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The Connection among Color, Lighting, and Anxiety

Mariah Palmer¹⁹

Color is a sensory stimuli that is encountered on a daily basis. There is a great deal of differing information pertaining to color research. Some of this research deals with color associations (Boyatzis & Varghese, 1994; Kaya & Epps, 2014). Other research studies the influence of color on emotional states or physiology (Jacobs & Suess, 1975; Kuller, Mikellides, & Janssens, 2008). Much of the prior research has concentrated on two primary colors; red and blue. The current study will look at the ways in which specific lighting conditions influence mood states, more specifically, anxiety levels. This research will have a goal of recruiting, at minimum, 90 participants. Participants will be tested in a lab setting where a colored light bulb will be manipulated. Color conditions that will be measured are red lighting, blue lighting, and neutral lighting. Anxiety level tests will be completed twice, once to obtain a baseline measure and once after exposure to a color lighting condition to test any effects that color may have had on anxiety. The hypotheses are that when exposed to red lighting, anxiety will increase, when exposed to blue lighting, anxiety will decrease, and participants in the neutral condition will have no significant change in level of anxiety.

One common perceptual experience among humans is the sensory stimuli of color. Moreover, color has many differing roles, for example, there are emotional associations made relative to colors (Boyatzis & Varghese, 1994; Kaya & Epps, 2014). Previous research also suggests that the concept that color may have an influential relationship with various emotional, biological, or psychological responses (Jacobs & Suess, 1975; Kuller et al., 2008). A great deal of previous research focuses on the associations between color and emotion versus an actual implicit influence of color on emotions or mood. However, there is a handful of research that does look at various influences of color on psychological aspects such as purchase likelihood, reaction times, performance, and other impacts (Bellizzi & Hite, 1992; Duncanson,

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2009; Kombeiz & Steidle, 2018; Wang, Shu, & Mo, 2014). Previous investigations on color have determined varying results, making it an imperative topic to continue studying.

There is a great deal of information that is relative to color associations. Many researchers first start color studies by speculating on what types of words or emotions are associated with different colors. Boyatzis and Varghese (1994) studied children's emotional associations to color. While specific reactions among the children differed, the ratings for color were overall positive at 69%. These data are similar to that provided by Kaya and Epps (2004), later studying adults' color associations, which was that 62.2% of color was rated positively. In the current research, Boyatzis and Varghese (1994) collected data by showing children nine different colors on sheets of paper. Researchers tested a total of 30 children. The colors rated as most "happy" were pink, which 44% of participants rated as happy, then purple (39%), and red (35%). The more negative attributes were "sad" which 21% reported gray (21%) and black (16%). Black was identified as being the most "angry" rated color at 24% of children. In a study by Kaya and Epps (2004), participants were tested to look for trends in emotions that were related to specific colors. A total of 98 participants with no color-blindness were shown 13 colors on a computer screen and then asked to give their emotional response to the color on the screen. With the 13 colors, there were 3 categories that they were separated into: principal hues, intermediate hues, and achromatic colors. The emotions were then coded to determine whether they were neutral, negative, or positive associations to the 13 colors shown. Overall, the frequency of positive association was 792 (62.2%) for all colors with 436 negative (34.2%), and 46 neutral (3.6%). As for principal hues, green was the most positive (94 participants), followed by yellow (92 participants), blue (78 participants), then red and purple (63 participants). The most negatively associated color was gray where 89.8% of participants rated this unfavorably (Kaya & Epps, 2004). While this study cannot describe implicit emotions

resulting from color, it gives some insight into further color research. For example, if data shows that participants relate colors to emotions, or moods, it is possible that they do this because they are physically feeling these emotions. These two studies show that there are significant color association patterns that remain similar over time and demographic

Another study, which focused on children's color emotions, had children complete an activity where they used colored crayons to fill in positive or negative emoticons (Annamary et al., 2016). Upon testing a total of 382 children, the researchers found that the boys colored in a happy face more often blue (44.8%) and girls colored a happy face more often pink (63.6%). However, an equal percentage of boys (46.8%) and girls (46.9%) colored in the negative emoticon with the red shade. The information provided by this study again shows the trends with color and emotional association (Annamary et al., 2016).

