A Colorful Impact: The Psychological Impact of Colors

Barbie West[a], Joshua Silberman[a]

This paper offers analysis of research done by professionals and studies of said professionals recreated by an undergraduate student. The goal of this research was to identify a connection between colors and emotions. Through tests and surveys, there was a connection indication; however, it is still unknown the exact connection.

Keywords: colors, color, impact, psychology

There are many connections in our everyday lives. There are connections between two people in conversations, connections made in our mind to do simple arithmetic, connections made from our brain to our fingers as to press keys on a keyboard, and millions of more connections made daily. The explanation of these connections typically all trace back to science. Every connection we make trace back to how each person processes the information, and, based on the connections made, people respond to the information in different ways.

Colors and emotions are two individual factors in our lives. It is possible that emotions and colors are connected because many individuals can connect a color to an emotion and an emotion to a color. Colors typically carry an emotion with them. For instance, around Valentines Day, red and pink are highly connected to love. Emotions can also carry a color with them. For example, anger is typically connected to red. There are different emotions that red could be connected to and different reasons why. The connections might be made because of cultural connections, social connections, or personal preferences. Colors and emotions are connected in different ways, but two things are often left unsought: Can color can heighten emotions and, in turn, impact task performance and can individuals can connect a color to an emotion and vice versa.

Multiple studies suggest that a colored environment can impact task performance and memorization, and other studies suggest that individuals can make a connection between colors and emotions and vice versa. In this research study, multiple studies will be recreated to see if individuals' task performance and memory are impacted by color. To do this, two separate groups of students will meet at three scheduled times (per group), each time giving them an academic test and a memorization test in three different colored rooms to see if their scores change depending on the color of the room. The first room will be a normal, unchanged room. Then, the second room will be primarily blue or red, and the last room will be the color not used during the second meeting. By doing this and looking at the data, the results should reflect a clear resemblance of the studies' results or to reflect the opposite of the read studies' results. Also during this research, studies will be recreated to see if individuals can make a connection between a color and an emotion and vice versa. To do this, students will be asked to fill out two individual surveys. One survey will ask "What color do you think of when you think of these emotions?" followed by a list of 10 emotions, and the other survey will ask "What emotion do you think of when you think of these colors?" followed by a list of 10 colors. By doing this, the results will clearly show if there is a repetition of certain colors being connected to a certain emotion and certain emotions to certain colors; this would indicate that there is a definite connection between the two.

Research Question

What is the psychological impact of color? Specifically, how does color impact task performance and emotional responses?

Literature Review

Each day individuals are impacted by the environment around them, and, unknowingly, color is one of those things that impacts them. Colors can be viewed as a type of expression or emotion, but color can evoke different types of expressions or emotions. Colors can impact task performances and emotional response of individuals by provoking increased levels of arousal or calmness or based on personal preference.

The colors blue and red reportedly impact test scores and memorization of students. In a study done by Bart Hulshof of University of Twente, students were tested in a cool colored meeting room, blue, and a warm colored meeting room, red. Some students took an "IQ test" and a quiz on "EMT words" in a meeting room with features that were mainly blue, and the others were in a red room. By gauging their responses to each test in each room, Hulshof was able to conclude that the students in the blue room had higher results in on the "IQ test"; meanwhile, the students in the red room had higher "scores on 'EMT words'" (Hulshof). Hulshof did not understand what caused this difference, so he thought "educational level may explain the differences in 'IQ test' scores…however, no differences were found". Because there were no differences found that could be linked to educational differences, the only independent variable that could have caused the difference was the room color; therefore, Hulshof looked at their behavior. The students in the blue room did not express as much arousal as the ones in the red room possibly because "cool colours are associated with calmness and serenity, effects of low arousal [meanwhile] warm colours are associated with stressfulness and excitement, effects of high arousal" (Hulshof). The students in the blue room were more relaxed and experienced higher levels of calmness than those in the red room who were more aroused and experienced higher levels of stress. Relaxation could have increased performance because "[when] the mind [is] flexible, [and] the body [is] relaxed…a state of relaxed alertness

a. Challenge Early College High School, Houston, TX, 77081

is optimal for performance" (Goleman). The more relaxed the body and mind are, the higher the likeliness of the brain performing better. In the blue room, the students experienced more relaxation leading to higher performance levels on the IQ test. When one is stressed, the brain focuses on what is causing the stress and not the task at hand. Meaning if the color of the room influenced the students' levels of stress or calmness, then the arousal of the room was reflected in the scores of the students. In the red room, Hulshof found that the "EMT word" scores, "twelve fictional three-letter words which participants had to remember", were higher because "warm colours enhance cognitive performance on detail-oriented tasks" (Hulshof) and this task required much attention to detail. Since red is considered a warm color, the memory quiz in the red room might have reflected the idea that, compared to the blue room, warm colors help with remembering more details, and the scores of the memorization were likely to be higher in the red room because this task required much attention to detail. Looking at the colors red and blue and how they impact levels of stress and calmness, there is a clear correlation between the calming essence of the blue room and the performances on the IQ test, and the stress arousing red room and the memorization performances.

The colors red and green impact the way a student responds to questions also. In a study Teresa Kutchma of Minnesota State University retested, she said, "[In a 1985 study done by LD Rosenstein] the effects of red, yellow, blue and neutral room color on mood increased test scores of males and females when taking the SAT" (Kutchma). Kutchma give the students a SAT test and a test that measured their estimation accuracy, and she focused on the red room and the green room. The participants first took a base-line test in a room that was black and white or blue and yellow to see what they would score without being influenced by color. By comparing their test scores in the red and green room to the base-line test, Kutchma saw that the participants were scoring higher on the SAT test in the red room. The only factor that changed in the trials was the color of the room; therefore, the color of the room had to have had some impact on their task performance. Kutchma found that in the red rooms the partakers were more "aroused and excited"; whereas, the "green had contrasting effects" (Kutchma). Since red is a warm color, it is known that red increases levels of arousal and stress which is said to lead to an increase in attention to detail; whereas, green is a cool color and often times emotions connected to are safety and calmness. Although "red room conditions were also shown to have an exciting and stimulating effect on emotional states," the individuals in the red room had "inaccurate performances [with motor tasks involving mental judgment]" (Kutchma). In the red room the participants were more accurate with given information on the SAT most likely because the red room was said to increase their attention to details; whereas, they scored lower on the estimation likely because there were less details. Meanwhile, the participants in the green room were "more accurate… when asked to estimate size, length, weight…" (Kutchma). In the green room, the participants were more relaxed than those in the red because green is a cool, calming color. With increased levels of calmness, the participants were able to focus more and estimate better than those in the red room who were aroused and stressed. The study done by Kutchma show some type of correlation between color and task performance in her participants. It is best understood that the colors of the room had impacted their task performance and their moods because the was the only variable that changed which led to the SAT scores being higher in the red room and the estimations better more accurate in the green room compared to their base-line tests.

