procedure will be used to analyse the data of recall performance between three experimental groups using Statistical Package for Social Sciences (SPSS 17.0) to examine the cause and effect relationship between those variables.

Can colour really affect our ability in remembering certain information? Some people say that certain type of colour can help us in increasing our memory performance and some other types may decrease our memory level. How far this claim is true? Do you ever come across a situation where you remember certain words on an advertisement that you just look at it for a few seconds? Is the colour of the words that help you to remember or something else? People use colours for multiple purposes. Some may use colours to convey information or to strengthen the message that they want to deliver, while others use colours for decorative or art purposes. Several studies have been conducted in the past to understand this phenomenon. There is no doubt that colour have an ability to attract attention (Pan, 2009, 2010). With the increase level of attention it can help us to be more focus. Thus, it will enhance our ability to remember the information better. Another interesting feature of colours is that, it may also trigger emotional sense and consequently helping in remembering certain information (Kaya & Epps, 2004). Naturally, people tend to associate certain emotion with specific colour such as red with danger, anxious or worry. This association actually help people to focus and attend to the information, which in turn increase the likelihood of the information to be remembered (Myers, 2006). In relation to this, the current study will focus on the relationship between colour and memory performance.

Statement of Problem

In Malaysia, The Ministry of Education has started to promote the use of Information and Communication Technology (ICT) as a tool to increase productivity, efficiency and effectiveness in the educational sector (Chan, 2002). Most of the educational institutions today have shifted from a traditional talk and chalk method to slides or power point presentations which are more attractive, colourful and eye-catching. Can the use of more colourful and attractive tools make teaching and learning process more efficient by enhancing one's memory performance? It is therefore, the aim of this study to understand the relationship between colour and memory.

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According to Pricewaterhouse Coopers which is one of the largest professional service organization, advertising is a massive sector and most of the companies spend huge amounts of money in promoting their products. The 2003 on-line advertising revenues reached approximately \$7.3 billion and up more than 21% over 2002 revenue (as cited in Moore, et al., 2005). Based on media research conducted by The Nielsen Company (2011), the same phenomenon happen in Malaysia's advertising market with the growth of 16 percent in year 2010 at RM 7.7 billion. This growth was marked by overall increased across all media including In-store (+43%), Internet (+29%), Terrestrial TV (+18%), Newspaper (+14%), Radio (+13%), Magazines (+9%), Outdoor (+7%) and Cinema (+6%). In order to make sure the money spent counts, most of the company compete among themselves to come out with the most attractive and influential advertisement as possible. Obviously most advertisements use colours as one of the important element in influencing people's attention, attitude and decision making. Based on research conducted by Experian Simmons a company that carry out research on consumer related issues, founded the top 10 most popular fast-food restaurant in American in 2009 is Mc Donald, followed by Burger King and Subway restaurant (Kelley, 2009). 80 percent of the top 10 fast-food restaurant listed by the research are branded with vivid colour. For example like McDonald used yellow and red colour in the logo while Burger King also used red colour. This shows that colour do play an important role in influencing consumer behaviour.

Many studies have been conducted to explore the effect of colour on memory such as Pan (2010), Smilek, et al. (2001) and Spence, et al. (2006). Most of the studies focus on the figure colour rather than the background colour. The figure is referred to "thing-like" region while the "back-ground-like" like region as the ground (Palmer, 2003). Those studies shows that by making the figure coloured its can enhance memory performance compare to non-coloured figure (Pan, 2010; Smilek, Dixon & Merikle 2001; Spence, Wong, Rusan & Rastegar, 2006). Therefore it is interesting to see whether the ground colour could have the same effect as the figure colour. In line with that, the current study aims to extend the scope of the previous studies in focusing more on the effect of the ground colour on memory. In particular, the objectives of the current study are:

1. To identify whether the colour of the background have an effect to overall memory performance.
2. To examine whether the colour of the background could have significant effect on immediate recall.
3. To find out whether there are differences in memory performance between colour and non-colour background condition.

Significance of the Study

Based on the research conducted on colour and memory, most of it focuses more on the figure colour rather than the background. Indeed it was reported that figure with warm colour can increase the level of attention as consequently helping in restoring the information better in our memory (Farley & Grant, 1976, Greene, Bell & Boyer, 1983; Pan, 2010). In contemporary world today, colour usage is not limited to the figure but also the background. Therefore it is important to see the effect of the background colour in memory performance. By this research it might wider our understanding regards to the effect of colour on human memory system especially the background colour.