Wang et al. (2014) investigated how the colors blue and red priming conditions would influence emotional states in participants. In order to do this, they tested 31 Chinese college students with no color-blindness. To mask the purpose of the study, the task given to the participants was to decide if a word they were presented with was either true or untrue; however, the researchers were focused on the time that it took a participant to respond to a specific word. They used a total of 180 words, splitting them up evenly into positive, neutral, and negative. The researchers found support for their hypothesis that red induced positive and negative emotional states and that blue induced positive emotional states (Wang et al., 2014).

In a comparable study looking at task time, Kombiez and Steidle (2018) tested 146 participants to see if performance was facilitated by accent lighting of either blue or red. Participants were tested, up to eight at a time, in a room that was lit with white lighting and accent lighted with either red, blue, or white projection. Participants were asked to do multiple tasks including, mood ratings and regulatory focus (connect the dots activity), preceding ratings

of task difficulty, motivation, and fun. Participants were measured on each of these items including speed and accuracy of regulatory focus activity. The results of this study indicated that the room lighting significantly influenced the regulatory focus activity in speed; however, it did not significantly report that the lighting influenced accuracy of the task. The data did not show any statistically significant support for any influence on other measured variables (Kombiez & Steidle, 2018).

Studies have also been completed researching the influence that color has on businesses, or selling opportunities. Bellizzi and Hite (1992) did a two-part study to gather data on the feelings of consumers. In the first experiment, researchers tested 70 women and only exposed each participant to only one of the conditions. The two conditions in the study were either a red projection or a blue projection on the wall. The projectors gave information on four television options and participants were asked to decide which one they would prefer to purchase, along with one option to purchase none at all. The data of this experiment showed significant differences between the two conditions. In the red condition, more participants (39%) selected none at all versus less participants (18%) selecting this option in the blue condition. Additionally, the average theoretical amount spent in the two conditions was less in the red condition (\$314) versus in the blue condition (\$458). The researchers found that no other factors, such as time spent shopping, age, education, or income influenced their results (Bellizzi & Hite, 1992). In a continuation of this study, 107 undergraduate students were questioned in color conditions of red and blue. In the second part of the experiment, researchers were curious about the interior settings of a furniture store and whether it would influence purchase choices. Participants were shown slides of the interior of this particular store in either the red or the blue condition and then asked about their opinions of the store. Similar to first experiment, blue and red provided significant differences (Bellizzi & Hite, 1992).

In a more dated study, looking at trait anxiety and color exposure, Jacobs and Suess (1975) tested 40 undergraduate students by exposing each of them to a color condition and measuring their anxiety after periods of time. Participants were randomly assigned to either blue, red, green, or yellow. Participants were then given the State-Trait Anxiety Inventory that they would fill out 3 times, spending a total of 5 min on each. The data show that the blue and green ($M = 30.47$) conditions significantly differed from the two other color conditions, red ($M = 42.70$) and yellow ($M = 41.10$) at the $p < .025$ level. These data are consistent with previous data that show how red is a more arousing than blue or green (Jacobs & Suess, 1975).

Much like this study, Kuller et al. (2008) completed a three-part experiment looking at the arousal impacts of different colored rooms by comparing a multi-colored room versus a gray room and then a red versus blue room. In the first experiment, researchers measured the arousal levels of 12 participants exposed to both conditions. The two conditions were the colorful room and the gray room. They found that there was no significant difference in the assessment of emotional state between the two conditions (Kuller et al., 2008).

Previous research provides both data that supports and does not support the current study, making it even more essential to continue looking for answers. Knowing that color may influence mood, arousal levels, decisions, and even task or time management, the current study will look at how lighting may influence levels of measured anxiety. Similar to studies like Bellizzi and Hite (1992) or Kombiez and Steidle (2018), the current study will use artificial colored lighting to test three hypotheses. Bellizzi et al. (as cited in Bellizzi & Hite, 1992) provide the information that warmer colors (such as red) are more arousing than cooler colors (such as blue) which are the reasoning for the following hypotheses. The first, is that participants in red lighting will have increased anxiety from pre- to posttest. The second is that

participants in blue lighting will have decreased anxiety from the pre- to posttest. The third hypothesis is that participants in the control setting will have no change in measured anxiety.

