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The Effect of Text Color and Text Grouping on Attention and Short Term Recall Memory

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Abstract

This study sought to discover whether there was a connection between the attentional draw of a word, as represented by text color and grouping, and the likelihood of it being transferred into short term recall memory. College students at Harding University in Searcy, Arkansas were given one of six timed memory test scenarios and asked to recreate the list to the best of their ability. The students were then asked to complete a series of posttest questions designed to measure their perception of their own performance on the test. The students were also asked to complete a demographics questionnaire that established a brief history of their current and previous scholastic behavior. The participants' performance on the memory test was then compared to the information from the posttest survey as well as the demographics questionnaire. I hypothesized that both text color and text grouping would positively influence short term recall memory so that a combination of the two would result in the most accurate recollection of the word list.

Keywords: short term memory, recall memory, attention, perception of color, grouping

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The Effect of Text Color and Text Grouping on Attention and Short Term Recall Memory

Memory has long been a topic of intense research and discussion among scientists of many specialties, but many questions still remain about the structures and pathways associated with memory. The transfer of information from working memory to long term memory is one such topic of current research. Working memory is unique in that the information housed there does not stay there long. (For the sake of this discussion, “short term memory” and “working memory” will be synonymous.) The information housed in short term memory generally stays encoded there for a matter of seconds before being transferred to long term memory or forgotten (Atkinson and Shiffrin, 1968, pp. 103). This transfer of information is especially important to learning and cognition (Baddeley, 2012, R39), and researchers are seeking to determine what characterizes the information chosen to be transferred into long term memory compared to what is forgotten. Recent research hypothesizes that the key characteristics that function in marking information for being encoded into long term memory is its attentional draw (Pan, 2010, pp. 127). For example, a student in class is not likely to remember what their professor was wearing two weeks ago, but they may be more likely to remember the professor suddenly shouting and waving their arms around to make a point. Something as mundane as clothing is less likely than something loud and unique, like the shouting, to be encoded into long term memory.

A more applicable example of attentional draw can be found in studies that examine grouping as a factor that contributes to the likelihood of information being encoded into long term memory. This train of thought comes largely from the works of George Miller, who famously came up with the theory often referred to as Miller’s Law. This theory suggests that the average adult’s immediate capacity for remembering information is limited to a span of thirty seconds, and therefore the brain must break information up into chunks; however, Miller also

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notes that there is a limit to the effectiveness of chunking, and it seems to cap somewhere around seven “chunks” (Miller, 1956, pp. 9). Miller notes that information that must be learned appears to be naturally broken up by the brain into chunks through a process called recoding, and that retention is increased when this technique is used (Miller, 1956, pp. 11). Thus, according to Miller, information that is presented in chunks of less than seven is more likely to be remembered than information that is presented in large blocks or within dense discourse. This comments both on the capacity of short term memory and the average human attentional capacity. Thus, “chunking” for the sake of efficient transference may be the result of the human brain’s natural tendency to notice small groups of information.

More recent studies delving into the phenomena of chunking involve the works of Baddeley (1975), Chen and Cowan (2005); and Gilbert, Boucher, and Jemel (2014). The 1975 Baddeley study examined memory by “exploring the hypothesis that the immediate memory span is not constant;” in other words, Baddeley manipulated word length, number of syllables and/or phonemes, and temporal duration to create a “phonetically-based store of limited temporal capacity” that functioned as a supplement to our basic understanding of working memory. This study found, among other things, that the average human memory span is “sensitive to word length” and that there is a “systematic relationship between articulation time and memory span” (Baddeley, 1975, pp. 586). Chen and Cowan (2005) did a similar study that created two-word chunk associations among participants to investigate “chunk capacity limits and length limits that come into play.” Their study found that “for the free recall of 12-word lists, 6 pre-learned pairs could be recalled about as well as 6 pre-exposed singletons, suggesting a chunk limit” (Chen and Cowan, 2005, pp. 1235). Finally, Gilbert et al. (2014) did an oral chunking study examining the recall of three or four word groups, which had similar results to the previous two: “the perceptual

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chunking of speech facilitates information buffering and processing on a chunk-by-chunk basis” (Gilbert et al., 2014, pp. 1). For the purposes of this research, these studies helped me to design the format of the spacing within three of my scenarios as well as the length of the words chosen for the word list. To this end, I chose a list of fifteen monosyllabic syllables that were formatted into two different grouping types: a straight block of fifteen words and five chunks of three words each. It was my intention to use this format to augment approximately half of my participant groups’ natural chunking tendency, as outlined by Miller and the aforementioned researchers, so that it could be compared to those who had to “self-chunk” within the blocked design.