The experimental stimuli used by the past studies are limited to the number, alphabet, alphanumeric and symbols. All of these stimuli are common in which the participants were

used to be exposed in their everyday life. Therefore it might give some degree of assistance to the participant in remembering the stimuli. Thus, the usage of uncommon (rarely seen) shapes will minimize the potential of extraneous variables and be able to see the effect of colour on memory clearer.

The participants used in the current studies are of the Asia cultural background specifically Malaysia. None of the similar study has been conducted in this group of population before. Besides, most of the studies conducted before used participants with western type of cultural background. Therefore, this research can enrich the knowledge of the colour effect to memory on different set of population. Towards some extent it can strengthen the scope in explaining the cause and effect of colour to memory across cultural setting.

This study is important in that it will help to understand more on the relationship between the background colour of information and memory performance. From the application aspect, if the colour of the background can result in better memory retention, it can be used to increase the effectiveness in delivering messages, communication, and work performance. For instance, books are always printed out in white or neutral background colour and most people have to spend some amount of money to buy the highlighter which has a vivid colour ink to aid them in focusing and memorizing certain important points. If the colour of the background could really help in improving memorization, it will lead to a new revolution of printing sectors. Perhaps, all the books will have coloured background that will help the readers to focus and remember better. It also can help Muslim to memorize Quran more effectively. Teachers can deliver information more efficiently and thereby maximizing students' academic performance especially in memorizing important points, facts, and information. Road signs could have a greater effect on the drivers in following the traffic rules and regulations. These are just few examples of the applications of colour usage in our daily life. Thus, it will lead to the enhancement of human memory performance to its maximum.

Literature Review

A number of models have been developed in order to describe and understand how human memory works. Atkinson and Shiffrin have proposed one of the influential models of memory. In this model, memory is made up of three structures; sensory register store, short-term store and long term-store. In this model, the information that comes from the environment will go through the sensory register including visual (iconic) and auditory (echoic) stimuli. Sensory memory can register a huge amount of information but its only retains for seconds or less than that. Attention is needed to allow the information to move to the short-term store. Finally, the information will be transferred to long-term store as a result of various types of control processes such as rehearsals and interacting effects of new and retrieved information (Sternberg, 2009). The use of control processes such as elaborative rehearsal, heuristic, analyzing, modifying information and others are important to allow the information to be transferred from one memory structure to another deeper memory structure. Therefore, it is important that the stimuli available in the environment to have the potential to activate the attention and to be involved in control processes in order for the stimuli to be remembered. Based on a number of previous studies (i.e; Farley & Grant, 1976; Greene, et al., 1983; Kaya & Epps, 2004; Pan, 2009, 2010), it has been proven that colour is one of the variables that has those potential. It can influence the level of attention and also give rise to emotional arousal which is helpful in control processes that will later enhance the memory

performance (Farley & Grant, 1976; Greene, et al., 1983; Kaya & Epps, 2004; Pan, 2009, 2010).

Short-term memory store (STM) is characterized by a limited capacity system for temporary storage. STM is also known as working memory which play an important role in complex task such as learning, reasoning and comprehension. The information in the STM can only be hold for a very short period of time. Past research have found, the duration of STM is limited to approximately 3 to 12 seconds. A well-known study of STM duration was conducted by Peterson (1959) who found that, the participants in his experiments were able to remember about 80 percent of the letters after a 3 seconds delay. However, the percentage drops to 10 percent after 18 second delay (cited in Coon, 2010). According to Miller (1956) the capacity of STM is also limited up to eight items based on measurement of digit span. However the capacity of STM in holding information could be increased by several techniques like chunking (Miller, 1956). Research has shown that by using chunking in terms of the meaning can boost up the capacity level to 20 words or more.

