

AVOIDANCE MOTIVATION AND COGNITIVE PERFORMANCE

by

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ABSTRACT

Past research has found that avoidance motivation can be induced by red color priming and has a detrimental effect on cognitive performance. It has also been found that when put in a state of ego-depletion, one also performs worse on a cognitively demanding task. The present study sought to determine if an unconscious presentation of the color red is enough to induce avoidance motivation, as well as to check how ego-depletion plays a role in moderating this effect on an anagram task. The results from this experiment do not support the hypothesis and no effect of either avoidance motivation nor ego-depletion had a significant effect on cognitive performance.

CHAPTER I

INTRODUCTION

Avoidance motivation is a psychological thought process in which the focus is to lower the probability of a negative outcome (i.e. avoiding an accident while driving or drinking coffee to avoid sleepiness), rather than a thought process framed to ensure safety or alertness (i.e. driving slow to promote safety or drinking coffee to increase energy and focus) (Mehta & Zhu, 2009). Avoidance motivation can be induced by salient and emotionally meaningful features of the environment (Friedman, 2008). In particular, color has been suggested to induce avoidance motivation, an effect termed “color-in-context” (Elliot & Maier, 2014; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Mehta & Zhu, 2009).

The purpose of the study reported here is to provide a more rigorous experimental test of the claim that visual color (specifically the color red) can induce avoidance motivation in a manner that has a negative effect on cognitive functioning. There is substantial evidence (reviewed in Chapter II, below) for a *conscious* effect of color-in-context on avoidance motivation. However, it remains to be determined if avoidance motivation can be induced by the *unconscious* perception of color. This is the first goal of the present study reported here. Furthermore, additional evidence suggests that color-induced avoidance motivation is enhanced by the effects of *ego depletion* – the phenomenon in which the performance of a task requiring self-control inhibits one’s

ability for self-control on a subsequently performed task (Bertrams, Baumeister, Englert, & Furley, 2015). Unfortunately, this past evidence for ego depletion is limited by several study design confounds (reviewed in Chapter II, below). Thus a secondary goal of the present study was to examine if color-in-context-induced avoidance motivation would be modulated by ego depletion when those previous confounds were eliminated using an improved study design.

This introductory section will first explain avoidance motivation and color-in-context effects, including evidence that color can affect cognition via priming. Priming refers to the phenomenon in which the processing of a stimulus is affected by a prior presentation of that stimulus or an associated stimulus, known as the prime. It will be shown that past research has yet to determine if the influence of color priming is dependent on the prime being presented inside or outside of awareness. It will then be shown how ego-depletion has played a role in moderating the effects of avoidance motivation, as well as the recent debate on the existence of ego-depletion as a phenomenon.

CHAPTER II

LITERATURE REVIEW

Avoidance Motivation

The existing evidence suggests that avoidance motivation negatively affects cognitive performance by inducing anxious and self-protecting tendencies within a specific achievement context. An achievement context refers to any situation in which both success and failure are possible and based on evaluation of performance (Elliot, et al., 2007). The negative tendencies induced by avoidance motivation typically reduce, rather than enhance, performance because they prescribe behavior towards avoiding anything negative, without necessarily directing behavior towards something more favorable (Roskes, Elliot, & De Dreu 2014).

Avoidance motivation can be measured by using both self-report questions (for example “was it more important to avoid failure or to achieve success”) or by using a task in which a choice must be made to either avoid a negative outcome or approach a positive outcome (Mehta & Zhu, 2009). Using Mehta & Zhu’s (2009) self-report questions to obtain an avoidance motivation score, Harmon-Jones & Sigelman, (2001) found that avoidance motivation is associated with an asymmetry in alpha-range (8 – 12 Hz) frontal oscillatory activity of the cerebral cortex, where this asymmetry is driven mainly by an increase in activity of the right frontal cortical hemisphere. Harmon-Jones and Sigelman (2001) examined whether asymmetrical frontal activity was indicative of motivational direction rather than emotional valence using electroencephalographic (EEG) recordings of brain cortical activity. Although previous research had suggested that approach

motivation is associated with a left prefrontal increase, and avoidance motivation a right prefrontal increase, these observations were confounded, respectively, by the occurrence of positive and negative emotions (Harmon-Jones & Allen, 1997). By inducing a negative approach-based emotion, it could be determined whether the brain activity is correlated to either approach or avoidance motivation. The negative and approach-based emotion used by Harmon-Jones and Sigelman was anger. To test this hypothesis, forty-two participants completed a task designed to either cause anger in some subjects (experimental group) or induce no emotional response in other subjects (control group). A measure of aggression was also taken after performance of the task. The results of this study found that those in the angry task condition exhibited increased left frontal activity in the alpha range compared with those in the neutral condition. Those in the angry condition also scored as more aggressive. These findings supported the conclusion that asymmetrical frontal activity is more greatly associated with motivational direction rather than emotional valence. In fact, alpha-range EEG frontal asymmetry has been long observed to reflect motivational direction with greater right activation for avoidance motivation and greater left activation for approach motivation (Kelley, Hortensius, Schutter, & Harmon-Jones, 2017).