Research suggests that emotions can be connected to color based on personal preference. Naz Kaya, past assistant professor at the University of Georgia, asked her participants, "What emotional response do you associate with this color? How does this color make you feel?" and "Why do you feel this way?" In which, the students "were allowed to state only one emotional response for each color" (Kaya). Kaya's study looked at if participants could personally connect an emotion to a given color or vice versa and why they gave that response. By answering the three questions, the participants would undeniably connect emotions to colors or vice versa. With each color Kaya presented to the participants came positive and negative responses. When exposed to blue, some students responded with negative emotions such as "sadness, depression, and loneliness", and other students responded with a positive emotion such as "relaxation and calmness, followed by happiness, comfort, peace and hope" (Kaya). Although blue may represent sorrow to some people, it may represent calmness to others. The students were shown other colors and majority of the colors had responses that had negative and positive emotions as well. Each student had their own response to each color based on personal preferences even if they thought their response was not based on preference, something unconsciously made them respond the what they did. Because the students were able to match an emotion to a color, there are indications that the two are correlated in some way. The participants might have had a reason why they thought sad or calmness when they saw blue, but others might not have had a specific reason. Whether or not the participants had a reason of choosing the emotions they did for each color, recognizing that personal preference is one way that emotion is connected to color is important because it means that the participant A might have different feelings towards blue than participant B. If participant A likes the color blue and participant B does not, then participant A will probably have a positive emotional response; meanwhile, participant B might have a negative emotional response. A person's preference of a color will impact the way that they emotionally respond to that color.

Research also suggests that color can be connected to emotion by personal preference. Anders Steinvall, Senior lecturer at Umeå University in Sweden, studied the relationship between terms of emotions and colors by asking one main question to his participants: "What color or colors does emotion X call to mind?" (Steinvall). Steinvall, to show that there was a correlation between the terms of emotion and color, would present the partakers with a term of emotion and record their responses. One term Steinvall used was love, and he found that "two color categories [had] almost equal strength – pink and red" (Steinvall). When the term "love" was presented to the participants and 39.86% of them responded with "red" and 33.33 % of them responded with "pink" (Steinvall). Out of the countless colors, the participants mainly related two colors to love. Many things could have caused them to give the response they did. They might have connected red and pink to love because of Valentine's Day or because they love the colors red and pink. They chose to connect the specific colors to certain emotions for a reason. They might have connected their favorite colors to positive emotions; whereas, they might have connected colors they do not necessarily like to negative emotions. Noticeably when presented with an emotion their response was one color, but when presented with that color they did not necessarily connect it to that same emotion. When presented with the word "love", one may think of the colors pink and red;

however, when presented with red, one may think of anger. People connect colors to different emotions differently because of their personal preferences. Favorable colors or colors that have had some significance in their life will correlate to a positive emotion; meanwhile, colors that have negatively impacted their life (e.g. black representing the death of a loved one) will be related to a negative emotion. By connecting a color to an emotion, a person might be influenced in the way they knowingly or unknowingly emotionally respond to something of that color.

While there is an idea of how task performance and color are connected and while all the dots have not been connected as to exactly how emotion is connected to color or vice versa, the studies discussed have shown how they might possibly be connected. In the studies by Hulshof and Kutchma, the colored rooms indicated a connection that either improved test scores or had little impact on them. In Hulshof's study, the participants in blue room experienced a higher level or relaxation which resulted in higher "IQ test" scores; meanwhile, the participants in the red room experienced a higher level or arousal which resulted in higher scores on the "EMT words". Narrowing down how task performance and color are exactly related would most likely go into detail about how the color influences the participant in anyway if it does. Also, it would likely study the general relationship between color and people. In the studies of color and emotion, participants were able to present a clear relationship between the two; however, it is still not clear how the brain connects the two. Kaya's participants were able to give an emotional term for each color they were given, and Steinvall's participants were able to give a color for each emotional term they were given. Narrowing down the connection between emotion and color would probably go into depth on the parts of the brain that makes connections and how the connections between color and emotion are made.

Method

This research project focused on the psychological impacts of color. Specifically, if the colors of a room could impact the test scores and memorization scores on different individuals, and if different individuals could connect an emotion to a color and a color to an emotion. To understand if the color of a room could impact the test scores and memorization scores of people, three studies were recreated. The first study was by Bart Hulshof of University of Twente, and the second study was a combination of a study done by Anders Steinvall of Umeå University in Sweden and a study done by Naz Kaya of the University of Georgia.

In the first study done by Bart Hulshof of University of Twente, students took an "IQ test" and a memorization quiz on "EMT words" in a meeting room with features that were mainly blue, and the others were in a red room (Hulshof). To recreate this study, three tests were created with each one consisting of 10 SAT questions: 5 English and 5 Math. Khan Academy was used to ensure that each test had questions of the same category that were equally difficult. Each test had one English question from the following categories: Words in Context, Command of Evidence, Frequently Confused Words, Modifier Placement, other. Similarly, the Math section consisted of one question from each category: Linear Function Word Problems, Isolating Quantities, Linear and Quadratic Systems, Units, and Systems of Linear Inequalities Word Problems. Each test was accompanied by 20 sets of 3 random letters that the participants would have to memorize.

9 random seniors (Group 1) and 9 random juniors (Group 2) were asked to take the series of tests. Seniors and juniors were the students chosen to take the tests because it was necessary to make sure that they had taken or were currently taken the classes that they would need to answer the questions on the tests since they were SAT based questions. Group 1 and Group 2 met separately for a total of 3 times on different days. Group 1 and Group 2 both took a base-line test in a normal classroom. During each session, participants were given 15 minutes to take the test, 3 minutes to memorize the list of "EMT Words", and 3 minutes to write down as many "EMT Words" as they could remember (Hulshof). The setting in the original study consists of one room that was mainly blue and one room that was mainly red (Hulshof); however, due to lack of resources, the participants were facing blue or red butcher paper over the front board and had the butcher paper over their desks. This way if they looked up or down they were seeing blue during the blue test and red during the red test.