Attention, Arousal and Memory

Attention is an important process in memory. Atkinson and Shiffrin in explaining the modal model of human memory system mentioned that attention is needed to transfer the information from the sensory store to the short-term store (as cited in Stenberg, 2009). According to James attention refers to the process of selecting information that is available in the environment (as cited in Eysenck, 2009). This means that when we pay attention to certain information, we are actually selecting and limiting the amount of information to be processed. Research have found, by increasing the level of attention, the chances of the information to be stored in memory is higher (Eysenck, 2009). In other words, the information that we pay more attention to is more likely to be remembered than the information that we ignore and do not pay attention to. Numerous research have reported that attention can increase memory performance level in terms of the recall rates (Pan, 2010; Smilek, et. al., 2001) and also faster reaction time (Pan, 2009).

Arousal on the other hand refers to being alert physically and mentally which may involve various body system and hormones that contribute to the alertness (Stenberg, 2009). The concept of arousal may include the physical, emotional, psychological and physiological arousal. However, in the study of memory, emotional arousal is being stressed more than the other types of arousal. MacKay and Ahmetzanov (2005) conducted a study on the relationship between emotion and memory. They used taboo stroop paradigm. They predicted better memory for taboo words (which were more emotionally arousing) than neutral words. Participants in the study involved in three experimental conditions; colour naming, location recognition and free recall. It was found that the participants performed better in colour naming and location recognition which were emotionally arousing (taboo words) than the same conditions which were neutral (MacKay & Ahmetzanov, 2005). According to Christianson (1992) high level of emotional arousal was believed to have better retention in long-term recall while some researchers reported detrimental effects upon short-term retention. For instance in learning, the participants that have high arousal effect remembered better in the delayed recall rather than shortly after learning process. According to Kleinsmith and Kaplan words that can produce greater arousal effect were better remembered after one week than two minutes after the learning (as cited in Christanson, 1992). However, some researchers reported that high level of arousal lead to enhancement of both short-term and long-term memory. In an experiment conducted by Corteen which used aurally presented

words was reported higher recalled after 20 minute and 2 weeks delays (as cited in Christianson, 1992). The same result was reported in an experiment which used single arousing word, where the immediate and delayed (after 30 minutes) recall performance was better than non-arousal words (Christanson, 1992). From the studies mentioned above, the level of arousal and attention of certain type of information retrieved have a significant effect on memory performance whether in short-term and long-term storage.

Colour and Attention

Farley and Grant (1976) came out with a theory suggesting that colours have a greater effect on attention. This conclusion was based on their study on arousal and cognition. They compared colour and non-colour multimedia presentations on memory performance. It was reported that the coloured multimedia presentation resulted in better attention than the non-coloured condition which later enhance memory performance. Greene, Bell and Boyer (1983) further explain that warm type of colours such as yellow, red and orange have been found to have greater effect on attention compared to cool type of colours like brown and gray.

Pan (2009) found similar finding in his study on working memory and visual attention. In his study, participants were asked to identify whether the colour or the shape of the two objects that were presented were the same. There were two experiments in this study. In the first experiment the colour of the two objects were the same but the shapes were different while in the second experiment the condition was reversed. The result showed that the participants response times were faster in identifying the colour differences than the shape in both experimental conditions (Pan, 2009). This indicates that colour has greater ability to capture attention than the shape.

Pan (2010) extended his previous study on attention and working memory. This time he used visual geometrical shapes with various colours. The participants (n=22) were asked to memorize both colour and shape of the items. It was followed by a series of cognitive tasks before the memory test were conducted. In the memory test, the participants were asked to recognize the colour and the shape of the memory item that was presented before. He found that, participants performed better in recognizing the colour of the memory items than the shapes. The result revealed support to his previous studies where colour had a stronger attention effect than the shape, $F(1,21) = 4.984$, $p = .031$, $\eta^2 = .192$. This suggests that, colour display could produce higher level of attention and work more effective in working memory. From the studies mentioned, colour have the tendency to capture better attention level especially warm type of colour.

Colour and Emotional Arousal

Colour can also give rise to the emotional arousal. Several studies have been conducted to see this relationship. Kaya and Epps (2004) in their study on 98 college student volunteers in public institutions used ten saturated colours from the Munsell-Colour System for the study. It was found that twenty two emotions were associated with those colours. For instance, it was recorded that the majority of participants associated green colour with the feeling of calmness, happiness, comfort, peace, hope and excitement. While black colour was associated with the feeling of sadness, depression, fear and anger. This means, colours have the emotional arousing effect. However, the degree of arousal level may differ depending on the type of emotion or feeling being attached with it (Jackson, et. al., 2009). According to Jackson, Wu, Linden and Raymond (2009), some types of emotion may have a greater effect

on arousal than the others. For instance, anger was found to have greater arousal effect than happy or neutral type of emotion. Based on the studies mentioned, it shows that colour can produce emotional arousing effect but the range of arousal vary depending on the emotional element that is being attached with specific type of colour. For instance colour like red is being attached with stronger emotion or feeling compared to the other type colours.

