

The Effect of Color on Text Memory in

Relation to Learning Style

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Project for Distinction

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Abstract

Evidence has shown that pictures, and more importantly color pictures play a large role in recall (Spence, Wong, Rusan, & Rastegar, 2006). The present research compared memory for textual information when that information was presented alone (text only), supplemented with a black and white picture, or supplemented with a color image My research found that when color images are combined with textual information was an increase in recall over the same images in black and white. The secondary goal of my research was to see if there is a relation between the subjects' learning style (visual or verbal) and recall. I found that verbal learners had an increase

in recall for the text only information and that visual learners had an increase in recall for text information supplemented with color images.

The Effect of Color on Text Memory in Relation to Learning Style

When learning new and remembering old information, two major ways of communicating this information to students is through textual information and visual aids (pictures). Much research has shown that combining the two formats has had a positive effect on students learning. In Mayers and Gallini's (1990), study found that when textual information for the steps for creating mechanical devices, such as a pumps is combined with a picture showing the steps of how the pump works, there is a drastic increase in recall of how create a pump. Prior research has focused primarily on the effects of pictures in black and white on memory. The proposed research is based on the addition of color picture over one in black and white. By adding color images this should cause an increased effect on memory, making the picture worth a million words.

A related factor to be explored in this research is learning style. Those who have better strengths in visual learning may benefit more from the picture. This may allow participants to recall more information when given a text plus a complementing image than when given the text alone. In Kirby and Moore's (1988) study, they found that visual learners approach a task with mostly visual strategies and verbal learners use verbal strategies. This concept will be further explained in this research because it showed that those who are better visual learners are able to gather more information from the pictures complementing the text than those who are verbal learners.

Likewise, those who are verbal learners may benefit more from the text than those who are not verbal learners.

Text Comprehension

One of the first key components in learning and memory is the ability to comprehend information presented in text. In Verhoeven and Perfetti's (2008) research stated that in order to comprehend text a person must be able to identify words, and then people must process the words, turning them into a linguistic representation. In order to fully comprehend the text at hand the researchers state that must also rely on prior knowledge not just the text they have just read. Verhoeven and Perfetti state this is due to the fact that text is not completely explicit and some parts are missing and need to be filled in. Verhoeven and Perfetti's research goes along with the information

that having prior knowledge or the perspective of the reader aids in the comprehension, thus allowing for an increase in overall recall. The results of Kaainen and Hyona supports that prior research showing that in order to gain valid results the text and picture combination will have to be one that is not very recent allowing for none of the participants to have knowledge of the topic. This will put the participants all on an even sca

white images were more accurately recalled than words, but there was no difference between color and black and white.

Anglin and Levie's (1985) results go along with Paivio, Rogers, and Smythe's (1986) study that found that there is no difference between solid color pictures and basic black and white drawings. The main problem is that in Anglin and Levie's study was that they had an eight week delay for participants. Participants may only be guessing if they had seen the image, not that black and white is better recalled. Anglin and Levie's research contradicts the hypothesis that was given in the present research, because it only looks at half the equation. The current research looked to see if there is a significant benefit of having color images in combination with text.

Picture and Text Combinations

As shown earlier in the research by Ratner & McCarthy, (1992) and Leong, Tse, and Loh, (2008) there are many positive benefits of pictures and strong text comprehension. Recent studies have taken this a step further and combine the two. One study done by Garry, Strange, Bernstein, and Kinzett (2007) studied whether photographs can cause false memories of what really happened in the newspaper stories. Garry et al.'s study asked participants to play the role of a newspaper editor and correct three past newspaper articles, one of benefits of red wine, one on a hurricane, and one on O! Magazine. The researchers removed the pictures and asked the participants to place a box where they thought was a good place for a picture. Garry et al. research was concerned with the hurricane article, the other two were only included as filler stories. The researchers deployed a 48 hour delay before they administered session two. Garry et al. then administered during session two a memory test to participants to see whether they thought sentences presented on the test were mentioned the previously read articles. Their 30 question test consisted of nine old (ones that were directly from the articles), nine new (ones that are on topics unrelated), and twelve lure sentences. Lure sentences were sentences that were in the previous articles but the main points were changed. One example of the main point being changed was "Beer contains vitamin B6, which research suggests that may be effective in fighting some kinds of tumors"; here the researchers change the main word wine into beer. Garry et al.'s goal was for the participant to remember the sentence in its entirety and after identifying it they then had to decide how sure they were. The researchers