Proposed Methodology

Participants

For this research study, participants will be recruited through the Lindenwood Participant Pool (LPP), through flyers placed around the campus of Lindenwood University, and online through Facebook. The anticipated participant count is 90 participants, with 30 per condition. As a result of only being able to recruit a sample of convenience, a majority of the participants will be college students from Lindenwood University. However, all consenting adults will be allowed to participate. Participants will be compensated in one of two ways; those recruited through the LPP will earn two bonus points while participants recruited from flyers or Facebook will be given the option to enter a drawing for a \$25 Amazon e-gift card.

Materials and Procedure

The anxiety scale, derived from Abdel-Khalek (2000), and demographic questionnaires will be set up online using Qualtrics (see Appendices A and B for questionnaires). The questions utilized to measure anxiety will be adapted so that an equal number of each question type will be distributed for the pretest and the posttest. No other changes to the questions or to the measuring of the questions will be made. The demographic questionnaire will be designed by the primary investigator. A secondary survey will be utilized so that non- LPP participants would be able to submit their email address with confidentiality (see Appendix C). This information will be necessary for the participants who wish to enter into the e-gift card drawing. This second anonymous survey will be used to ensure that no records of the participants would be traced back to their data provided. Participants will fill out the surveys on an iPad to warrant privacy for those who take it. The activities for the participant

to select from will also be consolidated by the primary investigator from a variety of webpages (see Appendix D for activities and links to webpages). These activities will be offered on paper, in the testing room. Participants will be given non-colored pencils to fill out the activities if they choose to do so. The room that the participant is in will be one of three colors: blue, red, or neutral white lighting. The lightbulbs used are the Phillips Hue which adapt to many different colors to keep setting up the study simple. The lightbulbs will be inside of lamps rather than in ceiling lights; however, the ceiling lights will be turned off in all conditions.

When participants meet at the location, they will first be asked to fill out the informed consent and agree to participate. Following this, participants will then answer the pre-test outside of the testing room. They will then enter the testing room where they have the option of partaking in the offered activities or just sitting in the colored room. When participants enter the testing room, they will be asked to refrain from using their own cell phones as it may interfere with the collected data. They will be timed for a total of 7 min on the primary investigator's cellular device. After the 7 min, they will take the post-test inside of the testing room while still under the influence of the color, or non-color stimuli. Upon completion, participants will be debriefed on the purpose of the study and thanked for their contribution. Non-LPP participants will be given the option to provide their email on the second anonymous survey. After all data is collected, the e-gift card drawing will take place by encoding the participants by number and using a random number generator. Additionally, upon collection of data, statistical analyses will be conducted using SPSS and Microsoft Excel.

Projected Results

The anticipated results of this research study are that red and blue lighting color will have an impact on anxiety levels. Statistical analyses will be conducted to see if red lighting increased participant anxiety, if blue lighting decreased participant anxiety, and if there was no change

among participants in the control condition. Using either SPSS or Excel, related samples *t*-tests will be conducted to look at each of the lighting conditions (red, blue, and control). Descriptive statistical analyses will also be conducted to look at the demographics of the participants in all conditions.

Discussion

As mentioned earlier, there are varying conclusions drawn about the influence that color and lighting have on mood states. This study is proposing to look at how color, lighting, and anxiety intersect and to hopefully provide more information regarding this area of literature. This research will tentatively offer suggestions on how color influences mood so that changes could be made in our daily lives to reflect the data. For example, if the color red shows to increase anxiety, then suggestions can be made to decrease the amount of red one is exposed to per day. Not only that, but it may also increase interest in this area of study and further encourage researcher to study how color influences our daily lives.