Additional research has indicated that color differences may also play a role in the transference of information into long term memory. Certain environmental colors are perceived to have specific effects on mood and attention (Soldat and Sinclair, 1997), and therefore may have their own sway over memory retention if properly utilized (Mehta and Zhu, 2009). Several studies have been done on the effect of color on memory, such as a study by Bynum and Kaya (2006), which explored the effects of color on the memory of college students with a set of selection tasks; a study on the psychological effects of the color red by Andrew Elliot (2007), and a study by MacKay and Ahmetzanov (2004), which explored the relationship between emotion, memory, and attention by using a modified form of the Stroop test. Other studies, like the ones done by Charles Allen (1990) and Vernon and Lloyd-Jones (2003), experimentally investigate the relationship between colors and implicit versus explicit memory to determine how different colors affect how information is encoded. These studies, among others, have indicated potential for color to be an influencing factor in the transference of material to long term memory. However, the research on this subject is vast and complex, so there is not yet a clear

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picture of the exact effect that color could have on memory. For the purpose of this study, this literature led to the selection of my experimental colors: black (control), blue, and red. These colors were the most common selections in the related literature, and this is most likely because they are commonplace enough that they would not distract, but different enough to have an effect on attention.

Hypothesis

Given the breadth of the results in the related literature, this study is likely to result in a variety of relationships; however, it is my hypothesis that the results of this study will show an increased accuracy score on the short term recall memory test within the blue, grouped scenario. Furthermore, it is hypothesized that the poorest scored will be found within the black, single block scenario followed closely by the red, blocked scenario. Theoretically, the combination of attentional draw by the color of the font and the grouping of the list within the blue, grouped scenario will allow for a significant difference in recall. The scenarios that lack augmented chunking and different coloration should, if the studies above are to be believed, require more work with less attentional draw and will therefore have a lower recall score.

Method

Participants

The participants of this study were college students from the Harding University in Searcy Arkansas. These 117 participants were selected from a variety of classes across campus and represent a cross section of the student population. Of the participants who chose to answer the demographic questions, 59 were female and 57 were male. These respondents ranged in age from 18 years old to 55 years old, the most common age being 19 years old. Similarly, the most common classification within the sample was the sophomore classification, and the most

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common major was Psychology. 97 respondents indicated that they were right handed and 15 indicated that they were left handed. 63 respondents indicated they identified as introverted, and 46 indicated that they identified as extroverts.

Materials

The materials used for this survey can be divided into three sections: a memory test, a post-test survey, and a demographics survey. As stated previously, following a disclaimer and instructional page (see Appendix A) participants were given one of six timed memory test scenarios and asked to recreate the list to the best of their ability. The six scenarios are as follows: a black text, single block word list; a black text, grouped word list; a blue text, single block word list; a blue text, grouped word list; a red text, single block word list; and a red text, grouped word list (see Appendix B). The word list consisted of fifteen monosyllabic words which were chosen by example from the literature (Gilbert et al. 2014) and put into a random list generator to ensure their order had no subconscious order. A blank page was included after the memory test with a single line of instruction that read "please write down as many words as you can remember in the order that you remember them" for the participant to recall the word list. This memory test was designed to determine whether color and spacing had an effect on the number of words the participant could remember as well as the accuracy of the order in which they remembered them.

Following the memory test, the participants completed a series of posttest questions (see Appendix C) designed to measure their perception of their own performance on the test as well as a demographics questionnaire (see Appendix D). These questionnaires were all done in black ink, and included explicit instructions. These forms, including the six scenarios, are included in the appendices as they appeared in the surveys.

Procedure

Each survey was given with the same set of instructions, the same time allowance, and the same random distribution of test materials. The instructions are included in the appendices, and were read aloud as they appear on the page before handing out the survey. A disclaimer was added to the cover page to ensure each participant knew that their participation was entirely voluntary and that their responses would be kept confidential. Each iteration of the survey data collection had exactly one minute to read through the word list and memorize it as best they could. The participants then had exactly one minute to recreate the list as they remember it. A stopwatch was used to ensure that the timing was the same for each section.

At the end of the 60 seconds allowed for the recall portion of the test, the participants were verbally instructed to continue to the questionnaire portion of the survey, regardless of whether they were finished recalling the word list. The participants were then given as much time as they needed to complete the post-test questionnaire and the demographics questionnaire. The post-test questionnaire asked the respondent to rate the memory exercise they had just completed on a variety of qualifying statements. A 6-point Likert scale was used for these questions, and the scale used appeared as included in Appendix C. The demographics questionnaire asked a variety of questions about the participant's personal identifiers including – but not limited to - gender, age, major, handedness, and perceived personality type.