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Research done by Verdi and Kulhavy (2002), looked at the effects of textual information in combination with images of maps. The researchers found that this combination of text and map allows for students to make cross connections of information, allowing for more information to

steps of how to build a pump, and lastly one with text and pictures with parts and steps. Afterwards participants were asked to take a recall test having them write down as much as they could remember about pumps as if writing for an encyclopedia for beginners in the subject. The second part was a problem-solving test containing five questions. For example: Why do brakes get hot? Mayer and Gallini found explanative pictures significantly improved creative problem solving and explanative textual recall. Mayer and Gallini drew three interesting conclusions. First, the text must be appropriate to the instruction goal, Mayer and Gallini mean between narrative and descriptive text. The second is the test must fit what you had the participants read. Lastly the picture must fit with the institution goal of the text. These findings by, Mayer and Gallini helped the current research by giving a clear indication of the way the text and picture combinations should be set up to maximize the effect that they will have on the participants. A similar study done by Hegarty and Just (1993) found similar results. Hegarty and Just presented subjects with pictures of pumps, text about pumps, or pictures and text about pumps. They found that those who had no mechanical ability of the task to assemble a pump were able to learn when they received the combination of the picture and text. When participants had this combination they outperformed those with a high mechanical ability. Hegarty and Just suggest these finding is because the participants use the picture as an external memory aid. This allows participants to store more information about the workings of the mechanism and allows for the information to be mapped out spatially.

Visual versus Verbal Learners

What is the distinction between verbal and visual learners? Capuano, Gaeta, Micaelli and Sangineto's (2004) study gives a good indication of what these are. Those who use and

preference, and 12 for dream vividness. Dream vividness was included in the Richard VVQ (1977), and was included now to look at imagery in participants who are visual learners. Kirby, Moore, and Schofield's modified questionnaire proved valid but they wanted to make sure that it truly tapped into learning style.

learning and memory are most important for students. The average age of participants was 19.32 years ($SD = 1.44$). A total of 56 participants (11 male, 45 female) were tested; I had to drop 4 participants because they did not fall into either learning style category, resulting in a final sample size of 52.

Materials

Visual-Verbal Questionnaire (VVQ; Kirby, Moore, & Schofield, (1988). This questionnaire was used to assess the participants' learning style, whether it was visual or verbal. The VVQ consists of 36 questions (12 verbal, 12 visual, 12 dream vividness). The results were tallied for each category and the category with the highest total was the preference of the participant. This assessment has shown to be reliable because of the research conducted by Kirby et. al. See Appendix A for a complete copy of the assessment.

Text Comprehension Task (Sooy 2008a). This task consisted of two articles. The articles contained four pictures in color and four in black and white. At the end of the article there were two questions to make sure that participants were not experts in the category or had prior knowledge of the topic. One of the articles is a hurricane article from Garry, Stange, Bernstein, and Skinzett's (2007) study. See Appendix B for a complete copy of this article. The other article is a global warming article from Time Magazine, Schmid, (2008). See appendix C for a complete copy of the article.

Memory Assessment (Sooy 2008b). This assessment was used to determine the over recall of information presented in the two articles. Questions were related to information provided only in text, in text with a supplementary black and white picture, and in text with a supplementary color picture. The Memory Assessment consisted of ten questions for each article, as well as four distracter questions for each article to make sure that participants were unable to figure out the true nature of the assessment. Scoring for the assessment were based on the total number of correct number of responses out of the total number possible for each question type. A pilot study was conducted showing the test as reliable and valid. See appendix D for a complete copy.

Procedure

In order to participate in this study, participants were required to fill out and sign a consent form indicating that they are willing to complete the two part study. At this point any general questions about the consent form and the participant's rights were answered. There were three different versions of the two news articles to prevent bias from the easier questions. This also allowed for participants to be tested in groups. Next participants completed a general demographics questionnaire to obtain basic information about each individual.

Participants then completed the reading comprehension task. Complete counterbalancing was used to randomize the order in which subjects read the articles. In order to eliminate any participants who had any expert prior knowledge about these topics there were two general knowledge questions about each article. Participants who did very well on these

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study and explain why any deception was needed. This was followed by a question and answer period to explain anything unclear to the participants. Then participants were thanked for their time and allowed to leave.

