Reading Rainbow: Does Color Play an Important Role in Education?

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Abstract

This study seeks to better education for individuals with Attention Deficit Hyperactivity Disorder (ADHD) through testing the use of color saturated educational tools. The hypothesis states that college students will perform better on a reading comprehension test that is printed on cream colored paper than on the same information printed on bright-white paper. One hundred fifty one students from a midwestern university participated in the study. A 16 item questionnaire and a reading passage were created to test reading comprehension scores. There was one independent variable (paper color) and one dependent variable (test score). In the future, this work could be used to inform elementary education institutes of the use of color-related materials and their positive benefits on ADHD education.

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"Tom, Tom, please stop staring out the window. Tom, look at your book and put down the pencil. Tom, no we can't leave for gym yet, please sit back in your seat. No Tom, you need your English book, not Science. Tom, Tom did you hear me? Put the pencil down Tom." The inability to focus afflicts us all from time to time, it is safe to assume that the average person suffers from attaining to one task when other less important matters take over their attention, but the limited ability to focus on all tasks is a serious problem and a diagnosable disease called Attention Deficit Hyperactivity Disorder (ADHD). Some statistics on ADHD:

- 5.9 million adolescents suffer from diagnosed cases of ADHD (APA, 2014).
- ADHD has increasingly been diagnosed throughout the years; on average 5% more children are diagnosed each year than the previous year since 2003 and prior to this it was on average a 3% increase (CDC, 2014).
- It is estimated that 5% of all children have been diagnosed with ADHD with an unknown number of cases that go undiagnosed each year (CDC, 2014).
- Estimations show the number of undiagnosed cases to be close to an additional 4% more than cases confirmed through diagnosis (CBSNEWS, 2007).
- Included with the cases of ADHD, 3% to 35% of children suffer from additional behavior difficulties and on average only 4% of these children are diagnosed (Conley, Marchant, & Caldarella, 2014).
- In some areas of the United States the number of ADHD cases is as high as 12% of students, meaning four students are struggling with attaining to educational tasks (CDC, 2014).

These numbers would imply that in an average classroom of 25 students, one child has confirmed ADHD, one child has undiagnosed ADHD symptoms, one child has a diagnosed behavior difficulty, and a possible two children have undiagnosed behavioral difficulties. So the scenario above involving Tom is not atypical for an average classroom teacher in the United States, in fact that teacher would be attempting to rein in Tom and two to six other students as well, in turn affecting not only the teacher's ability to teach but the education of the students with ADHD as well as those who are learning right beside them.

Background: Why and How We Need Help For These Children

These numbers may seem minimal to some and many will question why teaching to these students is so difficult, but for that teacher attempting to keep seven children on task who are not able to do so on their own, while trying to help them succeed in their education is a daily struggle. A simple Google search for "how to improve academics ADHD" lists the first 13 most related articles and every one of these articles is regarding medication and its ability or ineffectiveness in improving education for those suffering from ADHD. There is one problem with this logic, if a teacher is searching for ways to improve academics for a student with ADHD, that student generally has a diagnosis and is being prescribed medicine and it is still not working effectively in the classroom. When one is able to sift through the numerous articles on medication, from time to time one can find helpful tips for the classroom. These tips include items such as seating the child away from a window, giving the child less work than other students, and almost all suggest the use of color saturation in education; such as the recommendation that when able you should write directions down in colored chalk or bold colored markers in the assumption that color will attract the distracted child toward the material at hand (helpguide, 2014).

