

# Effect of highlight on memory recall



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This experiment was designed to investigate the effect of highlighting on memory recall. 30 subjects of aged 20 were chosen randomly. All the subjects were given a list of 40 words, in which 20 of them in black colour ink and 20 of them in yellow colour ink. The subjects were given 2 minutes to look at the list and were given 4 minutes to list down the words recalled after a 4 minutes filler-task. From the results obtained, the mean score of the yellow ink words recalled is significantly higher than the mean score of the black ink words recalled. Based on the data collected, a statistical test of T-test was carried out on the data and from the test it showed that the calculated t value is 2. 5362 which is greater than tabulated t-value 1. 699. Thus, it rejects the null hypothesis which is no significant difference between the yellow ink words and the black ink words recalled.

### **Experimental hypothesis :**

There is a significant difference between the yellow and black ink words recalled. The number of yellow ink words recalled is greater than the black ink words recalled.

### **Null hypothesis :**

There is no significant difference between the yellow ink words and black ink words recalled.

### **Research and rationale :**

The objective of this designed experiment was to investigate the effect of highlighting on memory recall.

Memory can be defined as the ability to acquire, store, retain [1] and then retrieve the information or experience [2].

Encoding, storage and retrieval are 3 of the main processes involved in memory.

Encoding converts the perceived information into a form than can be stored in brain. Storage means that the information is retained in the brain over time while retrieval means that use of the information retained in the brain [3].

Based on the proposal of Atkinson and Shiffrin, the stage model of memory has been divided into 3 stages, which is sensory memory(SM), short-term memory(STM) and long-term memory(LTM) to explain how memory works in brain [1].

### **Figure 1: Process of memory [5]**

The very first step of memory is sensory memory, which the information from surrounding or stimuli is retained for a very brief duration, around 200-500 milliseconds after it has been perceived [4]. Since its degradation rate is very fast, there is a tendency to forget if attention is drawn away and thus only certain parts of the information being passed into short-term memory [1].

Short term memory can be described as an active memory. Paying attention to particular information enables it to be retained, but only lasts for a little longer than sensory memory which is 10-20 seconds [5]. Since it can be quickly forgotten, in order to remember something after the information, it has to be transferred into long-term memory.

This ability causes certain parts of our brain being activated, the pre-frontal lobe [6].

## **Figure 2: Regions of brain [6]**

The information passed into LTM from STM via hippocampus, a seahorse tail shape region of the brain which consolidate the information of STM to LTM [6]. In contrast of

SM and STM, LTM can store a large amount of information for unlimited duration [7]. This form of memory is involuntary, which means that the information retained can be called into working memory when it is needed [1].

## **Figure 3: Hippocampus**

Highlighting, is one of the typographical technique to draw the attention of viewer. Based on the research of Fowler and Barker in 1974, the fact that highlighting can be a means to increase retention of memory was qualified [17].

Highlighting actually make use of colour psychology to boost human memory retention. Colour has been found to increase arousal based on proposal by Faber Birren [16]. Warm colours like yellow and red have been found to be more arousal when compared to cool colour like blue and green [8]. Warm colours appear more active in psychological effect due to it stimulates the adrenaline flow, resulting in increase in blood pressure and energy level. In contrary, cool colours tend to recede the effect [19].

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832 Later in 2002, Roozendaal found out that arousing events have the capability to increase memory due to the hormonal changes in the brain [16]. Likewise, Humphreys also proved

that the increase in arousal will increase the rate of response of stimuli, which then facilitates the retrieval of LTM by his “ tick-rate hypothesis” [10]. Therefore, from these researches, we can say that colour can increase one’s memory retention.

Moreover, this fact has been strengthened by Witchmann et al [15] who have shown that colour enhances recognition memory. This might due to increasing of the rate of discharge of neurons in the brain.

According to researcher from UMI A Bell & Howell Information Company, Michelle L. Gaddy, she found out that when colour highlights were used as a cue in a passage, the mean score was higher compared to the non-cued which was without highlighting.

#### **884Figure 4: Mean score of cue and non-cued passage**

The results from this investigation could benefit not only in commercial advertisement, but also in the process of teaching and learning. Marketing agencies often make use of this colour psychology to opt for the best colour to attract the interest of consumers and therefore increase their amount of sale. On the other side, highlighting has been found as a typographical cues and widely used in studying among the students. Students often highlight and glean the important key points on their text book, to facilitate their memory retention during their revision [21].