Results

Scoring

Coding for the memory assessment was determined by totaling the correct answers. Each participant had a total of eight possible questions in each condition (color, black and white, and text). In the analysis of the data participants received a score for each condition based on the number of items answered correctly.

Coding for the learning style assessment was done by awarding participants one positive point for each verbal response and one negative point for each visual response. The assessment contained 10 questions for visual, 10 for verbal, and 10 for dream vividness responses. The purpose of dream vividness was to act as a filler and was not used in the assessment of learning style. The participants' learning styles were calculated by adding up their points. If they had a positive score they were categorized as verbal and if they had a negative score they were categorized as visual.

Analysis

I was interested in determining if the type of image (black and white versus color) seen in context with the news articles makes a difference in the accuracy of recall for the corresponding text depending on the type of learning style of participants. First, I looked at the mean memory scores of each article condition (color, black and white, and text alone) and found that there were significant differences which will be discussed below. The mean of the color condition was higher ($M = 5.95$) than that of the black and white condition ($M = 4.40$) or the text condition ($M = 4.67$). To see a complete list of all the means and standard deviations see Table 1.

I conducted a 3x2 factorial ANOVA to examine differences in memory performance. The first independent variable was condition and it contained three levels: color, black and white, and text (within groups). The other independent variable was learning style which was a between groups variable containing two levels, visual and verbal. To determine if there was an overall difference in the three conditions (color, black and white, and text) I looked at the main effect. The main effect for condition was significant, $F(2, 86) = 20.59, p < .001, h^2_p = .32$. This means that there was a difference between the three conditions in performance on the memory assessment. The partial eta squared shows that there was a large effect size indicating that the three groups differed considerably in performance. To see a visual representation of the main effect between conditions see Figure 1. To follow up the significant main effect,

those who were verbal learners relied on the text greatly because they were able to answer more text questions right than visual learners. This means that though color images are important for memory that having text incorporated with color pictures would be the best combination, allowing for both types of students to get the most information out of the class.

With all the success of the study I did however find some limitations with the current study. There were only a few male participants, I would wonder what the results would show if there was a more even split between genders.

I do, however, recommend the more extensive research be done in this field. The difference in memory of visual and verbal information is key to the educational field. The current research did show some promising results but this is only the beginning. One area of research that could be studied further is when do participants get the benefits of color images. This would be looking to see if the same benefit existed when the color images are inverted. Inverted color means that for example a stop sign that should be red is instead blue.

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___The old saying “A picture is worth a thousand words” is certainly true for me.

___I have always disliked jigsaw puzzles.

___I find maps helpful in finding my way around a new city.

___My dreams are sometimes so vivid I feel as though I actually experience the scene.

___My powers of imagination are higher than average.

___I seldom dream.

___I seldom fantasize.

___I seldom use diagrams to explain things.

___I enjoy daydreaming.

___I often dream about things I’d like to be.

___I spend little time attempting to increase my vocabulary.

___I can hardly ever remember my dreams.

Appendix B

Report Says Arctic Temperatures at Record Highs

(WASHINGTON) — Autumn temperatures in the Arctic are at record levels, the Arctic Ocean is getting warmer and less salty as sea ice melts, and reindeer herds appear to be increasing while the polar bear population is decreasing, researchers reported Thursday. "Obviously, the planet is interconnected, so what happens in the Arctic does matter" to the rest of the world, Jackie Richter-Menge of the Cold Regions Research and Engineering Laboratory in Hanover, N.H., said in releasing the third annual Arctic Report Card. The report, compiled by 46 scientists from 10 countries, looks at a variety of conditions in the Arctic. The shocking report generated by these scientists shows that each year huge chunks of ice fall off the arctic ice shelf.

The region has long been expected to be among the first areas to show impacts from global warming, which the Intergovernmental Panel on Climate Change says is largely a result of human activities adding carbon dioxide and other gases to the atmosphere.

"Changes in the Arctic show a domino effect from multiple causes more clearly than in other regions," said James Overland, an oceanographer at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory in Seattle. "It's a sensitive system and often reflects changes in relatively fast and dramatic ways."

For example, autumn air temperatures in the Arctic are at a record 9 degrees Fahrenheit (5 Celsius) above normal.

The report noted that 2007 was the warmest year on record in the Arctic, leading to a record loss of sea ice. This year's sea ice melt was second only to 2007.