The second study conducted was a survey with two parts, one question per part, from two studies: one done by Anders Steinvall and one done by Naz Kaya. This was done to see if different individuals could connect an emotion to a color and a color to an emotion, so from Anders Steinvall's study, in the one question that was focused on he asked: "What color or colors does emotion X call to mind?" (Steinvall). Meanwhile, from Naz Kaya's study, in the one question that was focused on she asked: "What emotional response do you associate with this color?" (Kaya). With a similar question stated at the top of the papers, 10 colors or 10 emotions were listed, and participants were asked to respond, respectively, with an emotion or a color. Each question was on a separate sheet of paper, so the participant couldn't to use the colors or emotions listed to respond. The goal was for the participants to make the connections on their own, not based on what was already there.

There was not an established environment this test was meant to be taken in. Students were randomly selected throughout the school and ask to take the surveys that moment if they were willing and if they had the time. However, two things were controlled: a total of 12 students from each grade level with 6 from each binary gender. It was ideal to have participants from each grade level, each gender, and different ages; therefore, this research as inclusive as it could possibly get. By including different grade levels, genders, and a range of age, the research would be more accurate and inclusive because it would not be gender-bias or ageist.

Results

The research consisted two sections. The first section of the results includes the two trials ran which focused on how different colors impact task performance. The second section consisted of surveys students were asked to full out. This focused on individuals' ability to connect an emotion to a color and a color to an emotion. In this study, arousal was viewed as defined by William Revelle and Debra A. Loftus in Handbook of Emotion and Memory "a condition conceived to vary in a continuum from a low point in sleep to a high point in extreme effort or intense excitement".

PART ONE: The Tests

SAT Based Questions: How many questions the participant got right out of 10

			Group 1: Seniors		
Gender	**Age**	**Person**	**Base-Line (Test 1)**	**Red Room (Test 2)**	**Blue Room (Test 3)**
Male	18	11/18/00	3	DIDN'T TAKE	4
Male	17	06/12/01	5	7	8
Male	17	05/09/01	4	3	4
Male	18	03/18/00	5	4	5
Male	17	05/20/01	4	7	5
Female	18	11/13/00	3	4	4
Female	17	04/21/01	7	3	3
Female	18	02/18/01	6	5	7
Female	17	07/19/01	6	2	4
Avg.	17.44		4.77	4.375	4.88

			Group 2: Juniors		
Gender	Age	Person	Base-Line Room (Test 1)	Blue Room (Test 2)	Red Room (Test 3)
Male	16	03/06/02	5	4	5
Male	17	05/08/01	5	3	3
Male	17	12/18/01	6	3	5
Male	16	12/27/02	5	3	4
Male	16	08/30/02	5	2	DIDN'T TAKE
Female	16	05/08/02	6	4	DIDN'T TAKE
Female	16	03/14/02	3	6	4
Female	16	05/27/02	2	3	4
Female	16	07/05/02	6	4	6
Avg.	16.22		4.77	3.55	4.42

The two charts above show the two trials completed by the two groups. The three right columns have the number of questions that the participants got right on the 15-minute SAT based questions test out of 10. At the bottom, the averages are given

for each test, so comparing their overall scores can be compared easily. The SAT based questions test portion of the first section was the focus on the idea that a red room increases the level of arousal someone experiences resulting in lower academic tests, and a blue room increases the level of calmness someone experiences resulting in higher academic tests.

Here, the participants' own scores were compared based on the different colored rooms. A change in their score would indicate that something, possibly the colors, influenced them that day. In a study done by Bart Hulshof of University of Twente, participants had higher SAT-based test scores in the blue room and lower scores in the red room. Recreating Hulshof's study would allow for the findings in this research to be compared to the findings in Hulshof's study.

Through the results, it was found that for Group One the scores in the blue room were higher than those in the red room; however, the results are technically inconclusive because one student did not take the test in the red room due to scheduling problems. Since they did not take the test, it was not possible to input that score in turn making the results for that room questionable. Contrast to Group One, Group Two had higher scores in the red room. However, these results are questionable too because this time two students were unable to take the test in the red room due to scheduling problems. Because two students did not take the tests in the red room, the results were off big time. Looking at the students' scores in the other two rooms, it is believable that their absences made the results for the red room higher, and if they took the test, then the score for the red room would have been lower than the blue room.

The results of the two trials for the SAT-based tests contrasted each other. One thing that absolutely threw off the results were the absences in the trials. The results may haven told a different story if nobody had been absent. The results might have reflected what Bart Hulshof found or maybe the opposite of his findings; however, it cannot be said what the results would have been. A second thing that might have thrown off the results was the room setups. In Hulshof's tests, the rooms consisted on things that were primarily red or blue; meanwhile, the test rooms in this study, the desk had red or blue paper covering them and respectively the wall in front of the participants was red or blue. Another thing that might have messed with the participants' scores was the that they were getting tired of taking the tests; therefore, they resulted in guessing though this is typically expected. Overall, the results both support and refute Hulshof's findings; therefore, more action would be needed to conclude these findings

"EMT Words": How many words the participant memorized out of 20

Group 2: Juniors					
Gender	Age	Person	Base-Line Room (Test 1)	Blue Room (Test 2)	Red Room (Test 3)
Male	16	03/06/02	4	1	1
Male	17	05/08/01	7	2	4
Male	17	12/18/01	9	4	4
Male	16	12/27/02	8	5	6

Group 1: Seniors					
Gender	Age	Person	Base-Line Room (Test 1)	Red Room (Test 2)	Blue Room (Test 3)
Male	18	11/18/00	8	1	3
Male	17	06/12/01	11	10	4
Male	17	05/09/01	8	6	8
Male	18	03/18/00	4	3	4
Male	17	05/20/01	5	5	7
Female	18	11/13/00	9	8	7
Female	17	04/21/01	7	6	7
Female	18	02/18/01	10	8	6
Female	17	07/19/01	6	0	6
Avg.	17.44		7.55	5.22	5.77

Male	16	08/30/02	8	5	DIDN'T TAKE
Female	16	05/08/02	7	5	DIDN'T TAKE
Female	16	03/14/02	6	2	0
Female	16	05/27/02	6	0	0
Female	16	07/05/02	3	6	5
Avg.	16.22		6.44	3.33	2.85

The two charts above show how many "EMT Words" the participants got right out of 20. The participants had three minutes to memorize and three minutes to generate the list of words. At the bottom, the averages are shown for each room. The idea of the participants memorizing and generating a list focused on the idea that because of the red room increasing the level of arousal experienced they would, theoretically, have higher memorization scores, and in the blue room, the level of calmness would result in lower memorizations scores.

Here, the participants' memorization scores were compared to their own in each room. Again, a change in their scores would indicate that something, maybe the color, influenced them. In the same study mentioned earlier done by Bart Hulshof of University of Twente, he found that the participants had higher memorization scores in the red room and lower scores in the blue room, and the results found by the recreation of this study could be compared to the results of Hulshof's study.