Colour and Memory

As stated earlier, attention and arousal are important elements in memory performance. Colours can attract attention and produce emotional arousal. Consequently, both can increase the likelihood of the information to be stored longer in memory system.

Several studies have been conducted to explore the relationship between colour and memory performance. Pan (2010) in his studies as mentioned earlier came to a point that colour is an important asset that can result in better memory retention compare to the other factors like shapes.

In addition to the above studies, Spence, Wong, Rusan and Rastegar (2006) conducted a study to compare coloured images and gray-scale images of neutral scenes on 120 participants. They manipulated the natural scenes into two conditions; natural scenes images with colour and grey scale. They reported that participants' recognition of the natural scenes were approximately 5% higher in the colour condition compared to the grey scale condition, $F(1,112) = 47.0, p < .0001$. The same comparison was significant at the .05 level or better for each exposure duration.

Smilek, Dixon and Merikle (2001) also carried out a study to investigate the colour-memory relationship. They used digit numbers with different conditions; black and white condition, congruent colour digit condition and incongruent colour digit condition. They utilized the undergraduate students as their participants in the study. Three minutes were given to the participants to study the stimuli and another three minutes for them to recall the stimuli. The stimuli were exposed to the participants through a computer screen. Significant differences were found in each recall condition. The participants performed better in the congruent colour digit (congruent) condition compared to incongruent colour digit condition.

Smilek et. al. (2001) extended their study to delayed recall by comparing two types of stimuli; the black digit and line-drawn black shape after 48 hours. The same participants went through the same procedure. The result showed that participants' performance decreased but their performance was better in the black digit condition compared to black shape condition. However, the limitation of the study was on the usage of colour stimuli which was used only in immediate recall and not in delayed recall.

Based on the above studies it is clear that colours, attention and arousal can directly influence memory performance. Thus, as stated earlier, colours have the potential to produce such attention and arousal effect (Farley & Grant, 1976; Green, et al., 1983; Kaya & Epps, 2004) which could lead to the improvement of memory retention.

Lloyd-Jones and Nakabayashi (2009) have carried out a study on the effects of colour on object identification and memory and found out that there was differences in memory performance in object-colour spatial integration and object spatial separation. In their study two hundred and thirteen undergraduate students from the University of Kent were involved in the study. All participants were non colour-blind. 75 colour objects from various

categories were used in the study. All pictures were selected through object-naming task and colour agreement task before being used in the actual experiment procedure. There will be three condition of each object, correctly coloured (original colour), incorrectly coloured and greyscale. There were two experimental conditions; object-colour spatial integration and object-colour spatial separation. In the object-colour spatial integration the colour object was placed on the grey background while in the object-colour spatial separation, the grey object was placed on the colour background. In the study phase, participants rated object-colour typicality on 7-point scale and in a test phase participants required to press the A or the L key to indicate whether the object was correctly coloured or not. The speed of the respond was observed. The result were analyzed by participant and by item for each phase of the experiment. There was a significant effect of surface colour with higher ratings for spatially integrated condition ($M= 3.84$) than for spatial separated condition ($M=3.13$), $F(1, 184)=18.3$, $p<.0001$. In terms of the reaction times, it was reported a short time for correctly coloured than for incorrectly coloured in the spatial integrated condition, $t(83)= -2.58$, $p<.05$ but not for spatially separated, $t(83)=0.70$, $p>.05$. Therefore, coloured object with non-coloured background have better memory retention and faster respond time compare to coloured object with coloured background.

Another study by McConnohie (1999) used alphanumeric characters and showed them to the participants through slideshow with three background colour conditions; white, blue and green. All the figure characters were in black. The result comparison of white and green background slide was, $t(25)=0.416$, $p< .05$ and blue with white coloured background, $t(26)=0.505$, $p<.05$. The slide with the white background resulted in higher retention rates both in immediate and after an hour viewing the slides. This result is in contradiction with the previous studies but the colours chosen in study may explain the result obtained because the colours were cool which have lower degree of arousal.