Rising temperatures help melt the ice, this in turn allows more solar heating of the ocean. That warming of the air and ocean affects land and marine life, and reduces the amount of winter sea ice that lasts into the following summer. The study also noted a warming trend on Arctic land and an increase in greenness as shrubs move north into areas that were formerly permafrost. Another issue is that many mountain tops that were covered in ice now are bare.

While the warming continues, the rate of warming in this century is less than in the 1990s due to natural variability, the researchers said. In addition to global warming there are natural cycles of warming and cooling, and a warm cycle in the 1990s added to the temperature rise. Now with a cooler cycle in some areas the rise in temperatures has slowed, but Overland said he expects that it will speed up again when the next natural warming cycle comes around. Asked if an increase in radiation from the sun was having an effect on the Earth's climate, Jason Box of the Byrd Polar Research Center in Columbus, Ohio, said while it's important, increased solar output only accounts for about 17 percent of global warming. "You can't use solar output to say that greenhouse gases are not a major factor," Overland added.

Other findings from the report include: The Arctic Ocean continued to warm and freshen due to ice melt. This was accompanied by an "unprecedented" rate of sea level rise of nearly 0.1 inch per year. Warming has continued around Greenland in 2007 resulting in a record amount of ice melt. The Greenland ice sheet lost 24 cubic miles of ice, making it the largest single contributor to global sea level rise.

Goose populations are increasing as they expand their range within the Arctic. Data on marine mammals is limited but they seem to have mixed trends. They are adapted to life in a region that is at least seasonally ice-covered. There is concern about the small numbers of polar bears in some regions, the status of many walrus groups is unknown, some whales are increasing and others declining. This according to the National Oceanic and Atmospheric Administration is because many species are land and sea based.

"This is a very complicated ecosystem and we are still working diligently to sort out its mysteries," said Richter-Menge.

CD NEWS NETWORK

Category 5 Hurricane Kenna slams into Mexico TEPIC, Mexico (October 25, 2002)

The most powerful hurricane in decades crashed into Mexico's Pacific coast on Friday, destroying houses and ripping roads in fishing towns while burying hotel swimming pools under seawater in the resort of Puerto Vallarta.

Officials evacuated more than 20,000 people from coastal areas before Hurricane Kenna hit land about 40 miles (65 kilometers) northwest of Tepic with winds of 140 mph (225 kph).

Waves thundered over the coastal boulevard of Puerto Vallarta, 60 miles (100 kilometers) to the southwest, and swept over hotel swimming pools. Power was out to much of the city. The brunt of the hurricane hit Nayarit state, where Gov. Antonio Echeverria met aides by the light of a battery-powered fluorescent lamp to monitor the crisis. Power was knocked out in parts of the state capital of Tepic, a city of 250,000 people, and officials cut the rest due to danger from downed power lines.

"We are worried because never before in the history of the state have we had a phenomenon of this magnitude," Echeverria said, flinching as a metal window guard banged against the glass.

In Puerto Vallarta, Mayor Pedro Ruiz said at least 42 people were treated for injuries and 2,000 others had been evacuated to shelters – which ranged from humble schools to the meeting rooms of luxury hotels. Trees and power lines littered the streets of Tepic leaving many businesses destroyed. Some falling branches smashed into cars. Most of the homes in San Blas were destroyed or badly damaged and fishing boats were toppled at their docks.

Power was knocked out to a wide region and roads were slashed. Estimates of the storm surge were somewhere between 10 to 15 feet above normal.

About 3,000 evacuees, most from San Blas, gathered at a Tepic high school whose classrooms were crowded with children sleeping on blankets. "You can replace things, but not life," said Alicia Ortiz, 46, who brought her two sons to the shelter. Her husband stayed behind in San Blas to protect the ice factory where he works. Nayarit Civil Defense Director Jose Heriberto Betancourt said 20,000 people were evacuated from coastal areas of his state. Neighboring Jalisco and Sinaloa states reported thousands more evacuated there.

Red Cross officials said the coastal highway from Tepic to Mazatlan -- a key section on the road from Mexico City to the Arizona border -- was washed out, blocking ambulances.

Some drivers were trapped by trees on the highway from Tepic to San Blas. Local television reports said hundreds of houses in San Blas had been damaged or destroyed.