In Group One, the results were extremely close. In the red room, the participants had an average of 5.22 and an average of 5.77 in the blue room. This time each participant took the memorization tests; however, one person admitted that they did not try on the second memorization test which was the red room. Like Group One, Group Two scored higher in the blue room. The average memorization scores were 3.33 in the blue room and 2.85 in the red room. However, two participants did not take the final memorization test which threw off the results. Looking at the participants' scores in the first two tests, it could be suggested that their scores would have increased the results of the red room; however, this trend cannot be supported and it is impossible to know what would have happened because they did not finish the trials.

The results of the two trials for the memorizations tests support each other. One thing that threw off the results were the absences in the second trial. The results may haven told a different story if the participants were there for the last test. The results refute what Bart Hulshof; however, it cannot be said what the results would have been for the second group because of the absences. A second thing that might have thrown off the results was the room setups. In Hulshof's tests, the rooms consisted on things that were primarily red or blue; meanwhile, in the rooms, the desk had red or blue paper covering them and respectively the wall in front of the participants was red or blue. Another thing that might have messed with the participants' scores was the that they were getting tired of memorizing and generating the lists; therefore, they resulted in giving up. Overall, the results both refute Hulshof's findings; however, to make these findings more concrete more research would need to be conducted.

PART TWO: The Surveys

For the second section, 12 students from each grade level from 9th grade to 12th grade, 6 boys and 6 girls, were asked to fill out two surveys. Two outliers were included to make the sample size 50 and to see if adults also connected colors to emotions and vice versa. The questions asked on the surveys mocked two studies, one by Anders Steinvall and one by Naz Kaya. One asked, "What color do you think of when you think of these emotions?" (Steinvall) and the second survey asked, "What emotion do you think of when you think of these colors?" (Kaya). Here, the results would if the participants could make a connection between colors and emotions.

Research Article 2019

Average Age without Outliers: 15.96
Average Age with Outliers: 16.76
What color do you think of when you think of these emotions?

Grade	Gender	Age	Love	Hurt	Anger	Depression	Sorrow	Joy	Fear	Jealousy	Confusion	Excitement
12	Male	18	Pink	Dark Red	Red	Opaque	Bottle Green	Yellow	Blue	Brown	Purple	Gold
12*	Male	17	Pink	Red	Red	Blue	Blue	Orange	Black	Red	Purple	Yellow
12	Male	17	Pink	Red	Orange	Blue	Blue	Yellow	Purple	Red	Black	Orange
12*	Male	17	Pink	Grey	Red	White	Blue	Green	Purple	Yellow	Black	Orange
12*	Male	17	Pink	Red	Red	Black	Blue	Green	Grey	Purple	Yellow	Yellow
12	Male	17	Red	Red	Red	Black	Grey	Green	Yellow	Green	Purple	Yellow
12	Female	18	Red	Red	Red	Blue	Grey	Yellow	Purple	Red	Grey	Green
12*	Female	18	Pink	Red	Red	Blue	Blue	Yellow	Green	Purple	Green	Yellow
12*	Female	17	Pink	Red	Red	Black	Blue	Yellow	Green	Green	White	Yellow
12	Female	17	Red	Purple	Red	Black	White	Pink	Black	Green	Blue	Pink
12*	Female	17	Pink	Black	Red	Blue	Dark Blue	Yellow	Grey	Orange	Green	Yellow
12	Female	17	Pink	Red	Black	Blue	Green	Yellow	Green	Purple	Purple	Orange
11	Male	17	Red	Black	Black	White	Black	Blue	White	Purple	Yellow	Blue
11*	Male	16	Red	Brown	Dark Red	Dark Blue	Black	Yellow	Red	Green	Orange	Yellow
11*	Male	17	Pink	Maroon	Red	Black	Purple	Yellow	Black	Purple	Grey	Red
11*	Male	16	Red	Red	Red	Purple	Yellow	Green	White	Orange	Green	Green
11	Male	17	White	Red	Orange	Black	Blue	Pink	Grey	Red	Purple	Pink
11	Male	17	Red	Red	Red	Black	Blue	Green	Grey	Green	Grey	Green
11*	Female	16	Pink	Blue	Red	Blue	Black	Yellow	Black	Green	Grey	Yellow
11*	Female	16	Red	Grey	Grey	Black	Blue	Yellow	Orange	White	Purple	Pink
11*	Female	16	Red	Blue	Orange	Grey	Teal	Purple	Magenta	Green	Black	White
11	Female	16	Pink	Purple	Red	Blue	Grey	Orange	Red	Green	Grey	Yellow

www.jofsr.org

11	Female	16	Red	Blue	Red	Dark Purple	Blue	Yellow	Brown	Black	Purple	Yellow
11	Female	17	Pink	White	Red	Grey	Navy Blue	Yellow	Black	Pine Green	Lime Green	Gold
10	Male	15	Red	Black	Bright Red	Grey	Blue	Yellow	Black	Purple	Grey	Orange
10	Male	16	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black
10	Male	15	Red	Black	Red	Black	Black	Gold	Black	Blue	White	Gold
10	Male	15	Pink	Grey	Red	Black	Blue	Yellow	Brown	Maroon	Purple	Green
10	Male	16	Red	Maroon	Orange	Grey	White	Green	Black	Pink	Blue	Yellow
10	Male	16	Red	Black	Red	Light Blue	Yellow	Orange	Purple	Purple	White	Green
10	Female	16	Red	Black	Orange	Dark Blue	Grey	Yellow	Grey	Green	Purple	Yellow
10	Female	16	Red	Black	Yellow	Yellow	Blue	Pink	Yellow	Purple	Black	Green
10	Female	16	Red	Black	Red	Blue	Grey	Yellow	Black	Purple	Brown	Yellow
10	Female	15	Red	Grey	Orange	Black	Grey	Yellow	Indigo	Purple	Green	Blue
10	Female	16	Pink	Blue	Red	Black	Grey	Yellow	Purple	Dark Green	Light Green	Orange
10	Female	16	Red	Black	Red	Blue	Black	Yellow	Red	Purple	Blue	Yellow
9	Male	14	Light Red	Orange	Maroon	Black	Purple	Yellow	Orange	Green	Dark Red	Teal
9	Male	14	Red	Black	Dark Red	Grey	Purple	Green	Yellow	Purple	White	Blue
9	Male	15	Red	Orange	Dark Red	Blue	Light Blue	Green	Purple	Yellow	Grey	Green
9	Male	14	Pink	Red	Yellow	Purple	Brown	Orange	Red	Light Green	White	Light Blue
9	Male	15	Pink	Purple	Red	Black	Black	Yellow	Grey	Red	White	Yellow
9	Male	15	Red	Red	Red	Black	Purple	Yellow	Black	Green	Brown	Blue
9	Female	15	Pink	Black	Red	Navy Blue	Light Blue	Yellow	Purple	Green	Orange	Yellow
9	Female	14	Red	Red	Red	Black	Blue	Yellow	Orange	Green	Purple	Yellow
9	Female	14	Red	Purple	Red	Blue	Black	Green	Black	Yellow	Yellow	Green
9	Female	14	Red	Blue	Red	Black	Grey	Yellow	Black	Green	Brown	Orange
9	Female	15	Pink	Purple	Red	Grey	Purple	Orange	Orange	Green	Grey	Yellow