Color-in-Context Theory

Research suggests that avoidance motivation can be induced by salient and emotionally-meaningful features of the environment such as the color red (Elliot et al. 2007). The idea that a color, under certain circumstances (i.e. red in an achievement context), can influence cognitive processes is known as the *color-in-context theory*.

These researchers hypothesized that cultural and evolutionarily embedded predispositions

associate red with danger as well as failure, and thus perception of the color red induces avoidance motivation towards failure in achievement contexts. This avoidance motivational tendency undermines performance in this context indicating a detrimental effect on cognition (Elliot, et al., 2007). Past studies typically induced avoidance motivation using the method of *color priming*, in which task performance is affected by the prior presentation of a colored stimulus (*the prime*).

For example, Elliot et al. (2007) conducted six separate experiments that each showed a significant effect of red on cognitive performance. In the first experiment, American undergraduates solved 15 anagrams of the same length with only one possible solution. Here, each participant received a hard copy task packet with a participant number written in red, green, or black ink in the top right hand corner of each page of the test. Experiments 2 through 5 were similar to the first experiment, except that either the control color was changed from black to white (in Experiment 2) or grey (in Experiments 3, 4, 5, and 6), a different population was used to draw the sample group (i.e. American students participated in the first experiment and German students participated in the rest), or a different type of test was given (i.e. analogy IQ subset in Experiments 2, 3, and 6 or numerical IQ in experiment 4). It should be noted that Experiments 2 through 6 also contained a green color condition to test if opposite effects occurred when compared to the red condition. The fifth experiment was designed to examine a behavioral indicator of motivational valence. It has been shown that individuals exhibiting avoidance motivation often prefer a less difficult task to a more difficult task Atkinson (1957). The form in which the color was presented was also altered in some of these, usually presented in the form of a title word inside a colored box in the middle of a white page in experiments

three through five or on a slide if on the computer as in Experiment 6 (Elliot, et al., 2007). Experiment 2 simply used a colored folio paper stuck to the first page for color manipulation. In the 6th experiment, all stimuli were presented on a computer screen, while participant's EEG was recorded during the task to assess frontal EEG asymmetry. Participants also completed an IQ test. All six experiments provided behavioral evidence that red did have a detrimental effect on performance. In addition, Experiment 6 found asymmetrical cortical activity in the frontal cortex, with the right side showing greater activity in those in the red treatment condition, consistent with the hypothesis that red induces avoidance motivation (Elliot, et al., 2007).

The effect of red on performance has been supported further by Brooker and Franklin (2016). In this study, 359 children between the ages of eight and nine were tested on five tasks assessing the effects of several colors (red, orange, yellow, blue, purple, light blue, and light red) on cognitive performance. These tasks involved reading comprehension, numeracy, collage originality, collage detail, and embedded figures tasks. When looking at average cognitive performance, red was the only color showing a significant detrimental effect on performance through the induction of avoidance motivation. These findings strengthen the theory that red negatively affects performance by inducing avoidance motivation. By using a younger sample group this study also generalizes earlier findings to a different participant population.

Expanding on this research, Mehta and Zhu (2009) used a different task design to test red color effects on cognition. Instead of using achievement contexts, a detail-oriented task was used under the assumption that avoidance motivation would increase vigilance and focused attention while decreasing risk taking behavior; in turn, this would

lead to an increase in performance. These researchers tested both red and blue color effects on cognition in both detail and creative contexts. This was achieved by conducting six experiments testing the effects of red and blue on avoidance and approach oriented tasks (Mehta & Zhu, 2009).

The first experiment had two tasks. The first task required participants to solve 12 anagrams with either approach-related words (3), avoidance-related words (3), or neutral words (6). Here each color was presented as the background of the computer screen upon which the anagrams were displayed. When presented with red, participants performed better with faster completion times for avoidance-related words, compared to approach-related words. The opposite pattern was found when participants were presented with blue, whereas no effect was observed in the neutral condition (Mehta & Zhu, 2009). In the second task, participants rated pairs of advertisements for preference, with each pair again presented against a blue or red background. Each ad pair contained one ad that focused on avoiding a negative outcome with their product and the other reaching a positive outcome. Participants preferred the avoidance style ad when a red background was used, whereas the approach (achievement) style ad was preferred when using the blue background. Hence this first experiment not only demonstrated the expected effects of color priming on cognition, but also showed that these colors could induce the motivation that they were hypothesized to be associated with (Mehta & Zhu, 2009).