Children with ADHD often find themselves as outcasts in their classrooms, falling behind their peers both academically and emotionally. These maturation issues can lead to bigger problems later in life to include lack of self-esteem, emotional instability, anger issues, and alcohol abuse (Mayo Clinic, 2013). While in childhood however, these students show aggression tendencies because of home and classroom environment, most often due to cognitive disabilities that leave them falling behind their peers (Ercan et al., 2014). The possibility that a child will suffer in the long-term from the effects of ADHD, even with medication, is what motivates some teachers to find alternative methods to keep children both attained to material and keep appearance of normalcy to peers around the student. The suggestion of colored chalk or bold markers is not recommended by merely one source, the use of color saturated material is often cited by multiple educational sites as a proven effective treatment. If supporting the educational needs of these students, both treated and undiagnosed, was as simple as the color of their worksheet or material printed on a white board, why do schools not implement this treatment by eliminating bright white copy paper and black expo markers. As it turns out, schools are not alone in withholding this style of education; there are many naysayers with research studies that dismiss the effective use of color, however, ten times as many research articles correlates to this treatment method of color saturation and its effectiveness in the classroom. One researcher found that color coding organization systems were effective in higher education but the use of color and animation itself was not highly correlated with higher retention of information (Keller, Gerjets, Scheiter, & Garsoffky, 2006).

Future of ADHD Education: Color Helps Us All

Despite findings that color saturation does not work consistently with education, there are many studies that do support the use of color saturation in ADHD education; such as the

study that found using colored paper in handwriting assignments with students who suffered comorbid ADHD and speech or learning disabilities had improved handwriting skills, cortical activation is thought to be the lead reason for the improvement assisting in attention regulation (Imhof, 2003). This study was not the only study to find students attention enhanced when presented in color stimulation modes. Evidence also pointed to children with ADHD performing better on letter recognition and spelling tests when presented the information in bold color format; in fact color has been found to be more effective than adding animation or a non-color relevant change when information is presented multiple times to the child (Zentall, 2005).

There might also be a benefit in specific colors when supporting the notion that color stimulation is effective in learning; a research study has shown that warm colors cause positive emotions and children perform better on tests that are presented in this color palette versus a monochromatic gray-scale version (Plass, Heidig, Hayward, Homer, & Um, 2014). Color saturation is not limited to background stimulation only, as earlier stated the use of brightly colored markers during instruction is also effective in the case of students with ADHD (Zentall, 2005). Just as bold markers on white boards are effective so are colored fonts in reading booklets, a study has found that students with ADHD perform better on handwriting tasks when the font color was changed from black to a more attractive and attention grabbing choice (Zental & Kruczek, 1988). On average, a student with ADHD performs significantly worse on reading comprehension tests than the average student, one research study found the standard deviation to be as large as 12.9 from the average student test score (Ghelani, Sidhu, Jain, & Tannock, 2004).

Age Matters: Color Distracting Age Limit

Not all findings were supportive of the use of color; in fact studies have been conducted that show little to no correlation between color and improved performance (Schmidt, Ruskell, &

Kohl, 2013). A Colorado school used color coded tests for organizational purposes and wanted to ensure that color saturation was in fact not benefitting students who were given exams on colored paper (Schmidt et al., 2013). The study was conducted to determine if in fact students were excelling on the color tests versus a plain black and white test, results revealed that there was no support to the suggestion that color plays a role in performance when no difference was noted in the results of the exam (Schmidt et al., 2013). This test was also performed on college students; keeping in mind that a large population of students with aggressive cases of childhood ADHD either do not attend college because of poor academic performance through the lower grades or those who do have cases of ADHD have found coping methods that have led them down a successful academic path. Although there has not been much research into the number of ADHD cases in college, it is reported that on average 2% of students suffer from some ADHD symptoms (Weyandt, & DuPaul, 2008). Based on this information, it should be assumed that color use in academics for college students may not show a comparable difference as can be found in young adolescents.