9	Female	15	Red	Red	Red	Black	Purple	Yellow	Grey	Purple	Blue	Yellow
Outlier	Male	27	Red	Grey	Black	Grey	Black	Yellow	Orange	Green	Orange	Yellow
Outlier	Female	45	Red	Purple	Red	Black	Black	Blue	Black	Green	Orange	Blue
# of Cool Colors Associated			0	11	0	19	27	12	13	33	18	15
# of Warm Colors Associated			48	21	45	1	3	37	14	14	13	33
# of Neutral Colors			2	18	5	29	20	1	23	3	19	2
# of Uncategorized Colors			0	0	0	1	0	0	0	0	0	0

- * symbolizes that that person took part in the study of how room color impacts task performance

- In the chart above, the colors highlighted in red are warm colors, blue are cool colors, and light grey are neutral colors.

The graph to the right has the information above complied into a bar graph.
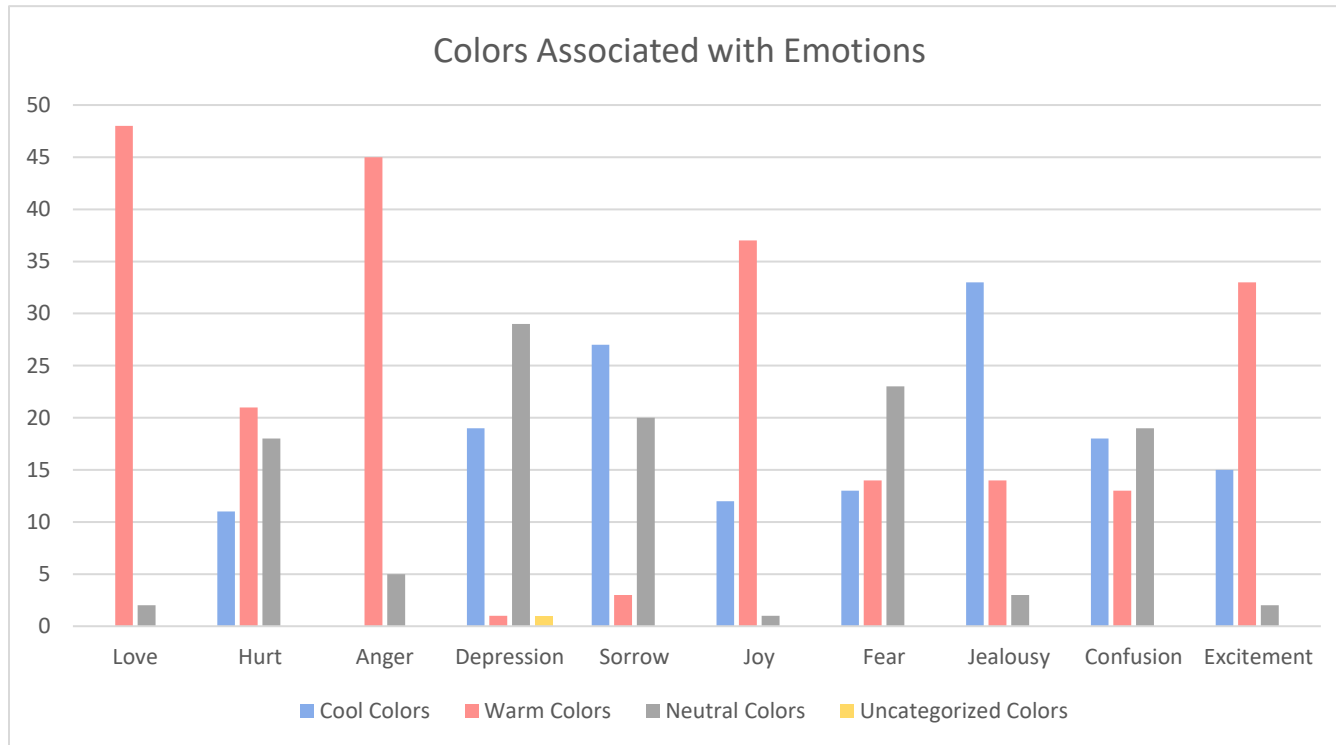
Colors Associated with Emotions

The chart and graph above show the results to the first survey that asked, "What color do you think of when you think of theses emotions?" (Steinvall). The main goal was to see that different individuals could connected a color to an emotion, and each person was able to do so. Then, the responses were divided into four categories of colors: Warm colors, cool colors, neutral colors, and uncategorized colors. The colors were divided based on an article by designer Carrie Cousins in which she defined warm and cool colors, and uncategorized colors were included too because one response was not a color, yet a level of transparency.

One pattern that was noticed was the emotions that involve higher states of arousal were connected to warm colors, which typically provoke higher states of arousal. Defined by Cousins, "Warm colors include reds, yellows and oranges", and in the survey results, the warm colors associated with the given emotions were typically the three mentioned. However, lime green, brown, gold, pink, and maroon were also included as warm colors because of their base colors: Lime green and gold both have the base color yellow and brown, pink, and maroon each have the base color red. Cousins also said that "warm colors can create an active response in the brain and bring feelings of excitement, passion and sometimes aggression", and the emotions that typically involve higher states of arousal were connected to warm colors more often than cool colors (i.e. love, anger, joy, excitement, and hurt).

One thing that was noticed was that cool colors were not connected to many of the emotions; however, there was one specific emotion the partakers connected cool colors to: Jealousy. Jealousy is often thought to be a high arousal emotion; however, a group of Biomedical Engineering and Computational Scientists from Aalto University School of Science determined that "jealousy is not very strongly connected to anger but rather to insecurity and doubt" (Toivonen). This might explain why jealousy was more connected to cool colors (i.e. blue, purple, green) than warm colors because "can make a person feel pleased, relaxed or even subdued" (Cousins). If cool colors can influence individuals to feel subdued, then that could be why there was a higher response of cool colors since cool colors (i.e. blue) are often partnered with sadness and somberness.

