

## Influence of colour on memory

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### ABSTRACT

Different design principles have been discovered by cognitive psychologist for the purpose of enhancing memory performance. It has been seen that retrieving process is impacted by several variables and one of them is colour. This research provides an overview of colour and memory retention. It comprises of the impact of family type on memory, association between age of participants and recall, most and least frequently words recalled, influence of colour on recall and association between sex of the participants and recall. The study reported the effect of colour on retention rate of school students in the age range of 11-18. Sixty students participated in the experiment conducted. The aim of the study was to determine the effect of the colour of a word on its recall. The independent variable was the colour of the words in the word list. The dependent variable was the number of words recalled by the participants. The research design was independent measures. A Mann-Whitney U test was conducted to analyze the data and the results indicated that there was no statistically significant difference in the number of words recalled based on colour. The group presented with list with all words in black ink on white background performed better than those who were presented with ten words in red ink and ten words in black ink on white background. Results of another Mann-Whitney U test show that females have a statistically significant higher recall than male participants.

*Keywords: Influence, Colour, Memory*

One majorly challenging question in memory research concerns how one can enhance their memory. Many different variables have been believed to influence retrieval such as attention, gender, age, etcetera. One of the variables that is supposed to influence retrieval is colour (Lauber, Kurz, Gollhofer, Taube, 2019). Colour as a variable will be discussed throughout this research paper. In 1942, Kurt Goldstein proposed that different colours provoke different physiological responses. To human beings, colour is illustrated as one of the most important visual experiences. Colour is vastly used in education, marketing and even sports (MIT, ERCIM, Keio, Beihang, 2016).

The Institute for Colour Research reveals that within the first 90 seconds of visual presentation people make subconscious judgments regarding a product, an environment or a person. Moreover, 62% to 90% of that judgement has been due to the colour of the subject

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(Ou, Luo, Woodcock & Wright, 2004). A research conducted suggested that in-store purchasing decisions made by the consumers go upto 73% (Henley Centre, 2010). Therefore, for successful sales, conveying the information about the product and catching the attention of the consumers through colour is crucial. Tests also indicate that black and white images are likely to sustain attention for less than 2 seconds whereas coloured images catches attention for more than 2 seconds (Singh, 2006). Fred R. Barnard said, “A picture is worth ten thousand words.” (1927). Consequently, images created out of natural colours could be worth a million words in terms of memory. According to findings of a study published by the American Psychology Association (APA), the quality of visual representation with the use of colour is helpful for processing and storing visual information better than objects lacking colour, which leads to a comparatively better recall.

Farley and Grant had been one of the first few researchers who had demonstrated that colour may have an influence attention (1976). Their study on attention and cognition helped provide evidence and explain this. They had contrasted the effect of multimedia presentations in either colour or non-colour conditions on performance by memory. Results showed that better attention was caused by coloured multimedia presentation than the non-coloured ones. It was further explained that in comparison to cool colours like gray and brown, warm colours like red, orange and yellow had a greater impact on attention (Greene, Bell, and Boyer, 1983). Kaya and Epps said that colour triggers emotional sense and helps in remembering specific information (2004). Naturally, individuals frequently associate certain emotions with a specific colours, as an example, red is associated with emotions like danger, anxiousness and worry. This correlation helps people in focusing and paying attention to the information presented to them, which makes it more likely for them to remember it (Myers, 2006). This indicates that, colour can increase recall and also, be responsible for high levels of attention. Therefore, it can be concluded that colours tend to capture attention which results in better memory (Pan, 2009, 2010).

The research studies mentioned above suggested that memory retention is positively impacted by colour. However, there are some research studies which contradict these findings. McConnohie conducted a study using alphanumeric characters and presented it to participants in the form of a slideshow containing three colours for backgrounds: blue, green and white while the text was in black (1999). With an assumption that colour positively influences memory, participants' performance was expected to be similar in all three background conditions. However, it was found that higher retention rates in both the delayed and immediate recall tasks were a result of white backgrounds and not blue and green backgrounds. These findings contradicted the results of previously mentioned researches which reported that colour leads to better recall. Furthermore, a research was conducted on influence of web page text and background colour on memory (Hall and Hanna, 2004). For each website, they used four types of text and background colour combinations. Their findings suggested that there was a significant difference between the four conditions. Moreover, the readability performance had been the highest in the black and white conditions, according to post-hoc tests conducted. The results obtained for readability were significant however, those for retention rate were not.