**975****Planning :**

Before conducting the real experiment, few trials were conducted to find out the most suitable method and materials which can be used in real investigation to give a reliable results.

**Trial 1 : Number of words**

This trial was conducted to find out how many words should be given in the list to be memorized as the objects of recall. Firstly, 15 subjects were separated into 3 groups. Then, a list a list of 25 words printed in black and 25 yellow words was given to first group. All of them were given 2 minutes to look at the list and a 4 minutes filler task was given to be solved. Then, they were given 4 minutes to list down the words they recalled as many as possible. The number of coloured words and black ink words recalled were counted.

Then, for the 2nd group, 40 words lists with 20 black words and 20 yellow words were given; 30 words lists, with 15 words printed in black and 15 words printed in yellow to the 3rd group. The mean of score was shown as below:

**30 words list**

**40 words list**

**50 words list**

**Black ink words**

**7.6**

**8.7**

**6.7**

**Yellow ink words**

**8.3**

**10.8**

**7.8**

**Table (a): Mean score for words recalled based number of words**

**1192**

There was a more significant difference between the black ink words and yellow ink words recalled when total of 40 words are used. Thus, 40 words list was chosen in real investigation.

Trial 2 : The colour of font

In this trial, few colours were chosen to find the most significant difference in the mean score between all the colour combination. 20 subjects were chosen and separated into 4 groups. A list of 20 black words and 20 yellow colour words was given to the first group, a list of 20 black words and 20 red words were given to the second group, a list of 20 black words and 20 blue words

given to the third and list of 20 black words and 20 green words given to the last group. They were given 2 minutes to look at the list and followed by a 4 minutes filler task. Then, they were given 4 minutes to write down the words they recall and the number of black words and yellow colour words were counted. The mean score for all the combination of colours was shown as below:



**Yellow**

**Red**

**Blue**

**Green**

**Black words**

**8.1**

**7.6**

**7.8**

**6.9**

**Coloured words**

**10.5**

**9.5**

**8.4**

**7.8**

**Table (b): Mean score for words recalled based on colour**

1435The results were more significant when list of combination of black ink and yellow colure ink words was used. Hence, they were opted as the combination in actual investigation.

Trial 3: The duration of filler task

This trial was conducted to opt for the best duration for filler task which enough to distract the subjects and prevent rehearsal but not too long to cause a significant degradation in memory. Mathematical questions were

selected as the filler tasks. The same procedure in trial 1 was carried out but with different duration of filler task which were ranged from 1 to 5 minutes.

**Duration of filler task****Colour of words recalled****Black****Yellow****1 minute****10.3****12.8****2 minutes****9.6****11.2****3 minutes****8.9****10.8****4 minutes****8.4****10.2****5 minutes****6.2****8.7****Table ( c ): Mean score for words recalled based on duration**

Thus, based on the last trial, duration of 4 minutes for filler task was enough to distract and prevent the subject from rehearsal while 5 minutes was too long until it was assumed to cause some degradation in their memory power.

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**Experimental Method :**

First , 30 students of aged 20 were selected randomly but from the same course as the subjects in the investigation . Each and every one of the subjects were told about the procedure of the experiment and what they should and should not do during the investigation . Then, each of the subject were given a list of 40 understandable scientific terms and English words, which at randomly 20 of them were printed in black ink and 20 of them printed in yellow ink at random position. They were given 2 minutes to look at the list and memorize as many as they could. After two minutes, a 4 minutes duration filler-task which consists of 10 mathematical questions was given to all the subjects at the same time. Then, they were given 4 minutes to list down all the words and terms they recalled on a piece of white paper. Finally, all the data was collected and recorded in organized form ( table ) and the number of yellow ink words and black ink words was counted respectively for each and every subjects. This was followed by a statistical test of T-test on the data collected.