I noticed that the neutral colors (i.e. black, white, grey) ruled the emotions depression, fear, and confusion. Each emotion mentioned are connected to unknowingness, emptiness, or being lost, and they each are typically low-level arousal colors. The partakers connected the neutral colors to the emotions that were more negative than positive and to the emotions that are typically associated with unknowingness, emptiness, or being lost. One thing that stood out was that even they are neutral, low arousal colors was that they connected to mild to moderate arousal emotions. White is typically a low arousal color, yet it was connected to depression and excitement which are both high level arousal emotions; meanwhile, depression, a high arousal emotion, a was connected to black, a low arousal color. The neutral colors were almost inversely connected. A high arousal color was connected to a low arousal emotion and vice versa.

Journal of Student Research

Average Age without Outliers: 15.96
Average Age with Outliers: 16.76

What emotion do you think of when you think of these colors?

Grade	Gender	Age	Red	Blue	Pink	Green	Yellow	Orange	Black	White	Purple	Grey
12	Male	18	Hurt	Fear	Love	Jealousy	Happiness	Hunger	Depression	?	Sweetness	Depression
12*	Male	17	Anger	Sorrow	Love	OK	Excited	Joy	Fear	Peace	Confusion	Sad
12	Male	17	Anger	Depression	Love	Envy	Joyful	Excited	Confusion	Bored	Fear	Confused
12*	Male	17	Angry	Sad	Amazed	Inspired	Energetic	Happy	Confused	Amazed	Suspicious	Gloomy
12*	Male	17	Hurt	Sorrow	Love	Hunger	Confusion	Hunger	Depression	Joy	Hunger	Fear
12	Male	17	Angry	Sad	Sick	Avarice	Danger	Anxiety	Sorrow	Tired	Confusion	Depression
12	Female	18	Anger	Sad	Caring	Triumph	Happiness	Confused	Depressed	Confused	In Love	Gloomy
12*	Female	18	Anger	Sad	Joy	Relaxed	Happy	Excited	Depressed	Neutral	Happy	Nervous
12*	Female	17	Love	Sadness	Love	Sickness	Happiness	Comical	Depression	Pureness	Sorrow	Confused
12	Female	17	Love	Joy	Happy	Fear	Sickness	Silly	Hurt	Pure	Calm	Sorrow
12*	Female	17	Love	Depression	Love	Confusion	Joy	Intelligence	Disappointment	Pure	Love	Depression
12	Female	17	Anger	Depression	Love	Sorrow	Happy	Excited	Anger	Peace	Confusion	Numb
11	Male	17	Love	Joy	Happy	Happy	Confused	Joy	Fear	Fear	Hate	Fear
11*	Male	16	Mad	Happy	Love	Neutral	Happy	Excited	Depressed	Neutral	Neutral	Sad
11*	Male	17	Love	Indifferent	Love	Disgust	Joy	Disgust	Depression	Happiness	Sadness	Confused
11*	Male	16	Happiness	Calm	Disgust	Pride	Confusion	Jealousy	Calm	Fear	Neutrality	Peaceful
11	Male	17	Powerful	Sad	Happy	Tired	Love	Angry	Depressed	Clean	Moody	Confused
11	Male	17	Anger	Sad	Love	Happiness	Happiness	IDK	Depression	IDK	IDK	Confusion
11*	Female	16	Anger	Sadness	Love	Envy	Happiness	Joy	Fear	Calmness	Uneasy	Doubt
11*	Female	16	Love	Sadness	Peace	Excited	Happiness	Confused	Loneliness	Emptiness	Confusion	Anger
11*	Female	16	Lust	Calm	Hyper	Jealousy	Safety	Woah	Void	Anxious	Love	Irritated
11	Female	16	Anger	Sadness	Love	Envy	Happiness	Happiness	Depression	Confusion	Thoughtful	Confusion
11	Female	16	Angry	Sad	Love	Disgusted	Happy	Goofy	Jealousy	Bored	Sorrow	Confused
11	Female	17	Anger	Grief	Affection	Envy	Hope	Anxious	Wonder	Fear	Endearment	Insecurity

www.jofsr.org

10	Male	15	Anger	Sadness	Love	Happiness	Joy	Fear	Depression	Confusion	Jealousy	Hurt
10	Male	16	Sad	Depression	Sorrow	Normal	Sad	Sad	Sad	Sad	Angry	Sad
10	Male	15	Love	Jealousy	Joy	Jealousy	Joy	Confusion	Fear	Confusion	Jealousy	Depression
10	Male	15	Anger	Sad	Love	Excitement	Joy	Neutral	Hurt	Happiness	Confusion	Depression
10	Male	16	Love	Confusion	Mixed	Happy	Excitement	Jealousy	Anger	Empty	Remorse	Depression
10	Male	16	Anger	Sadness	Calm	Joy	Excitement	Mellow	Depressed	Confused	Jealousy	Neutral
10	Female	16	Love	Sadness	Excited	Jealousy	Joy	Anger	Hurt	Confusion	Relax	Fear
10	Female	16	Love	Uncomfortable	Nervous	Happy	Stress	Mad	Confused	Calm	Jealousy	Sadness
10	Female	16	Love	Sad	Excited	Stress	Happy	Annoyed	Fear	Calm	Jealousy	Confused
10	Female	15	Angry	Calm	Cheery	Disgust	Joy	Annoyed	Fear	Confused	Confused	Depressed
10	Female	16	Anger	Sadness	Love	Jealousy	Joy	Excitement	Depression	Relief	Fear	Grief
10	Female	16	Anger	Sadness	Happiness	Happiness	Joy	Joy	Depression	Numb	Jealousy	Depression
9	Male	14	Pain	Serenity	Love	Gluttony	Joy	Embarrassment	Sorrow	Calm	Sad	Nirvana
9	Male	14	Love	Excited	Love	Sick	Fear	Troubled	Depressed	Confusion	Jealous	Bored
9	Male	15	Love	Disappointment	Love	Happy	Jealous	Hurt	Depressed	Sick	Scared	Confused
9	Male	14	Anger	Happy	Love	Depression	Excitement	Scared	Anger	Confused	Depression	Neutral
9	Male	15	Anger	Depression	Love	Happy	Excitement	Jealous	Depression	Confusion	Hurt	Sorrow
9	Male	15	Love	Happiness	Embarrassed	Nauseous	Proud	Excited	Depressed	Calm	Frustrated	Sleepy
9	Female	15	Anger	Sad	Love	Disgust	Joy	Happy	Depressed	Confused	Hurt	Sorrow
9	Female	14	Love	Sadness	Happy	Disgust	Excited	Warmth	Hopeless	Hopeful	Confused	Tired
9	Female	14	Anger	Sadness	Happy	Happy	Disgust	Happy	Sad	Happy	Sorrow	Depression
9	Female	14	Anger	Sad	Love	Greed	Happy	Excitement	Sad	Neutral	Calm	Sad
9	Female	15	Violence	Calm	Kindness	Envy	Positivity	Optimism	Lost	Nostalgia	Trust	Light-headed
9	Female	15	Anger	Love	Love	Jealous	Joy	Happy	Sad	Happy	Nausea	Sad
Outlier	Male	27	Love	Calm	Innocence	Greed	Joy	Warmth	Hate	Innocence	Love	Sad