Therefore, there have been researches which support the theory of colour leading to a higher recall and improvement in the memory retention. Contrarily, there have been studies which show that recall is higher in black and white conditions than other colours. The purpose of studying colour as a variable is to try and establish the possible ways to enhance memory for learning purposes.

## **METHODOLOGY**

### ***Aim:***

To test the effect of the colour of a word on its recall.

### ***Methodology:***

The method used to conduct the research was experimental. An experiment provides the researcher with a cause-and-effect relationship to draw out the conclusion whether the independent variable influences the dependent variable.

### ***Hypothesis:***

The null hypothesis states that there is no effect of colour on the recall of the words.

**Objective 1:** To determine the effect of family type on recall of words.

**Objective 2:** To check the relationship between age and recall of words.

**Objective 3:** To determine the most frequently and least frequently recalled word.

**Objective 4:** To check the effect of the colour of words presented on memory retention of the participants.

**Objective 5:** To determine the association between recall and gender

### ***Research Design:***

Independent measures design was used in the experiment. There were two groups- an experimental and control group. One individual was not part of more than one group which prevented testing effect in participants.

### ***Sample Characteristics:***

The sample consisted of 60 students, 30 participants in the control group and the other 30 participants in the experimental group. The participants were in the age group of 10-18 years as the conduction of the research was at school. Convenience sampling was used as it was easier and was more feasible for the researcher.

### ***Procedure:***

The procedure followed for data collection was experimentation as primary data was collected. The participants were asked to sign a letter of consent (Appendix A), ensuring them of their right to withdrawal, anonymity and confidentiality, prior to testing. The participants were then divided into two groups. After being given the standardized instructions (Appendix B), participants from Group 1(control group) were presented with a word list (Appendix C), all 20 words being in black colour. Participants from Group 2 (experimental group) were shown the same words (Appendix D) with 10 words in black ink and 10 words in red ink. Both groups were provided with 60 seconds to memorize the 20 words. The word list was then taken back and a response sheet (Appendix E) was provided to the participants to write down all words they could recall from the word list. The participants received 75 seconds for this recall task. The response sheets were collected and the participants were debriefed (Appendix F) about the experiment. For the analysis of the data, the response sheets were marked to see the number of words accurately recalled by participants, while also calculating the frequency of words being recalled by the participants. The data was tabulated and compared. Mann- Whitney U test was run on the data to derive statistical significance of the data and was then presented in tables and graphs.

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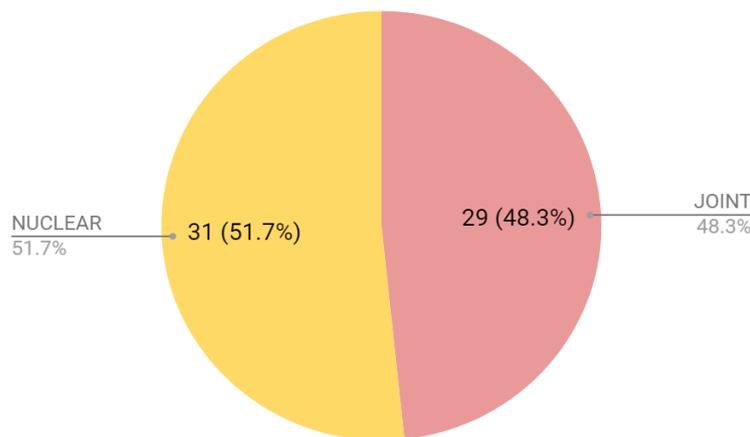
### *Ethical Guidelines:*

In order to ensure the safety of the participant, a number of ethical guidelines were taken into account. With reference to these ethical guidelines, care was taken that no participant was harmed physically, emotionally or mentally. All participants were provided with a letter of consent to sign to verify informed consent, ensuring that they had been a part of the experiment willingly and not by force. Participants were made aware of their right to withdraw so that, if at any point the participant was uncomfortable, they could willingly withdraw. All subjects were ensured about the anonymity and confidentiality of their data to make sure that the data could not be traced back to them and reveal their identity. In the debriefing session post-conduction of the research, participants were explained the aims and objectives of the study.