Emotion of Color

Is it true that color can influence the way a person feels, whether they feel hungry, angry, or calm, further supporting the notion that color can influence a student's mood while working in the classroom? An in depth look into color and emotional response found that green was found to be a calming, refreshing, beautiful, renewing, and peaceful; whereas red was found to be fiery, spicy, and romantic, both colors leave individuals feeling two different strong emotions (Kaya & Epps, 2004). The interior of a room, because of a color-emotion relationship, can affect a child's day by merely being surrounded by a color that elicits an unwanted emotion. Research showed that children actually want to be surrounded by color in their interior environment, young

children are most attracted to red, as bright toys are fun to play with but it was suggested that red could be a distracter as well and should be used sparingly on walls in a classroom, despite the apparent appeal to the color by children (Read & Upington, 2009). Using cool, calm colors on classroom walls with pops of color around posters helps maintain a calm classroom, yet brings excitement by highlighting educational tools using bold color.

Just like Dorothy traveling from her dull and dreary gray world to the Technicolor Land of Oz, color in the classroom can transform the way a child looks at everyday information. Color made the munchins appear happier and appreciative, made the wicked witch scarier and uglier, and made the journey to the wizard thrilling and rich on the lane of gold; the same might be applied to learning a new skill. Add a bit of color, stir in a bit of emotion, and like the good witch, we've found the needed magic to get these children to home plate in the classroom. This magic however has specific dimensions as well, some colors are better associated with learning tasks; such as, the propensity for the color red to associate with explicit recognition of presented materials, while green has a higher correlation with correct answers on implicit recognition (Clariana, 2004). Yellow, although often associated as a bright, sunny, warm color has been found to impede memory tasks, so surrounding a child in yellow while quizzing them on math facts could obstruct learning or highlighting information for a test in yellow could distract you from remembering the information later on (Clariana, 2004).

Relevancy

Understanding the colors necessary for positive learning affects is half of the battle, learning how and where to implement these colors is the remaining question to ponder when assisting students in this abstract manner. Many reports vary on implementation, adding the color saturation early in a lesson, adding the dimension late in a lesson, adding it through

background color, print color, or simply highlighting the important information for the child (Zentall, 2005). The end result is ultimately the same, the desire to attain a child with limited memory storage of important material with the desired result of exhibiting retention of the information at a later date (Imhof, 2003). Color is that important, this natural element that surrounds individuals in everyday environments, from outside to in, plays a role in how the world receives and retains information (Plass et al., 2014).

Hypothesis and Operationalized Variables

The following independent variable was measured by test results: paper color (cream or white) effectiveness. The following independent variables was measured by self-reported test items: gender, age, preference to color in education, and color blindness. The dependent variable (test scores) was measured by answering a 10 question reading comprehension test after reading through a 4th grade level reading assignment one time. The hypothesis stated that college students will perform better on a reading comprehension test that is printed on cream colored paper than on the same information printed on bright-white paper.

Method

Participants

One hundred students from a Midwestern university participated in the study; they did not receive any class credit or reward of any kind. All 100 participants' studies were used in the data analysis. Of those who participated, 45% were male and 55% were female. Breakdown of the 100 participant's reported ages were as follows: 70% age 18-20, 25% age 21-24, and 5% age 25 and above. Data were collected in accordance with the ethical standards of the American Psychological Association (APA, 2010). Students were also asked if they were color blind, 5% self-reported that they were indeed color blind.

Materials

A reading comprehension survey was created with a one page, fourth grade reading level reading passages, 10 reading comprehension questions, and an additional six self-reporting information variables. The self-reported material included items such as: "did you find the presentation of this material appealing," "do you find colorfully presented educational material more appealing in a classroom," "do you find reading comprehension tests to be difficult," and "have you ever been diagnosed as color blind." The survey was printed on two colors of paper: 50 were printed on bright white paper and 50 were printed on cream paper.

Procedure

Participants were asked to complete the 16-item reading comprehension survey during class time and in university common areas. The researcher explained the general goal of the study and explained that the study was not to assess the reading level of any individual student. Participants were also informed that they could withdraw from the study, without penalty, at any time if they became uncomfortable. Participants were informed verbally and in written instruction that all responses were anonymous and scores on the reading comprehension portion would not be linked back to any individual student. The students were then asked to read the reading passage on the front of the survey, turn over the paper and complete the questions on the back without looking back to the front of the paper. The surveys took no longer than 10 minutes for participants to complete. After completion of the survey, the experimenter debriefed the participants and answered any questions regarding the research study.