Outlier	Female	45	Love	Sad	Joy	Jealousy	Impatience	Confused	Depression	Peaceful	Hurt	Hurt
# of Positive Emotions Associated			20	9	41	15	40	21	0	10	8	0
# of Negative Emotions Associated			30	36	5	28	6	18	45	8	26	33
# of Neural Emotions Associated			0	5	3	6	4	7	5	29	13	15
# of Uncategorized Emotions			0	0	1	1	0	4	0	3	3	2

 * symbolizes that that person took part in the study of how room color impacts task performance

- In the chart above, the emotions highlighted in red are negative, green are positive, grey are neutral, and yellow are uncategorized.

The graph to the right has the information above complied into a bar graph.
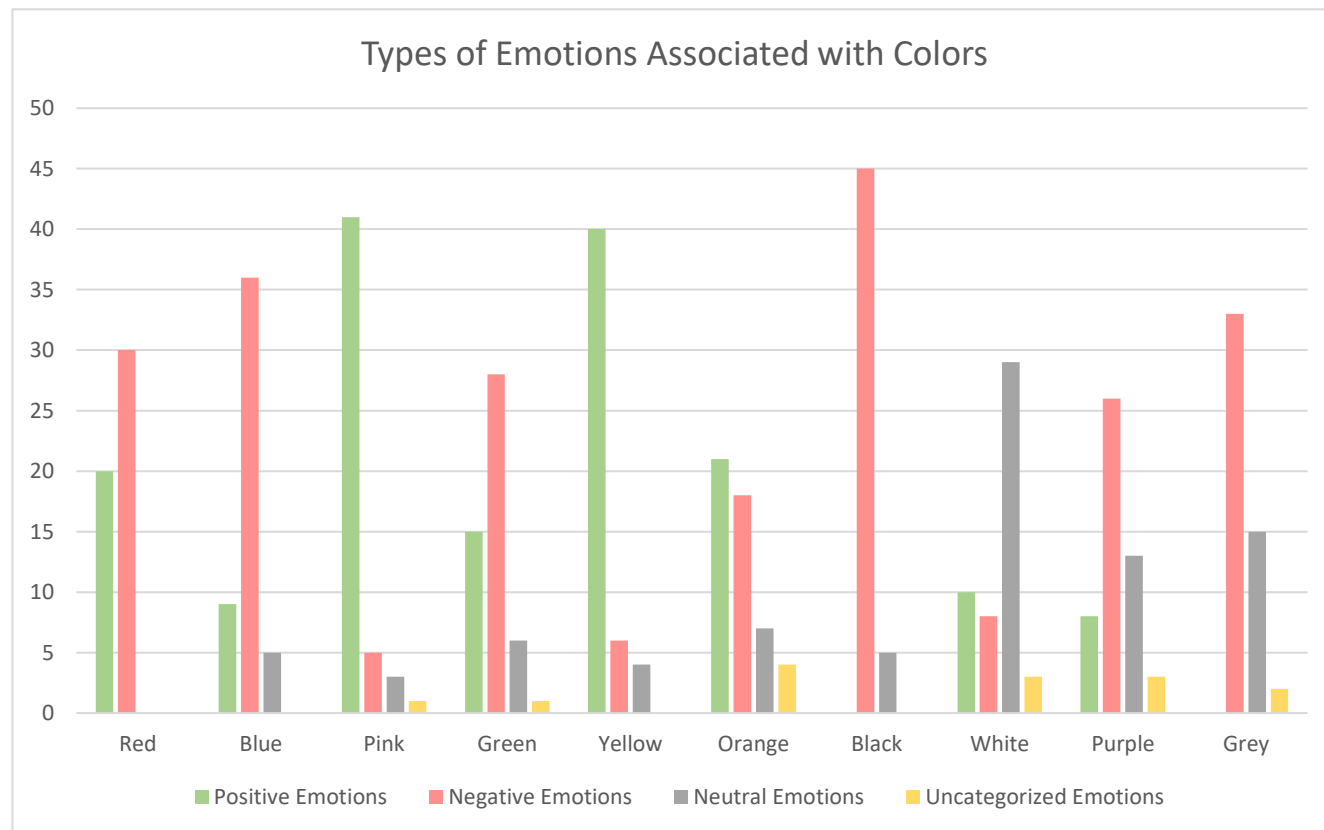
Types of Emotions Associated with Colors

The chart and graph above show the results to the first survey that asked, "What color do you think of when you think of theses emotions?" (Kaya). The goal was to see that different individuals could connected an emotion to a color, and in the results, each person was able to do so. Then, the responses were divided into four categories of emotions: Neutral emotions, positive emotions, negative emotions, and uncategorized emotions. The emotions were divided based on basic interpretation of emotions.

Uncategorized emotions were included because some participants answered "Woah", "OK", or "IDK" to some of the colors; therefore, these emotions could not be exactly categorized those as positive, negative, or neutral. Because interpretation of their emotions such as "Woah" or "OK" would throw off the research make the meaning of them what was desired for the research, "uncategorized emotions" was added as a category.

White is the only color that was majorly connected to neutral emotions. White was mainly connected to confusion. In this research study, confusion was considered to be a neutral emotion because without context it lacks that natural positive charge that love has or that natural negative charge that depression has. White is a low arousal colors that can have higher arousal states based on the individual. Confusion can be considered low arousal; however, like white it can also invoke higher states of arousal depending on the situation and the person.

Noticeably yellow, pink, and orange each had a higher amount of positive emotions connected to them than negative emotions. Yellow, pink, and orange are all warm colors meaning they are high arousal colors, and the emotions that they were connecting these colors to were majorly connected to are high arousal emotions: Love, joy, and excitement. Yellow and pink are typically connected to positive things by society. Yellow is often connected to the sun which is bright and often represents joy because when the sun is shining it is considered a good day. Pink is generally associated with love on Valentine's Day which is stereotypically a positive day for many people. Theoretically, it makes sense for both colors to be connected positive emotions since they are socially connected to positive ideas. Orange is not majorly connected to anything socially; therefore, this color could easily be connected to positive or negative emotions. In the results, orange was connected to positive emotions 21 times and negative emotions 18 times. The emotions associated with orange are based on personal preference because there is not a predetermined emotion connected to it by society like as love is connected to pink. Each of the colors are high arousal are they are connected to positive emotions, this could possibly be because the colors and the associated emotions are each high arousal and they have some unknown connection, the connections are socially generated, or they are purely based on preference.