## **RESULTS**

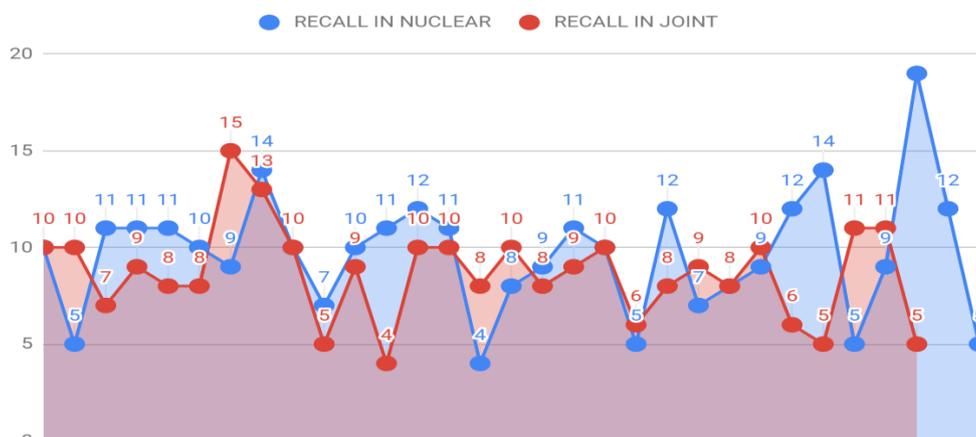
The research was conducted keeping in mind various objectives to be explored in relation to colour and memory.

**Objective 1:** To describe the socio-demographic details of the sample



*Figure 1. The family type of participants*

With reference to Figure 1, it is seen that 51.7% of the sample participants (31 subjects) belonged to a nuclear family, which is a household comprising of a pair of adults and their children ("NUCLEAR FAMILY | meaning in the Cambridge English Dictionary", 2019). The rest 48.3% belonged to a joint family, where the grandparents and first cousins live together.



*Figure 2. Scores of the participants belonging to different family types*

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With reference to Figure 2, we can see that recall by participants belonging to a nuclear family seems slightly higher than those from a joint family. To test the hypothesis if the family type of the participants influenced recall of the words, a Mann Whitney U test was conducted. The U-value was found to be 341.5 and the p-value was 0.05592. Therefore, the p-value was not significant at  $p < 0.5$  (Appendix G). This means that the hypothesis is rejected.

**Objective 2:** To check the influence of age on recall of the words

**Table 1 Recall Scores Based on Age**

|              | MEAN AGE | MODE OF THE AGE | NO. OF WORDS RECALLED |
|--------------|----------|-----------------|-----------------------|
| Control      | 15       | 14              | 9.6                   |
| Experimental | 15.3     | 14              | 8.8                   |

With reference to Table 1, it is seen that the mean of the age of participants is 15 years in both the conditions, also, the mode of the age of all participants in 14 years in both groups. Since, there seemed to be a difference between the number of words recalled, with the control group recalling greater number of words, the difference was tested for significance for which a t test was performed. Results of the independent means t test showed that the number of words recalled was significantly greater for the control group,  $p=0.002$ , significant at  $p<0.05$  (Appendix H).