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Appendix A

Pre or Post Test: Will counterbalance which test goes first.

Q1 Please rate your feelings of the following on a scale of 1 (rarely) to 4 (always).

	1 (1)	2 (2)	3 (3)	4 (4)
My nerves are strained. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel frightened. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I suffer from short breath. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think of things that worry me. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My heart beats fast. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get dizzy. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I expect bad things to happen. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am a nervous person. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My heart beats are irregular. (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel nervous. (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Pre or Post Test: Will counterbalance which test goes first.

Q2 Please rate your feelings of the following on a scale of 1 (rarely) to 4 (always).

	1 (1)	2 (2)	3 (3)	4 (4)
I am afraid of losing self-control. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am tense. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel anxious. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am not at ease. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I worry of the future. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel unstable. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My muscles feel tense. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel jittery. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel worried. (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am restless. (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix B

Q3 How would you define your current gender identity?

- Female (1)
- Other, please specify (2) _____
- Male (3)

Q4 What is your age?

Q6 Which of the following activities did you participate in during your time today? Please select all that apply, even if you did not complete the task.

- Word Search (1)
- Word Scramble (2)
- Crossword Puzzle (3)
- Sudoku (4)
- Maze (5)
- Other, please specify (6) _____

Q7 Select the following words that would describe your experience in the testing room, please select all that apply.

- cheerful
- energetic
- exciting
- Irritating
- loud
- neutral
- noisy
- peaceful
- quiet
- restful
- sad
- warm

Q5 Do you have any type of color blindness?

- Yes, please specify (1) _____
- No (2)

End of Block: Demographic

Appendix C

Start of Block: Email

Q1 Please provide an email that I can use to contact you if you win the gift card drawing:

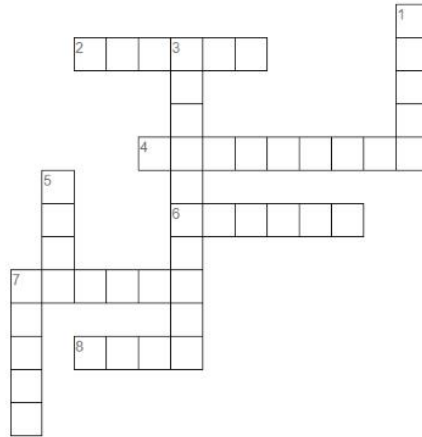
End of Block: Email

Appendix D

Crossword Puzzle

<http://www.whenwecrosswords.com/crossword/earth/264437/crossword.jsp>

Earth

**Across**

- 2 Small areas of Earth's crust that rise above water.
 4 Very large areas of land; there are seven _____ on Earth.
 6 The crust is broken into many pieces called _____.
 7 The layer beneath the crust made of melted rock called magma.
 8 The center of Earth.

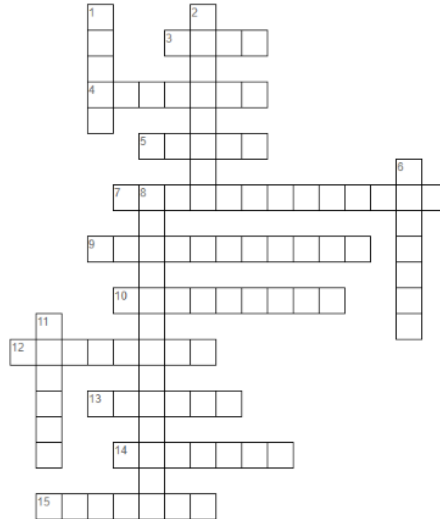
Down

- 1 The outer layer of Earth.
 3 A blanket of gases, including oxygen, on the surface of planet Earth.
 5 Hot magma that comes out of a volcano.
 7 Melted rock in the Mantle.