Results

For the analysis of this study, two separate two-way analysis of variances (ANOVAs) were conducted. These tests were run using an alpha level of $p = .05$. The first two-way ANOVA analyzed the relationship between scenario color and spacing and the participant's ability to

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correctly recall words from the given scenario list. The second two-way ANOVA analyzed the relationship between scenario color and spacing and the participant's ability to recall words from the given scenario list in the order they were presented. When determining the relationship between scenario color and spacing and the respondent's ability to recall individual words, no significance was found as $F(2, 116) = .274, p = .761$ (see Table 1). There was also no significance found when determining the relationship between scenario color and spacing and the participant's ability to recall the order of the given word list, as $F(2, 116) = .416, p = .661$ (see Table 3). These findings indicate that the color and spacing of the scenario word list did not affect the ability of the participants to recall the given words correctly, nor did it affect their ability to recall those words in the correct order.

However, it should be noted that for scenarios involving the colors red and blue, the most common score for word recall is 15 out of 15 and the most common score for correct order is also 15 out of 15. These indicate that the most common scores for correctly identifying words in the correct order is a perfect score for the red and blue scenarios. This trend does not apply for scenarios with black ink. The most common scores for these scenarios were a 14 for correct word recall and a 6 – which is less than 50% correct – for correct word order. Additionally, for scenarios with the single blocked spacing design, the most common score for correct word recall was a 14 and the most common score for correct word order was an 8. The statistics for 5x3 grouped spacing were 12 for correct word recall and 6 for correct word order.

Discussion

At the start of this study, I hypothesized that the results would show an increased accuracy score on the short term recall memory test within the blue, grouped scenario and that the poorest score would be found within the black, single block scenario. After analyzing the

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surveys from my sample of 117 participants, I determined that my hypothesis was incorrect. Neither of my two-way ANOVAs established any significant relationship between scenario color and spacing and the accuracy of a participant's short term recall memory. However, upon comparing the frequencies of correct word recall and correct word order, both indicated a higher likelihood of achieving a perfect recall score within the colored and grouped scenarios. This suggests the presence of a ceiling effect. A ceiling effect within the memory test indicates that the scenario word list was easier to remember than implied in the related literature. I found this phenomenon to be extremely interesting because it suggests that the effect of the scenario color and/or spacing may have an effect, but that it could not be measured by this particular test. A ceiling effect could easily be remedied in future research by increasing the word list to 25 words rather than 15 words.

Aside from the noted ceiling effect, my initial hypothesis could have been incorrect for a number of other reasons, the most prominent of which being my small sample size. A larger sample size would introduce more scores across all six scenarios and could produce a more defined trend; furthermore, judging by the ceiling effect, choosing my participants from a private university like Harding may have inadvertently skewed the data. Because Harding is a private, Christian university, the student body is exponentially more like-minded than a non-private universities would be. Students on Harding's campus have more points of contact with one another, and may therefore exhibit a similar approach to new material. A national sample size or a sample pool pulled from a more integrated campus would increase the variability of the participants and therefore better represent the broad category of the average American. If this survey were to be done across states, age groups, and environments, it may be possible that significance could emerge. Additionally, the structure of my study made it difficult to isolate

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specific interactions between variables. Alterations to the scenario layout and more explicit instructions may cut down on these complications, increasing the chances of finding a significant relationship.

Another consideration is that this study only sought to test short term recall memory, or working memory. The participants were given enough time to read, recognize, and potentially rehearse – to a minimal degree – the list before being asked to recall it. Thus, this study has no application to the effect of color and/or spacing on long term memory, or even on long term attentional significance. Further research may attempt to find a connection between increased recall and the devised scenarios within long term memory. Additionally, those with access to brain imaging technology may find it prudent to research whether font color has any effect on activity within the brain's attentional centers that correlate with increased recall within long term memory.

On a related note, my study diverged from the related literature and therefore introduces an interesting comparison: the studies in the related literature, like the 2014 study done by Gilbert on which I based my scenario word list, showed significance among the effect of color on short term recall memory when those words were recalled *orally*. My study had participants recall words *mechanically* on paper. It is possible that the mechanism being shown in the work of the related literature is limited to the pathways of verbal and auditory stimuli rather than written stimuli. This poses an interesting dilemma for educators who may frequently make use of colorful fonts, but have a curriculum based largely in written work. If further research indicates it holds no significance to recall memory, then school districts may be able to cut costs by employing more effective techniques.