The U.S. National Hurricane Center in Miami said the hurricane hit land near the fishing and tourist town of Tepic. Sustained winds -- which had reached 160 mph (260 kph) on Thursday -- dropped to 140 mph (225 kph) before the storm hit the coast, then slipped further to 80 mph (130 kph) as the storm raced into north-central Mexico in the direction of Texas at 24 mph (39 kph).

A spokeswoman for the city emergency department said at least 15 hotels, 22 restaurants, 48 clothing shops, 12 houses and seven shopping-office complexes had been damaged. On Saturday, troops, residents and business owners cleared chunks of wood, scraps of twisted metal and tons and tons of sand from the streets and parking lots. Backhoes and dump trucks rumbled through seafront streets usually crowded with suntanned residents. Hazel Burns, a 26-year-old student from Southampton, England, said she and friends had tried to leave the resort early Friday, but their bus was forced back by a fallen tree blocking the road. Back in town, they took a taxi through flooded streets, past floating cars and fleeing seaside residents.

"I don't think I've ever been so scared in my entire life. All the cars were floating around. We didn't know what direction to go in," she said. "The taxi driver was excited and kept saying, 'Hey, look at this!' I didn't want to look. I was just saying to myself, 'Just keep going, keep going!'"

General Questions for articles

1. Prior to reading this article, how much knowledge did you have on hurricane Kenna?

1	2	3	4
None	little	somewhat	a lot

2. Have you ever heard about this particular hurricane?

Yes	no
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3. What would you rate as your prior knowledge on the topic of global warming?

1	2	3	4
none	little	somewhat	much

4. During your college career how much instruction have you had on global warming?

1	2	3	4
none	little	somewhat	much

Appendix D

Text and memory Questionnaire

Please answer the following questions to the best of your ability based on the two articles that you read in the previous session. You want to base your responses on the content you remember from the articles and not on other facts you may know.

1. Which of the following matches what you read in the hurricane article?
 - a. **winds reached as high as 160mph (260kph) during the hurricane.**
 - b. over 250 people were killed during the destruction of the hurricane.
 - c. this was one of the most devastating natural disasters in Texas history.

2. According to the Global warming article what animal is decreasing in population?
 - a. orcas
 - b. reindeer
 - c. seagulls
 - d. **polar bears**

3. True/False

11. True/False. Because of the damage done following the hurricane, the city streets looked more like a garbage dump.

- a. **true**
- b. false

12. What percent of global warming did Jason Box say accounted for green house gases?

- a. 5%
- b. 25%
- c. 40%
- d. **10%**

13. Was the following mentioned in the articles? “Red Cross officials said that the coastal highway from Tepic to Mazatlan was washed out”

- a. **yes**
- b. no

14. True/False. The amount of green plants in Canada are decreasing drastically due to high temperatures?

- a. true
- b. **false**

15. Officials of Puerto Vallarta reported which of the following?

- a. the massive damage of the fires left up to 1,000 homeless
- b. **that 2000 people were evacuated and sent to shelters.**
- c. due to the seismic activity reports of many of the cities highways are destroyed.

16. Which of the following is a reason for the ice melting according to the article?

- a. rising temperatures with no sign of a cooling period.
- b. the increase in the radiation from the sun's rays.
- c. large amounts of oil pollution in our oceans.
- d. the increase in garbage dumps.
- e. **both A and B.**

17. Due to the strength of the storm which of the following caused the most damage in Tepic.

- a. high winds during the strong nor'easter.
- b. **the powerful winds from the hurricane**
- c. the sudden appearance of the tornado that ripped apart the small town.

18. Which of the following is true about mountains?

- a. due to their high altitude the peaks are often covered with ice.
- b. **many mountains today are bare, when in past years they weren't.**
- c. several animal species have begun to migrate to their home climate.

19. What category was the hurricane that hit the coast on Friday in 2002?

- a. category 2

- b. category 4
- c. category 3
- d. c**

28. True/ False. On average there has been a steady increase in water temperature since the 1940's?

a. true

b. false

29. True/False. According to Mexican officials this was one of the most devastating hurricanes that hit their coast in decades?

a. true

b. false

Table 1

Descriptive Statistics

Learning Style

Color

Black and White

Text

Overall $M = 5.95$ ($SD = 1.04$) $M = 4.40$ ($SD = 1.15$) $M = 4.67$ ($SD = 1.20$)

Figure 1

Mean scores on color condition memory assessment

Mean Scores (visual/verbal)

0

Interaction effect between variables