From the above studies, we can infer that colour can produce attention and arousal effect which can later enhance memory performance. However the findings from some other studies did not come to the same conclusion.

Figure and Ground

According to Gestalt figure and ground theory, we perceive our environment in its totality. The theory stated that, the environment that we see does not stand alone but is against the undifferentiated background (Payne & Wenger, 1998). This theory tries to understand the relationship between the two fundamental concepts, the figure and the ground. The figure refers to the object or entity that perceived to stand apart from background and the ground refers to the background against which a figure stand (Plotnik, 2008). This relationship is reversible in nature, in which the figure and the ground can be switched back and forth (see figure 1). Figure 1 can be seen as a vase or two faces facing each other or both. It really depend on what one want to see and which one we define as figure and ground. However our perception is influenced by our memory, past knowledge or cues in the environment. For instance, if we are familiar with the image of a vase we might perceive the figure as a vase rather than the faces or vice versa but it is reversible. Therefore, we can change our perception toward the figure from the vase to the faces by pushing back the figure image to the ground and bring forward the ground image as figure.

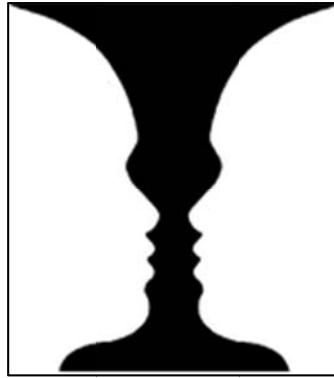


Figure 1. An Example in Which the Figure and the Ground are Reversible (Plotnik, 2008)

Various studies of colour and memory manipulated the figure colour rather than the ground (Farley & Grant, 1976; Lloyd-Jones & Nakabayashi, 2009; Smilek, et. al., 2001). Moore, Stammerjohan and Coulter (2005) conducted a study that focused on two variables; the colour of the background and the contrast between the background and the text. They found out that incongruity has more effect on recall and recognition while congruity has more effect on attitude. Therefore, it is suggested that regardless of figure and ground, colour still has an effect on memory. However, McConnohie (1999) used the ground as the focus of the study and compared it with the colour and non-colour background but the result was not significant. Therefore, it is important to further explore the effect of the ground with colour and non-colour condition in memory performance.

Theoretical Framework

The theoretical framework for this study is based on Atkinson and Shiffrin's "Modal Model" of memory. This model explains that human memory system consists of three parts, sensory store, short-term store and long-term store (Sternberg, 2009). Almost all the raw information that we receive from our senses either visual or auditory flow to the sensory register store. This structure only keep the huge amount of information for a short period of time.