**1790****Risk assessment :**

Generally all these experimental methods were in a very low risk. Before the investigation was carried out, the subjects were well informed that the experiment is not about intelligence test to avoid any burden on the subjects. Besides, they were told that all the results obtained will be kept confidential and they were told not to disclose any information or distract other subjects while the investigation was being carried out. Moreover, all <https://assignbuster.com/effect-of-highlight-on-memory-recall/>

the papers used of the list were plain white and not bright colour paper to prevent photosensitive epilepsy which may temporary impair their vision and concentration. After all the subjects were clear about the procedure, any of the subjects who was uncomfortable with the investigation were allowed to withdraw themselves from the investigation.

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**Results :**

**Subjects**

**Score of words recalled**

Black

Yellow

**1**

7

12

**2**

6

9

**3**

7

10

**4**

4

8

**5**

6

7

**6**

5

11

**7**

9

6

**8**

11

5

**9**

8

9

**10**

8

6

**11**

5

7

**12**

4

10

**13**

6

11

**14**

10

6

**15**

8

7

**16**

3

8

**17**

9

4

**18**

3

7

**19**

5

8

**20**

7

5

**21**

6

6

**22**

7

8

**23**

5



12

**24**

8

10

**25**

9

7

**26**

6

8

**27**

10

8

**28**

6

11

**29**

5

10

**30**

4

11

â' x

**197**

**247**

**6. 567**

**8. 233**

**2035 Table 1 : Score of words recalled according to colour for each subject**

**Graph 1 : Bar chart of mean score for each colour of words recalled**

**2049**

**Score of words recalled**

**Number of subjects ( Frequency )**

Black

Yellow

**0**

0

0

**1**

0

0

**2**

0

0

**3**

2

0

**4**

3

1

**5**

5

2

**6**

6

4

**7**

4

5

**8**

4

6

**9**

3

2

**10**

2

4

**11**

1

4

**12**

0

2

**13**

0

0

**14**

0

0

**15**

0

0

**Table 2 : Frequency table of score of words recalled based on colour**

**2122**

**2920**

**Graph 2 : Normal distribution graph of score of words recalled based on colour**

**2136**

**Subjects**

**Score of words recalled**

**d**

**d<sup>2</sup>**

Black

Yellow

**1**

7

12

5

25

**2**

6

9

3

9

**3**

7

10

3

9

**4**

4

8

4

16

**5**

6

7

1

1

**6**

5

11

6

36

**7**

9

6

-3

9

**8**

11

5

-6

36

**9**

8

9

1

1

**10**

8

6

-2

4

**11**

5

7

2

4

**12**

4

10



6

36

**13**

6

11

5

25

**14**

10

6

-4

16

**15**

8

7

-1

1

**16**

3

8

5

25

**17**

9

4

-5

25

**18**

3

7

4

16

**19**

5

8

3

9

**20**

7

5

-2

4

**21**

6

6

0

0

**22**

7

8

1

1

**23**

5

12

7

49

**24**

8

10

2

4

**25**

9

7

-2

4

**26**

6

8

2

4

**27**

10

8

-2

4

**28**

6

11

5

25

**29**

5

10

5

25

**30**

4

11

7

49

$\hat{d} = 50$

$$\hat{d}^2 = 472$$

### **Table 3 : Score for different colour of words recalled**

2323d = difference between value of yellow ink words and black ink words

### **T-Test Calculation :**

Formula :

### **Formulae**

### **Numerical value**

=

$$= = 1.6667$$

2

$$2.7778$$

=

=

$$= 3.5994$$

$$t = , \text{ where } = 0$$

=

$$= 2.5362$$

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### **Data Analysis :**

2716Based on Table 1, majority of the subjects scored higher for words printed in yellow as compared to the black ones. Among the subjects, 21