Results

There was one independent variable (color of paper) and one dependent variable (test score). To test the hypothesis, college students will perform better on a reading comprehension test that is printed on cream colored paper than on the same information printed on bright-white paper, an independent sample T-test was performed. Results indicated no significant difference (.819) in score between white or cream colored paper with a very small mean total score difference between the two colors of paper (.229). The hypothesis was rejected; there was no apparent difference in scores between the two colored papers.

Independent Sample T-test									
	Laverne test for equality of variance		T-test for equality of means						
								95% Confidence interval of the difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	lower	upper
Equal variances assumed	0.486	0.487	0.229	98	0.819	0.08	0.349	-0.612	0.772
Equal variances not assumed			0.229	94.791	0.819	0.08	0.349	-0.612	0.772

Other Results: Correlations

A frequency was run to determine the percentage of individuals who correctly answer questions on the reading comprehension survey; 58% of the individuals answered either or more questions correct on the quiz and less than 10% of the individuals scored below 50% (or less than 6 correct answers). However, despite the number of participants who scored high on the quiz, those who completed the quiz on bright white paper did on average (.12%) better than those who completed the same quiz on cream colored paper. It is interesting to note that only 11% of the participants were able to correctly answer all ten questions.

Discussion

The original hypothesis stated: college students will perform better on a reading comprehension test that is printed on cream colored paper than on the same information printed on bright-white paper. However, the results show there is no significance in correlation to paper color and test score and the data does not support the original hypothesis. Instead it appears as if students in higher education are not affected by the color of paper that material is presented on and it does not improve reading comprehension skills.

Limitations

If this study is repeated in the future, there are a few alterations that would improve the quality of the results. First, it would be beneficial to change the age level of the participants; due to the small number of college students who are affected by ADHD complications better results could be obtained from younger students. It was observed that many students chose to ignore the direction that they were to read the front once and not look back to find the correct answers and many did flip the paper over during the course of the reading comprehension portion, in the future providing the reading passage separately, collecting them, and then passing out the questions regarding the reading could provide better results. Also, after further research, it is possible that font color or highlighting important information is even more beneficial than paper color. A future researcher might instead print the survey out with colored font or highlight the important information, print on bright white paper and provide 50 surveys in colored font/highlight on bright white paper and 50 surveys on bright white paper.

Implications

If this study is repeated in the future, there are a few alterations that could improve the quality of the study. First, the age of the participants played a large factor in the results of this study. If you were to test grade school students versus college students, there might be a less

narrow margin between scores. Also, if you were to change the color of the font or highlight the important portions of the reading versus using paper color, you might find that results are better with the use of color; this could also show a significant difference in college students as well as grade school students. Future consideration of using this scale might include deleting question number six on the reading comprehension portion. This question related to a picture on the reading comprehension sheet and not the reading itself. This question was missed a majority of the time and could hinder results of the study. Finally, I found that many students flipped back to the front of the survey to answer questions, handing out the reading article separate from the questions might alleviate many false correct answers because had the students not looked back to find an answer they would have received a lower score.

Implications

In the future, this study could assist elementary education teachers in the instruction of children with known cases of ADHD. If a method of adding color to the classroom appears affective for students with ADHD, these teachers could also use this method to identify or assist other students with undiagnosed cases of ADHD. For example, if a student is performing poorly with regular education tools, adding color-infused teaching tools might help that student attain information and allow the teacher a platform with the parents and school psychologist on requesting a possible diagnosis. Adding color is a relatively inexpensive form that schools could adopt to better the education for their ADHD students, this study could be the link they need to develop these color-related tools in their classrooms.

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