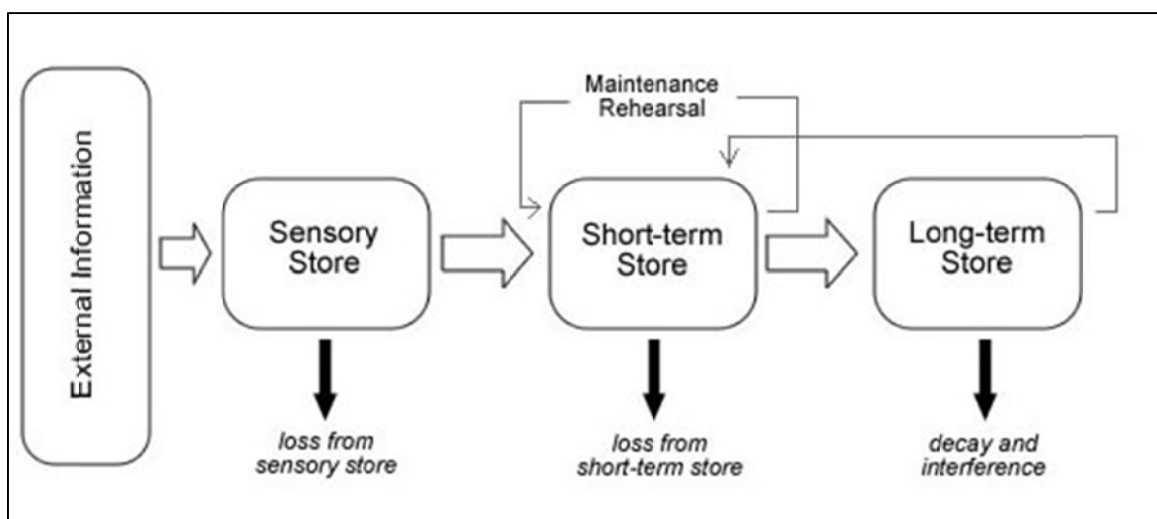


Figure 2. The Theoretical Framework based on the Atkinson and Shiffrin Modal Model of Memory 1968 (as cited in Sternberg, 2009)

The external information received by the senses is important in determining whether it could be further transferred to short-term store and long-term store. Those information that can capture attention will have better chances to be transferred from sensory store to short-term store. If not, the information will be lost. Several techniques or control processes are needed to transfer and maintain the information in the short-term store or in the deepest level of memory system, the long-term store, such as maintenance rehearsal and elaborative rehearsal. It all depends on the level or depth of processing of a stimuli used. Craik (1973) refers to this depth as extraction of meaning from the stimulus rather than the quantity of analyses performed upon it. Thus, the deeper the level of analyses produced, the more lasting and longer the memory will be stored.

Conceptual Framework

Colour, which has a capacity of triggering a dual effect of attention and arousal, is seen as a potential to cause stronger retention in both short-term store even in long-term store. Colour as an information from the external environment that goes through the sensory store has the potential to trigger the emotional arousal and attention (Farley & Grant, 1976; Green, et al., 1983; Kaya & Epps, 2004) which later increase the chances of the information to be stored in the memory (Pan, 2010; Smilek, et al., 2001; Spancer, et al., 2006) including short-term memory (immediate recall). It is believed that the arousal effect which can be produced will enhance the recall especially in delayed condition. The same effects are also predicted from the stimuli with coloured background. In contrast, the non-coloured background stimuli are unable to capture attention which cause the information to decay and cannot be transferred to short-term memory. This will be seen in the low rate of memory test.

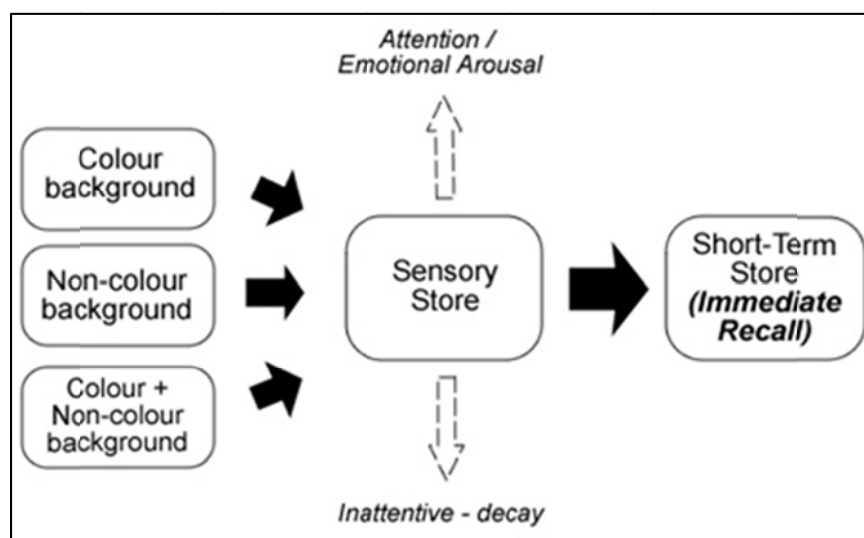


Figure 3. The Conceptual Framework

The current study intends to look at the effect of the background colour of an object on memory performance in three different condition; coloured background, non-coloured background and mix between coloured and non-coloured background. Since most of the previous studies manipulate the figure colour object, it is interesting to evaluate whether there are any differences in memory performance with the background colour of an object compared to non-colour background. Therefore, it is hypothesized that:

1. Shapes with coloured background condition will be recalled better than shapes with non-coloured background condition in immediate recall.
2. Shapes with coloured background will be recalled better than shapes with non-coloured background in mixture of colour and non-coloured background condition.