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have a higher score for yellow ink words and only 9 of them have slightly higher score for black ink words. This may due to the minority of them do not have a habit of highlighting during their studies. Hence, when carrying out the experiment , they can hardly concentrate with the coloured words. On the other hand, the bar chart in Graph 1 showed that the mean score for black ink words recalled was 6. 567 and for yellow words recalled was 8. 233. Thus, the shape shows the mean score for yellow words recalled was significantly higher than black words recalled. Furthermore, based on Table 2 and Graph 2, they clearly show that the score for black ink words recalled was ranged between 3 to 11 with a mode of around 5 to 6 . On the other hand, the score for yellow ink words recalled was ranged from 4 to 12 with a mode of around 7 to 8. Moreover, there was no subject in the score of 0 to 3 and 13 to 15 for both colour of ink. From the chart shown in Graph 2, the scores for yellow coloured words were significantly greater in frequency than black ink words from score of 7 to 12. On the contrary, score of black ink words recalled from 3 to 6 had a higher frequency. The table also depicts that only 2 subjects scored a point of 3 for black ink words. The reason that results in this occurrence might be the yellow ink words had dragged their attention away from the black ones. This indicates that yellow highlighted words were more arousing as a visual stimulus. Besides, there was one subject whose score is exceptionally low which was 4 for the yellow ink words recalled. This anomalous might due to the subject had no initiative in this investigation because no rewards will be given and might due to tiredness. Moreover, there were 2 subjects with

exceptionally high score for yellow words recalled. This could probably due to the subjects have excellent memorizing power compared to the others.

From the shape of Graph 2, we assumed that the score for each colour of words recalled was normally distributed. Thus, T-test was selected to test the hypothesis because it was used to deal with problems when subject involved  $n \leq 30$ . From the results and statistical test, it was proven that the number of yellow ink words recalled is significantly greater than number of black ink words recalled. This is because the calculated t-value is 2.5362 which is greater than the tabulated t-value 1.699 at 5% probability level for degree of freedom of 29 in one tailed paired sample t-test. Thus, there was less than 5% chance the results happened by chance and more than 95% the results were significant different, with the score of yellow words recalled greater than the score of black words recalled. Hence, the experimental hypothesis was accepted and the null hypothesis was rejected.

There're two main ways colour could boost scene recognition, first by “improving edge detection and surface segmentation and by being bound as a property of a memorial representation” [quoted from 20]. Colour could help in encoding process as well as recognition which is called encoding-specificity effect which could boost memory retention. This principle asserts “that memory is enhanced when the same information available at encoding also available at retrieval” [quoted from 20].

3001This means that those activated brain areas during encoding process are also being activated during retrieval, and thus will aid in access of



information to be stored in memory. Colour and words are processed in different region of the cortex. Thus, the

use of colour in context can drag the attention of the reader, and thus increase the likelihood for them to send them to LTM [18].

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3894When our sensory receptors detect visual stimuli, the neuron in the sensory organ is activated. Then, this results in a reverberating circuit of neural activity in our brain and send the stimuli into STM [13]. The information in STM is then transferred into LTM when the rehearsal is repeated and eventually activate the neurons in hippocampus. This involves a process of binding of glutamate, a neurotransmitter to  $\alpha$ -amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptor ( AMPA ) in postsynaptic membrane. Then, there is an inflow of calcium ions which depolarizes the cell. This depolarization affect the other glutamate receptor, N-methyl D-aspartate ( NMDA ) which control the calcium ion channel. The calcium ions bind to several enzyme in postsynaptic membrane which then triggers a cascade of event [14]. The second messenger, cAMP is formed and boost the activity of protein kinase A. This protein kinase is then moves to cell nucleus, activating CREB protein which will bind to CRE region and then to CREB-binding protein, switching on and off certain genes [9] which then synthesise proteins to enlarge the synapses and boost the production of protein for memory consolidation. It is the stimulation of the release of neurotransmitter into the synapse which build up a memory traces [12].

Highlighting in this case acts as a visual stimuli that causes a higher discharge rate of this protein to increase human memory retention.

### **Evaluation :**

Reliability is very important in an investigation. Thus, few precautions were taken to increase the reliability of the results. First, a large number of 30 college students were chosen as the subjects of investigation. Moreover, all the subjects were chosen randomly to prevent selection bias in the investigation. Furthermore, all of the subjects were chosen from the same course so that the scientific terms given were understandable for all of the subjects. These steps were to ensure that the results was representative of the college students. To further improve the reliability, the subjects taken were all the same age, which eliminate the occurrence of anomalous results due to memory degradation with age.

Besides, to eliminate factors which were not attributed to memory, subjects were tested on colour-blind test and any subjects who show positive results were removed from the sample to give a more reliable data. Moreover, all the subjects were allowed to use optical aids so that clarity did not become one of the limiting factor.