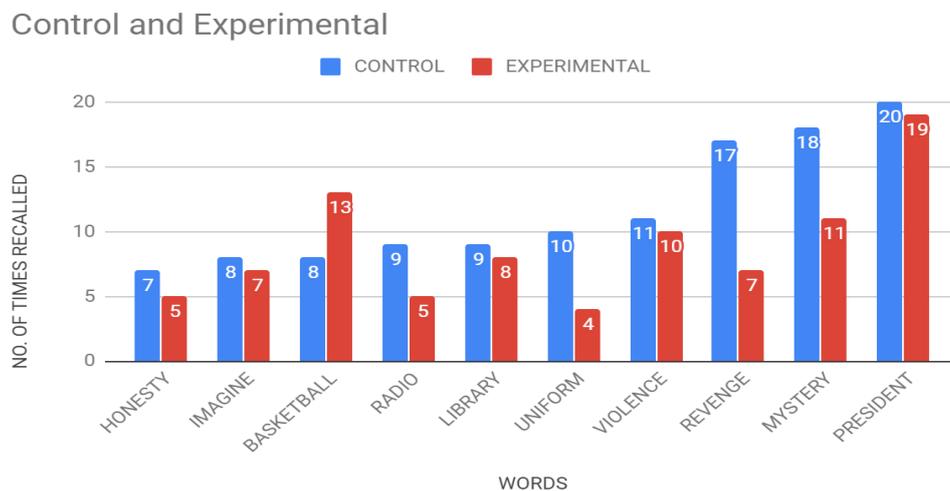
**Objective 3:** The most frequently and least frequently recalled word

**Table 2 The Most and Least Recalled Words**

| WORD      | TOTAL RECALL |
|-----------|--------------|
| Chocolate | 51           |
| Honesty   | 12           |

With reference to Table 2, the most frequently recalled word in the word list was ‘chocolate’, which was recalled by 51 out of 60 participants (85%). The least frequently recalled word is ‘honesty’, which was recalled by 12 out of 60 participants (20%).

**Objective 4:** To check the effect of colour on recall of the word



**Figure 3. Frequency of words recalled**

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With reference to Figure 3, it is seen that the recall of words by participants in the control group is more than the experimental group. This means that the words in black ink on a white background were remembered more.

**Table 3 Frequency of the Recall Words by Participants in Both Groups**

| WORDS                     | CONTROL | EXPERIMENTAL |
|---------------------------|---------|--------------|
| HONESTY                   | 7       | 5            |
| IMAGINE                   | 8       | 7            |
| BASKETBALL                | 8       | 13           |
| RADIO                     | 9       | 5            |
| LIBRARY                   | 9       | 8            |
| UNIFORM                   | 10      | 4            |
| VIOLENCE                  | 11      | 10           |
| REVENGE                   | 17      | 7            |
| MYSTERY                   | 18      | 11           |
| PRESIDENT                 | 20      | 19           |
| <b>TOTAL</b>              | 117     | 89           |
| <b>MEAN</b>               | 11.7    | 8.9          |
| <b>STANDARD DEVIATION</b> | 4.76    | 4.55         |

Table 3 shows the number of times the words were recalled by participants in both groups. For the control group, the words were black in colour and for the experimental group, they were red in colour. The mean of words recalled in the control group by the participants was  $11.7 \pm 4.76$ . The mean of words recalled by the participants in the experimental group was  $8.9 \pm 4.55$ . This shows that the average recall of the words was higher in the control group where the words were all in black.

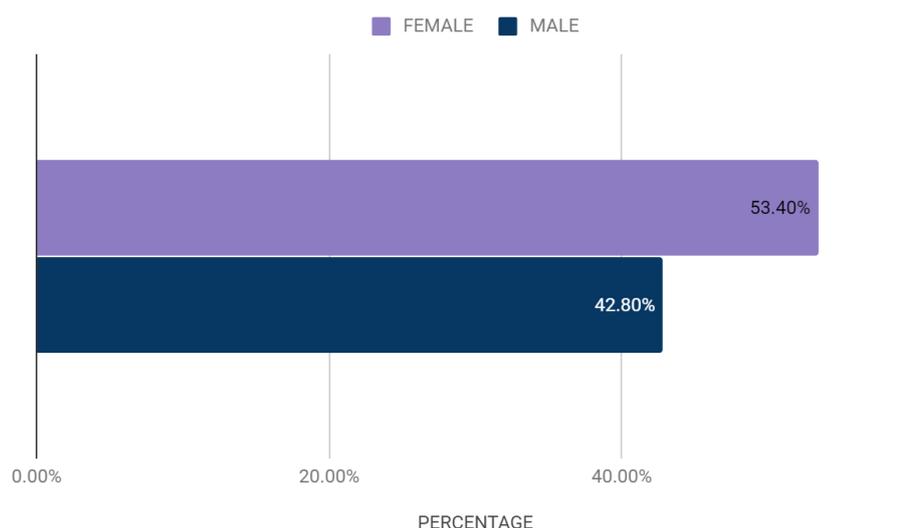
The Mann-Whitney U test was run on the data for further analysis of the data. The results of the test determined the value of U to be 31. The critical value of U at  $p < 0.5$  is 27. The p-value is 0.08076. Therefore, the result is not significant at  $p < 0.05$  (Appendix I). With reference to the results presented, the null hypothesis is accepted.