Methodology

Design

The experiment will be using between group experimental design. The independent variable for this experiment is the background colour and the dependent variable is the number of shapes that are correctly recalled by the participants. There will be three groups of participant which each group will be given different treatments. The first group will be given an experimental stimuli with coloured background slides (red colour) while the second group will have experimental stimuli with non-coloured background slides. However, the third group will be having a combination of colour and non-coloured background slides which will be shown alternately.

Participants

90 undergraduate students of Kulliyah of Islamic Revealed Knowledge and Human Sciences, age ranges from 19 to 22 will be recruited to participate in the experiment. There will be 30 participants in each condition. Convenient sampling method will be used. Normal or corrected-to-normal vision is required in all participants and informed consent prior to participation will be sought.

Materials

Three sets of stimuli will be used, consisting of 50 geometrical shapes each. Each shape (the figure) is non-coloured with black outline and will be printed on red background in the first set and non-colour background in the second set. However, the third set consists of 25 geometrical shapes with red colour background and another 25 shapes with non-colour background. The figure measurement is 4.74cm x 3.39cm and the ground measurement is 19cm x 25cm. The sequence of the slides will be presented in the same order in each condition. The shapes will be presented using Microsoft Office Power Point 2007 through the computer screen.

Procedure

An inform consent form will be given to each participant as an agreement to participate in the experiment. General information regarding the nature of the study will be given to all the participants. An instruction will be given to the participants regarding the task that they are required to do in the experiment. In order to make sure that all participants understand the task, a short trial will be given to each participant before the actual experiment begins.

This experiment will consist of a study and a test phase. In the study phase, participants will be presented with slides consisting of 50 geometrical shapes; in each condition. Each slide will be shown for duration of 200ms. The participants are required to focus and to remember the shapes on the slides to the best that they can. They will give a short break after all slides are presented. The test phase will begin after a delay of 200 ms.

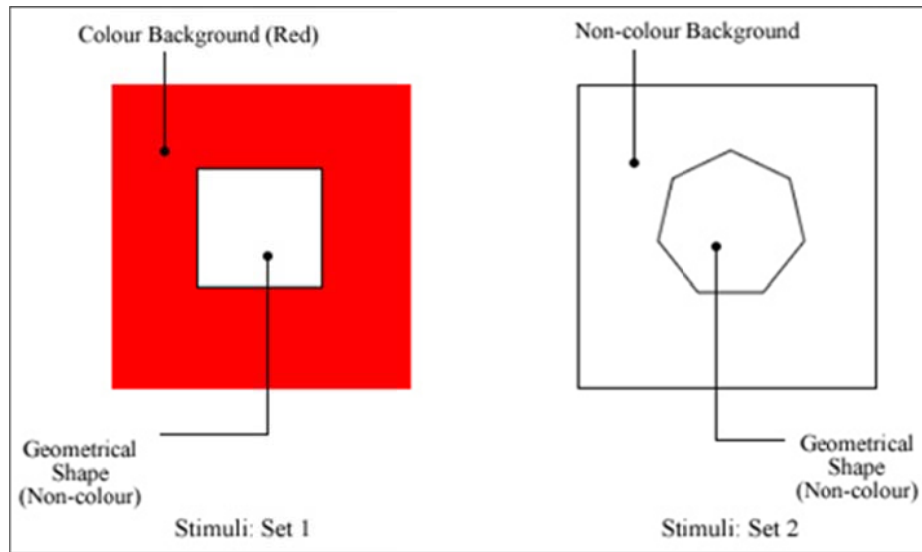


Figure 4. Example of the Experimental Stimuli; Set 1 (Colour Background) and Set 2 (Non-Colour Background)

The test phase will be conducted after the study phase with a delayed of 200ms. In this phase, each participant will be given a response sheet and a pencil. The response sheet contains images of 75 shapes i.e. 50 old shapes (shapes that have been presented in the study phase) and 25 new shapes (shapes that have not been presented in the study phase). Participants have to tick YES if they can recall that a particular shape has been presented in the study phase. They have to tick NO if they can recall that the shapes have not been presented in the study phase. No time limit is imposed for the participants to finish the task.

All the responses will be collected and analyzed. The statistical procedure will be conducted by comparing the recall performance between the three groups. The descriptive statistic will be run to know the mean, medium and mode of the data. Analysis of variance (ANOVA) statistical procedure will be used to analyze the data of recall performance between three experimental groups. The Analysis will be done by using the SPSS computer software version 17.0.