Crossword Puzzle

<http://www.whenwecrosswords.com/crossword/earth/251019/crossword.jsp>

Earth



Across

- 3 the dense metallic center of the Earth
- 4 the investigation and exploration of natural events and of the new information that results from those investigations
- 5 landforms with low relief and low elevation
- 7 the outer part of the magnetic field that interacts with these particles
- 9 the crust and the uppermost mantle grouped into a rigid layer by scientists
- 10 Earth's entire solid body
- 12 topographic features formed by processes Earth's surface
- 13 shaped like a ball, with all points on the surface at an equal distance from the center
- 14 the amount of mass in a material per unit volume
- 15 areas with low relief and high elevation

Down

- 1 the brittle rocky outer layer of the Earth
- 2 landforms with high relief and high elevation
- 6 the force that every object exerts on all other objects because of their masses
- 8 the plastic layer within the mantle
- 11 the thick middle layer in the solid part of the Earth

Word Search

All About Plants



ANGIOSPERM
BARK
BRYOPHYTES
CARBON DIOXIDE
COMPLEX
CONE
CONIFER
FERN
FLOEM
FLOWER
FRUIT
GLUCOSE
GYMNOSPERM

LARGE
LEAF
LIGHT
MEDIUM
MOSS
NAKED
NONVASCULAR
OXYGEN
PLANTS
POLLINATION
PROTECTED
SEEDED
SEEDLESS

SEEDS
SHORT
SIMPLE
SMALL
SPORES
STOMATA
SUGAR
SUNLIGHT
TALL
UNPROTECTED
VASCULAR
WATER
XYLEM

http://www.whenwordsearch.com/word_search/all_about_plants/23262/word_search.jsp

Word Search

http://www.whenwordsearch.com/word_search/earth/38/word_search.jsp

Earth

Spot words to describe Earth

I	S	E	E	V	D	N	E	R	O	C	R	E	T	U	O	E	K
C	T	R	L	Y	Y	K	A	D	K	L	T	F	J	L	T	V	
C	N	E	J	T	C	J	E	H	J	R	O	R	M	T	A	Z	X
U	E	H	Q	P	E	P	E	Y	S	M	E	W	N	R	B	Y	T
Z	N	P	L	U	J	C	L	D	Y	O	Y	A	E	N	S	A	P
Q	I	S	U	R	X	X	T	R	E	V	M	Y	Z	D	O	Q	V
M	T	O	W	E	A	Y	Y	O	G	R	A	V	N	E	H	O	N
V	N	R	G	T	L	F	D	G	N	L	O	A	D	O	Z	D	M
C	O	D	K	A	N	P	N	E	E	I	L	C	C	L	W	G	L
D	C	Y	H	W	J	P	K	N	B	S	C	E	R	T	R	Y	B
R	T	H	N	T	M	E	O	F	I	G	A	P	E	E	U	O	Y
I	X	O	J	L	B	Z	N	U	D	N	Y	R	L	J	N	W	W
H	V	F	C	A	O	Q	J	E	S	U	R	J	M	A	A	N	E
T	N	S	F	S	Y	H	P	L	M	A	Z	Q	Y	E	T	H	I
B	U	V	W	E	L	R	Y	O	X	I	M	K	I	X	M	E	A
N	H	R	D	I	O	R	E	H	P	S	E	T	A	L	B	O	S
V	V	D	N	E	R	T	E	N	A	L	P	E	U	L	B	E	Y
M	P	A	U	D	V	G	E	Z	G	N	Z	S	U	E	Z	L	R