Negative emotions were connected to red, blue, green, black, purple, and grey more often than positive emotions. Noticeably many of the emotions that are majorly connected to negative emotions (i.e. red, black, grey) are generally connected to negative things by society. Red, black, and grey are all commonly connected to negative emotions. Red is mostly connected to anger, black is commonly connected to depression, and grey is often connected to solemn or a drowsy feeling. For individuals to connect blue to negative emotions makes sense because blue is its own color and emotion. The color blue is often connected to the idea of feeling blue; however, it could be connected to a positive emotion based on personal preference too. Purple is a cool color which naturally means low arousal; however, the negative emotions it was connected to indicated that many individuals connect high arousal emotions such as fear or jealousy to this color. This is interesting because many of the colors and emotions connected have similar levels of arousal. Red is a high arousal color and anger is a high arousal emotion; Blue is a low arousal color and sadness is a low arousal emotion. The same idea with green was seen, though green can be considered to have a predetermined emotion connected to it. Though green provokes low levels of arousal, it was connected to jealousy and greed which are both provoke high levels of arousal. Green could have been connected to serene because green connects to nature; however, green is more often connected to money and greed by society. Considering that individuals connect a low arousal color to a high arousal emotion suggests that personal preference plays a larger role in the connections than originally thought. From the results, the participants were able to make some sort of connection from color to emotions, but how they made the connections or what caused them to make those connections is still unknown.

Looking at both charts and both graphs, something similar to what Anders Steinvall noticed in his study, where he asked participants to respond with a color for a given emotion, was seen. When presented with an emotion their response was one color, but when presented with that color, they did not necessarily connect it to that same emotion. When given the word "love", one may think of the colors pink and red; however, when presented with red, one may think of anger. It can be argued that high arousal emotions were connected to high arousal colors, in lieu low arousal emotions to low arousal colors, because of the level of arousal they provoke; however, to know this, the research would involve looking deep into each participant's reaction including their heartbeat, blood pressure, and body temperate amongst other things. This would require knowledge, skills, and resources that were not able; however, one thing that is certain that can cause the answers the participants gave is their personal preference. Each student had their own response to each color based on personal preferences even though if they think their response was not on preference, something unconsciously made them respond the what they did. While accounting for each person's favorite color in the research and analyzing why it is their favorite would be difficult, it is important to recognize that personal preference is one way that emotion is connected to color is important because it means that the participant A might have different feelings towards color X than participant B.

Overall

The available research that was read and the research that was personally conducted suggest that there is a connection made between color and emotion. It is mainly focused on if the participants can make a connection or if it can impact their performance, and that this research follows the same ideas. However, if it can be proved that blue does cause students to be calmer during testing than another color, it is important to start playing with that factor. According to the American Test Anxieties Association, "[a]bout 16-20% of students have high test anxiety" and "[a]nother 18% are troubled by moderately-high test anxiety." If this is true, then what is being done doing to minimize the impacts of test anxiety? As a student, standardized testing can induce

test anxiety. If there is a way to help lower the risk of test anxiety, then why not try it? That is where the recreation of Hulshof's study comes in. If it can be proved that blue does help increase a state of relaxation, then that should be investigated and studied more to make sure individuals are performing to their best ability on tests. However, one fear that comes from the idea of using the color blue in some way during testing is that fear will become an adapted emotion associated with the color blue if it is overused with the idea of testing. Despite the idea of fear being associated with blue during testing, this research falls short in the testing category and there should be more in-depth research done. If more detailed studies are done on the colors red and blue during testing and they show that one color causes higher levels of relaxation and it is proved, then students' test anxiety can be reduced or an effort can be made to try to reduce their test anxiety so they can perform to their best ability.

One flaw in this project is color-blindness was not considered, nor were the participants asked if they were color-blind. Though this was unintentional, it could have played a part in the research. Statistically, about 1 in 12 men are colorblind and 1 in 200 women are color-blind; approximately, only 2.5 males out of the 25 who took part in the survey, and 1 male out of the 12 who took part in the tests would have been impacted by color vision deficiency. Color-blindness might be the reason "uncategorized emotions" had to be included in the charts because the one individual put "IDK" as their emotional response to purple, orange, and white. The individual who answered with that response was male; therefore, he might have been the one male who was colorblind. This hole in the research was recognized after the research was conclude, and it would be impossible to go back to account for it in the surveys because it was all anonymous. Because of this flaw, studies similar to the ones this research referenced or to this one that strictly revolve around how shades of colors impact those who are colorblind would need to be completed. Hopefully with further research, a definite connection between colors and emotions or shades and emotions will be established and explained.

References

Cousins, Carrie. "Color and Emotion: What Does Each Hue Mean?" *Codrops*. Tympanus, 3 Apr. 2012.

Driscoll, Richard. "Test Anxiety". *American Test Anxieties Association*. 2016.

Freiders, S., et al. "The Influence of Color on Physiological Response." *Journal of Advanced Student Science.*

Goleman, Daniel. "A Relaxed Mind is a Productive Mind." *Mindful: Healthy Mind, Healthy Life.* Foundation for A Mindful Society. 10 Sept 2015.

Hulshof, Bart. *The Influence of Colour and Scent on People's Mood and Cognitive Performance in Meeting Rooms*. MS thesis. University of Twente, 2013.

Kaya, Naz and Helena Epps. "Relationship between color and emotion: A study of college students." *College Student J* 38.3 (2004): 396. 19 Oct. 2018.

Kutchma, Teresa M. "The effects of room color on stress perception: red versus green environments." *Journal of Undergraduate Research at Minnesota State University, Mankato* 3.1 (2003): 3.

Revelle, William, and Debra A. Loftus. "The Implications of Arousal Effects for the Study of Affect and Memory." *The Handbook of Emotion and Memory: Research and theory* (1992): 113-149.

Steinvall, Anders "Colors and Emotions in English". *Anthropology of color: Interdisciplinary multilevel modeling*. Ed. Dedrick, Don, et al. John Benjamins Publishing Company, 2007.

Toivonen, Riitta, et al. "Networks of emotion concepts." *PLoS One* 7.1 (2012): e28883.