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To conclude, this study has only scratched the surface of an extensive network of pathways and procedure that construct memory. While significant results would have been satisfying and ultimately promising for those seeking to “hack” their brain into better remembering things, failing to accept a hypothesis serves to illuminate the brain’s immense ability to take in a variety of stimuli and process each mode differently. My results could indicate another mechanism at work within the brain’s written word comprehension centers - or even within the brain’s fine motor systems - that differ from those present within the visual association and auditory centers. Similarly, they could also indicate an underlying preference for oral recall as opposed to mechanical recall; this could have serious implications for public and private schools, as most are entirely centered around a system of mechanical recall. It is also equally likely that a reproduction of this research design on a larger scale could produce significant results, thereby solidifying previous research on the effect of color and spacing on short term recall. Either way, these implications warrant further research to address these inconsistencies.

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Table 1

ANOVA Summary: Scenario Color and Spacing by Word Recall

Dependent variable: Number of words correctly recalled from given scenario word list.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Between Groups	21.548 ^a	5	4.310	.577	.717	.025
Scenario Color	12.727	2	6.364	.852	.429	.015
Scenario Spacing	5.678	1	5.678	.760	.385	.007
Scenario Color * Scenario Spacing	4.092	2	2.046	.274	.761	.005
Error	828.759	111	7.466			
Total	850.308	116				

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Table 2

Table of Means: Effect of Scenario Color and Spacing on Participant Ability to Recall Words from Scenario Word List

		Color			
		Red Ink	Blue Ink	Black Ink	
Spacing	Single Block Spacing	M = 11.76 SD = 2.914 n = 21	M = 11.52 SD = 3.669 n = 21	M = 11.89 SD = 2.105 n = 19	M = 11.72 SD = 2.945 n = 61
	5x3 Grouped Spacing	M = 12.53 SD = 2.458 n = 19	M = 11.45 SD = 2.874 n = 20	M = 12.53 SD = 1.663 n = 17	M = 12.14 SD = 2.430 n = 56
	Total	M = 12.13 SD = 2.7 n = 40	M = 11.49 SD = 3.264 n = 41	M = 12.19 SD = 1.910 n = 36	M = 11.92 SD = 2.707 n = 117

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Table 3

ANOVA Summary: Scenario Color and Spacing by Recall Order

Dependent Variable: The score of the participant's ability to recall the order of the words correctly; missing words counted wrong.

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Between Groups	79.150	5	15.830	.670	.647	.029
Scenario Color	17.843	2	8.922	.378	.686	.007
Scenario Spacing	42.540	1	42.540	1.800	.182	.016
Scenario Color * Scenario Spacing	19.638	2	9.819	.416	.661	.007
Error	2622.970	111	23.630			
Total	2702.120	116				

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Table 4

Table of Means: Effect of Scenario Color and Spacing on Participant Ability to Recall

Scenario Word List in Order

		Color			
		Red Ink	Blue Ink	Black Ink	
Spacing	Single Blocked Spacing	M = 8.10 SD = 5.485 n = 21	M = 9.10 SD = 5.205 n = 21	M = 7.16 SD = 4.413 n = 19	M = 8.15 SD = 5.053 n = 61
	5x3 Grouped Spacing	M = 9.11 SD = 5.269 n = 19	M = 9.40 SD = 4.614 n = 20	M = 9.47 SD = 4.474 n = 17	M = 9.32 SD = 4.533 n = 36
	Total	M = 8.58 SD = 5.339 n = 40	M = 9.24 SD = 4.614 n = 41	M = 8.25 SD = 4.532 n = 36	M = 8.71 SD = 4.826 n = 117

Appendix A

Disclaimer

Your participation in this experiment is not required, but your participation is greatly appreciated. You may decide at any time not to participate. Your answers will be kept confidential regardless of your amount of participation. If you do not intend to participate, please wait quietly until those around you are finished. Please do not put your name anywhere on this form, and please try to answer every question to the best of your ability. Thank you.

DO NOT TURN THE PAGE UNTIL ASKED TO DO SO.

Instructions

The following activity is an exercise designed to test your memory. After the memory test, there will be a brief questionnaire asking about your experience with the test. This follow-up section will not be timed.

Please do not turn the page until asked to do so.

Once you have been asked to turn the page, you will be given 60 seconds to look at the words and memorize as many as possible. When the 60 seconds are over, you will be asked to turn the page and write down as many words as you can in the order you remember them.