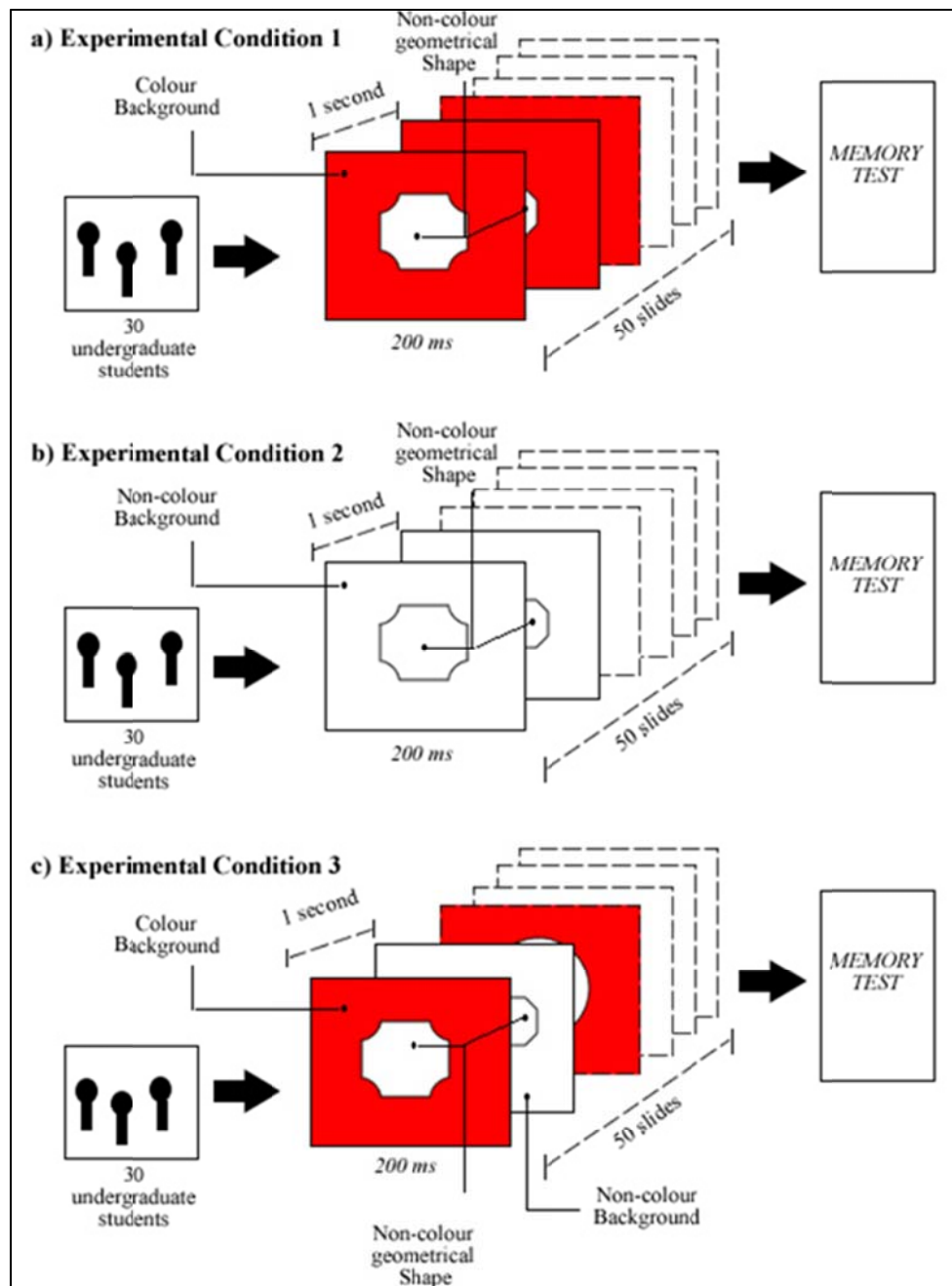


Figure 5. Schematic Illustration of the Experimental Procedure. (A) Shows the Study Phase and the Test Phase for Immediate Recall. (B) The Second Test Phase for Delayed Recall which will be Conducted after 48 Hours.

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