3527Other than the subjects' factors, objects used in this experiment should be taken into consideration too. First, the terms and words in the list of given should be match the standard of the college students and familiar to them so that the ambiguity can be eliminated. Besides, to control the variable, all subjects were given the same list of terms and words. Moreover, to prevent photosensitive epilepsy, only plain white paper was used as the material of

the list so that the subjects will not be affected during the process of memorizing. Due to different printer will give different intensity of the colour, same printer was used to print the list for all 30 subjects. Not to forget the probability of rehearsal, filler task of mathematical questions was given to every subjects too before they could start to list down the words they recalled.

Environmental factor plays an important role in improving reliability too. In order to prevent distraction, all the subjects were asked to carry out the investigation in a completely silent room. Moreover, the subjects were asked to arrange themselves far from each other so that discussion could not be carried out which might affect the reliability. Due to the control and the coloured words to be investigated were both in a list, there's no need two separated group to carry out the test. Thus, by having the same group of subjects doing both, we eliminate the chances of two different group having different memory capacity. Lastly, the experiment was carried out in the morning as this is the time when every subjects in their best performance level which can eliminate the factor of tiredness.

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### **Limitation and Modifications :**

In real life investigation, not all factors can be kept under control, we named it as limitations. So in this investigation, one of the limitation is when choosing the subjects. Although the subjects were chosen randomly, but they were not be representative of all the population due to the subjects only chosen from one college. Due to the subjects were all scholars, majority of

them have greater memory capacity and thus more effective memory and learning skills when compared to normal population. Thus, subjects should be chosen from a wider population like from other colleges. Besides, one of the other limitation was there were some scholars among the subjects have a much higher memory capacity compared to other subjects. Hence, these groups will give anomalous results which is much higher. Moreover, different subjects have different standard of English . Thus, there was a possibility that some of them did not come across some of the words given in the list. To avoid this, the words chosen in the list should not be too deep and are understandable for all groups of people.

3986Another limitation was the aim of filler task was very difficult to achieve. This was because we couldn't control what the subject was thinking about and they might rehearse while completing the filler task. Moreover, some of the subjects might not get enough sleep the night before. Thus when they perform in the investigation, they could not really focus on the objects given to be memorized. Thus, all the subjects chosen should be informed to have enough sleep before they involve in the experiment and those who not able to concentrate were eliminated from the subjects. Before the investigation was carried out, they were told no incentive will be given. Hence, some of the subjects might not give their full performance during the process. Thus, in the process of choosing the subjects, we have to select from those who are really willing to give full cooperation.

Lastly, all the subjects selected have different memorizing skills and techniques. Some of them capable of linking all the words into a story which

was proven to facilitate human memorizing power and some of them just purely rehearse repeatedly. Thus, this is another limitation which couldn't be controlled.

Further research can be carried out to find the effect of different colour of highlighting on memory retention. Comparison between genders can be further investigated as well to find whether there is difference between their memory retention.

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### **Evaluation of Sources :**

Source 1 is an website article written by Kendra Cherry who had written a diverse topic about psychology in an psychology education website. Hence, it is highly reliable. Besides, source 2, 4, 7, 8 and 9 are from Wikipedia website. It is a web-based encyclopedia and is continually updated to provide the newest and current information. Thus, it is regarded as a reliable source. Source 5 are reliable sources too as it was reviewed by Robert McCluskey, an expert in brain topic and is a reputable author in America and has won Caldecott Medal and Source 11 is under American Chemical Society too. Source 6 is a website under Canadian Institute of neurosciences, mental health and addiction and thus is regarded as reliable too.

Besides, source 12, 13 and 14 are books related to psychology and brain which has been written by reputable author and publisher besides being peer reviewed by experts. Thus, the facts must be trusted and reliable.

Moreover, source 15 to 21 are scientific journals, articles and research papers done by some experts. Thus, these should have a very high level of credibility as they were written by experts who are knowledgeable in this particular field and published to the public for references.

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### **Conclusion :**

From the results, it clearly shows that the score of yellow ink words recalled is significantly higher than black ink words recalled. This has been proven statistically by T-test which showed that t-value is 2. 5362, greater than 1. 699, the tabulated t-value at 5% confidence level for degree of freedom of 29. Thus, experimental hypothesis is accepted and yellow highlighting in learning appears to be more efficient.

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