Write down as many as you can remember, but do not worry if you are missing some.

You will have 60 seconds to do this.

Please do not communicate with those around you or use any sort of electronic device for the duration of this brief test.

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Appendix B

Scenario A

terse

glove

yell

the

blunt

box

clear

dog

trek

or

sneeze

and

zip

kind

school

Scenario B

terse

glove

yell

the

blunt

box

clear

dog

trek

or

sneeze

and

zip

kind

school

EFFECT OF COLOR AND GROUPING ON RECALL

Scenario C

terse

glove

yell

the

blunt

box

clear

dog

trek

or

sneeze

and

zip

kind

school

Scenario D

terse

glove

yell

the

blunt

box

clear

dog

trek

or

sneeze

and

zip

kind

school

EFFECT OF COLOR AND GROUPING ON RECALL

Scenario E

terse

glove

yell

the

blunt

box

clear

dog

trek

or

sneeze

and

zip

kind

school

EFFECT OF COLOR AND GROUPING ON RECALL

Scenario F

terse

glove

yell

the

blunt

box

clear

dog

trek

or

sneeze

and

zip

kind

school

Appendix C

Post Memory Test Questionnaire

1. Did you use any memory techniques to help you remember the words (e.g. word plays, pneumonic devices, writing them down, etc)?

1. Yes

i. Briefly describe

it: _____

2. No

2. Were there any words you did not understand on the test?

1. Yes

i. Which one(s)?

2. No

3. Did you use the full 60 seconds to look at the list on words?

1. Yes

2. No

Rate the following statements on a scale of **1-6**.

1. Strongly Disagree 2. Disagree 3. Slightly Disagree 4. Slightly Agree

5. Agree 6. Strongly Agree

4. I think that I did poorly on the memory test.

1

2

3

4

5

6

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5. I think that I have a good memory.

1 2 3 4 5 6

6. I do not often forget dates or times.

1 2 3 4 5 6

7. I have little to no difficulty remembering diagrams from my textbooks.

1 2 3 4 5 6

8. I have difficulty remembering details I read in my textbook.

1 2 3 4 5 6

9. I highlight as I read.

1 2 3 4 5 6

10. I generally do better on essay tests.

1 2 3 4 5 6

11. I generally do better on multiple choice tests.

1 2 3 4 5 6

12. I generally do better on true-false tests.

1 2 3 4 5 6

13. I must read things several times in order to adequately remember them.

1 2 3 4 5 6

14. I get anxious when I am required to remember something for a class.

1 2 3 4 5 6

15. I experienced significant stress during the memory test.

1 2 3 4 5 6

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16. I think I had enough time to perform well on the memory test.

1 2 3 4 5 6

17. The words on the memory test were easy for me to remember.

1 2 3 4 5 6

18. The font color of the memory test made it hard to remember the words.

1 2 3 4 5 6

19. The spacing of the memory test made it hard for me to remember the words.

1 2 3 4 5 6

20. I found it very difficult to remember the words in order.

1 2 3 4 5 6

Appendix D

Personal Demographic Questionnaire

This questionnaire is completely anonymous. Please circle or fill in the answer that you feel most closely represents you and/or your views.

1. What is your gender?
 1. Male
 2. Female
2. How old are you? _____
3. What is your classification?
 1. Freshman
 2. Sophomore
 3. Junior
 4. Senior
 5. Other
4. What is your current GPA? _____
5. What was your high school GPA? _____
6. Select your major, or the option that most closely describes it. Select two if you are double majoring.
 1. Bible & Ministry
 2. Biology, Chemistry, or Biochemistry
 3. Business
 4. Cognitive Neuroscience
 5. Communication or Linguistics

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6. Computer Science
 7. Criminal Justice
 8. Education
 9. Engineering, Physics, or Mathematics
 10. English
 11. Exercise Science or Kinesiology
 12. History
 13. Music
 14. Nursing or Pre-Professional Health
 15. Psychology
 16. Social Work
 17. Undecided
 18. Other: _____
7. How many hours a week do you spend studying? _____
8. Do you plan on going to graduate school?
1. Yes
 2. No
9. On average, how many hours of sleep do you get per night? _____
10. On average, how many naps do you take per week? _____
11. How many caffeinated beverages would you say you drink per day? _____
1. Which of these beverages do you drink most often? _____

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12. Which hand is your dominant hand? (This is most often the hand you write with.)

1. I am right-handed.

2. I am left-handed.

13. Do you consider yourself to be introverted or extroverted?

1. Introverted

2. Extroverted