**Objective 5:** To compare recall between male and female participants

**Table 4 Percentage of Words Recalled Based on Gender**

| SEX    | NUMBER OF PARTICIPANTS | PERCENTAGE OF RECALL | MODE | MEAN $\pm$ STANDARD DEVIATION |
|--------|------------------------|----------------------|------|-------------------------------|
| Female | 19                     | 53.40%               | 17   | $10.15 \pm 8.89$              |
| Male   | 41                     | 42.80%               | 34   | $17.55 \pm 10.75$             |

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*Figure 4. Percentage of words recalled based on sex*

With reference to Table 5 and Figure 4, we can see that the percentage of words female participants recalled is 53.40% which is 10.60% more than the recall of males which is 42.80%. Since, there seemed to be a high difference between the recall of words by male and female participants, a Mann Whitney U test was conducted to check the presence of significant difference. The Mann-Whitney U test indicated that the number of words recalled was significantly greater for females than for males,  $U=81.5$ ,  $p=0.001$  (Appendix J).

## DISCUSSION

The sample consisted of 31 participants belonging to nuclear families and the rest 29 from joint families. To check if the family type influenced recall, a Mann Whitney U test was conducted. Mann Whitney U test is a non-parametric alternative test which is used to test independent samples and is used to compare the sample means coming from the same population. It is used when the requirements of the t-test are not met or the size of the independent samples are unequal. According to the test, the data was not significant. Therefore, it can be said that the family type did not influence the recall of words in the participants.

The findings suggest that the mean was 15 for the age of participants in the control condition and 15.3 for the experimental condition. As we can see, despite nearly all participants being in the similar age range, the mean of the number of words recalled was higher for the control condition where the words were presented in black ink with white background. However, in the experimental condition, it was lower, where the words were in red ink. By comparison, the control group was associated with numerically greater number of words recalled. To test this hypothesis that the control group was associated with a statistically significantly greater number of words recalled, an independent t test was performed. The results of the t test were significant at  $p<0.5$  with  $p$  value=0.002. There are researches which show that recall is better when tested with data presented in black and white (Hall and Hanna, 2004). The mode of the age of participants was 14 in both the conditions.

It was seen in Table 2, that the most frequently recalled word was 'chocolate' and the least frequently recalled one was 'honesty'. One possible explanation could be the familiarity of the word 'chocolate' to the participants. 'Chocolate' is also a word used more often than

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'honesty'. Secondly, the serial position effect could also provide us with an explanation for 'chocolate' being the most frequently recalled word (Glanzer and Cunitz, 1966). According to this theory, words presented at the beginning and the end are recalled better than the ones in the middle due to the primacy and recency effect. Words at the beginning of the list are rehearsed excessively and so, are shifted to the LTM, this is known as the primacy effect. Contrarily, the words at the end of the list are stored in the STM, so they can be recalled, this is the recency effect. The word 'honesty' was placed in the middle of the list which is why the number of times it was recalled is low because it was lost from the STM and never reached the LTM. Whereas, 'chocolate' was placed at the beginning and it was transferred to LTM and hence, was recalled more often.

The mean of the number of words recalled for the control group is  $11.7 \pm 4.76$  and for the experimental group, it is  $8.9 \pm 4.55$ . Due to the mean and SD both being higher for the control group, the recall of words seemed higher in the control group with all words in black ink. Since, according to the results of the Mann Whitney U test, the p-value was insignificant at  $p < 0.05$ , therefore, the alternative hypothesis was rejected and the null hypothesis was accepted. Findings suggested that the colour of the words had no effect on its recall by the participants.