BLUE PLANET
CONTINENTS
HYDROGEN FUEL
HYDROSPHERE
INNER CORE
ISLANDS

MANTLE
MOON
OBLATE SPHEROID
OCEANS
OUTER CORE
OZONE LAYER

SALT WATER
SUN
TECTONIC PLATES
TERRA
THIRD
WORLD

Sudoku

<https://www.websudoku.com/?level=3>

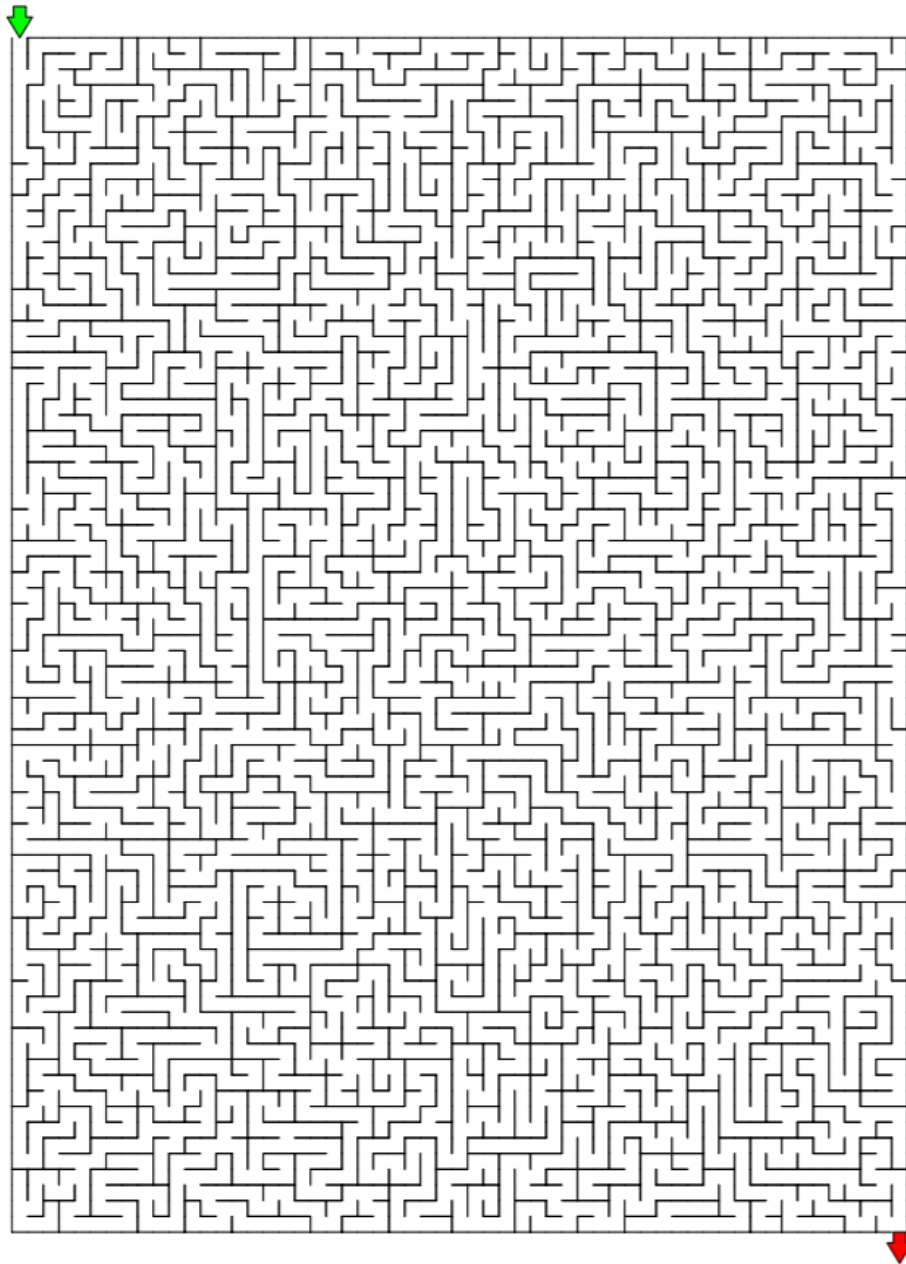
9		5	4					
		4	3				5	
		2			6	7		
				4		5		
5	4			2			7	9
		6		1				
		9	5			8		
	2				7	9		
					1	4		3

Sudoku

<https://www.websudoku.com/?level=3>

3	2			4	7			5
8					3	6	4	
5		4						
				1				
2		8				3		4
				3				
						4		1
	5	6	4					7
4			1	8			5	9

Maze Game



https://krazydad.com/mazes/sfiles/KD_Mazes_ST_v8.pdf

Maze Game

https://krazydad.com/mazes/sfiles/KD_Mazes_ST_v8.pdf