The percentage recall of words by female participants was relatively higher than that of the male participants, therefore, it can be said that females had a higher recall of words than males. Despite the number of females in the sample being lesser than males, the number of words recalled was significantly greater for females,  $U=81.5$ ,  $p=0.001$ . The findings suggested that the data was significant, for which the research hypothesis was accepted. This indicates that memory retention in females is higher than in males.

Various researches have been conducted suggesting that females have higher memory retention than males. Research indicates that females consistently perform at higher levels than males in tasks involving episodic memory (Herlitz, Nilsson & Bäckman, 1997). Research also suggest females perform better on face recognition tasks in comparison to males (Christianson & Loftus, 1987). In 1976, Henson, Cannell and Lawson conducted a research in which they surveyed 300 Michigan residents known to be in a motor vehicle accident. When the responses were compared with official reports, the findings suggested that females reported more accurate data than males. With references to various researches, females displayed greater verbal memory than males (Lewin et al., 2001). However, there have been researches which contradict the findings stated previously. Males have been reported to perform at a higher level than females on the WAIS-R(S) subtest Information (Herlitz & Yonker, 2002). Research shows that male participants demonstrate greater spatial (Kaufman, 2007; Lejbak et al., 2011; Masters and Sanders, 1993; Nordvik and Amponsah, 1998), and object working memory (Lejbak et al., 2011) in comparison to female participants.

Through this research, memory and the factors influencing memory were studied. It was observed that the family type of the participant does not have an impact on the recall of words. Moreover, the colour of the word was not seen having an impact on the recall of the word. However, it was seen that the gender does have an effect on the recall of the words. The female participants had statistically significantly higher recall than the male participants.

### CONCLUSION

Through the previously discussed objectives, it was seen that the family type of the participants, colour in which the words were presented and the age range of the participants did not have an effect on the recall of words. However, the findings suggest that females have greater memory retention in comparison to males. In terms of real-life implications, it was seen through the findings that the serial position effect does impact recall. Therefore, learning the difficult things at the beginning or at the end rather than somewhere in the middle can be beneficial in terms of retention and retrieval (Glanzer and Cunitz, 1966). However, there was no significant difference between the recall of words in red ink and words in black ink, which shows that recall is not influenced by the colour in which data is presented. This contradicts the theory given by Farley and Grant who suggested that colour has an influence on recall (1976). Moreover, a highly significant difference was found between the number of words recalled by females and those recalled by males. Thus, it can be said that females have better short term or working memory (IJDR, Gabriel, 2016). The results can be applicable in real life as words learned at the beginning and at the end are recalled better, so this can be a strategy for students in learning purposes. The findings showed that females have better recall, however, the social limitations are taken into account. It is not necessarily true that the memory of all males is weaker in comparison to females.

However, one limitation of this research is that the sample was too small to be applicable to the target population of all students in the age range of 11-18. Moreover, the sample consisted of students studying in the same school, so the sample to population generalizability is low. The internal validity of the study was high as most of the extraneous variables were controlled. However, this leads to a low external validity due to unrealistic situation and controlled environment. One strength of our experiment was that, independent measures design was used, which meant that one individual could not be part of more than one group. This helped preventing testing effect in participants and also led to relatively higher external validity due to more participants being tested on. However, this design may also lead to greater participant variation which may have had an effect on the findings. Most of the ethical standards were met, however, factors like recall capacity of the participants could not be controlled. Moreover, students are often asked to recall information, and that could act as a variable for higher memorizing and recall capability.

A few modifications for replication of the study could be selecting a larger sample size consisting of students from various schools for a diverse sample. The participants could also be presented with more number of words to measure serial position effect, influence of colour on recall and gender differences in memory retention more accurately. Words with different number of syllables could also be used for the purpose of further research along with participants possibly be presented with data other than a word list which could help in testing different parts of the memory and may lead to possible discoveries of new cognitive processes.

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### **Conflict of Interest**

The author declared no conflict of interest.

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