Experiments 2 and 3 in this study each gave participants either an avoidance- or an approach-related task on a computer with the background manipulated to blue, red, or neutral color. Again it was found that red improved performance on the avoidance-related task and decreased on the approach task, with the opposite pattern holding true for the

blue condition. Experiment 4 in this study had participants complete a task that was scored on both detail (avoidance) and creativity (approach) scales. Here participants were given 20 object (toy) parts that were all either red or blue and told to design a child's toy. Those using the blue set created more novel toys and those with red sets created toys that were more practical with parts relevant to each other. Similar to the second task in the first experiment, in Experiment 5 participants chose a preference for an advertisement that was either detail oriented or required creativity. Each participant saw both ads with either a red or blue background. In the red background condition, the ad with more details given was preferred where the other ad was preferred in the blue treatment (Mehta & Zhu, 2009). The last experiment simply tested for awareness of color effects without actual color manipulation. Here participants were instructed that a detail-oriented task was to be completed and asked if they thought a blue or a red background would help improve their performance. They were then instructed that another task would also be given to them that involved creativity and again asked which color would improve performance. Blue was chosen significantly more often for both styles of tasks (Mehta & Zhu, 2009). Each of the experiments found the color red to induce avoidance motivation, thereby decreasing cognitive performance.

While a compelling amount of research has been conducted supporting the theory that red influences cognitive performance in specific contexts, conflicting results have also been found. For example, Steele (2014) replicated the design used by Mehta and Zhu (2009) using a larger sample group of two hundred and sixty-three participants. No effects of red or blue were found on cognitive performance suggesting that the findings of Mehta and Zhu (2009) may have been the result of Type-I error due to low sample size.

Steele (2014) suggested two ways to improve the overall study design. First, variability in the average length of the avoidance-related anagrams versus the neutral anagrams could have reduced any color effects present. Second, the content of the anagrams could have been confounded by varying levels of difficulty between word types (Steele, 2014). Other research examining the role of motivational valence in regards to *color priming* has identified several flaws in the basic design of previous studies, such as not controlling for many different aspects of variables including word length, difficulty, standardization of the brightness or contrast of the color stimulus, ensuring researchers are blind to participant condition, and most importantly accounting for the context of the experimental condition (Elliot, et al., 2007; Mehta & Zhu, 2009; Steele, 2014). In order to fully establish color-in-context effects on avoidance motivation, future research designs must take these factors into account (this is one improvement of the present study; see Chapter III, below).

Priming mechanisms of the Color-in-Context Effect.

The Color-in-Context effect can be viewed as a manifestation of conceptual red color priming. It is assumed that the prime affects performance by creating a response in accordance with the cognitive schemas related to the prime. This leads to an increase in processing efficiency, as well as activation in brain areas related to the relevant type of response (Wagner, Koutstaal, Maril, Schacter, & Buckner, 2000).

A response-mapping model has been used to explain two different types of priming, perceptual priming and conceptual priming (Scherer & Lambert, 2009). Perceptual priming occurs when the prime shares some or all of a physical aspect with the target (Kim, Porter, & Goolkasian, 2014). An example of this is repetition priming,

where priming effects are increased the more an object is repeated (Martens & Gruber, 2012). Conceptual priming refers to a commonality shared between the stimulus and the prime, however in this case the relatedness need be only semantic, rather than physical (Kim, et al., 2014). This type of priming has been shown to occur with the use of cross-modal presentations of conceptually similar stimuli. For example, Kim et al. (2014) showed representations of 80 different objects with either a semantically-related or a neutral prime presented beforehand. Each object was represented by four different stimuli, two pictures and two sounds. For example, a cat stimulus would be shown as either a picture of two different cats or the sound of two distinctly different cat sounds. In congruent trial conditions, in which the prime and target are semantically related, the prime and target were presented as different representations of the same object in order to avoid the induction of perceptual priming from any physical relatedness between stimuli. The results of this study showed the presence of priming effects regardless of modality, providing support for the idea of a conceptual prime (Kim, et al., 2014).

It has been shown that cognitive performance can be contextually influenced by the perception of specific stimuli related to the task at hand (Bargh, Gollwizer, Lee-Chai, Barndollar, & Trotschel, 2001). This study had participants primed with either impression formation-related words, such as evaluate, or memorization words, such as retain or absorb, and given a list of words to remember. It was hypothesized that since stimuli that induce impression formation are remembered better than stimuli that do not, those primed with impression formation-related words would remember the list better than those primed with other words. This contextual effect was shown to be so great that impression

formation priming improved list memorization to a greater degree than priming with memory-related words (Bargh et al., 2001).

Unconscious priming and Color-in-Context Effects.

Priming effects can also be induced unconsciously (Ansorge, Klotz, & Neudmann, 1998). This is often achieved by the use of a mask. A mask is a stimulus presented immediately before a prime (paracontrast mask) or after a prime (metacontrast mask) that disrupts the prime's visibility (Breitmeyer, Ogmen, & Chen, 2004). Color can induce priming effects on cognition, even when primed outside of awareness with the use of a mask (Breitmeyer, et al., 2004). For example, Breitmeyer et al. examined how metacontrast and paracontrast masking of color influences perception and cognition. In an initial experiment, they used paracontrast and metacontrast masks to determine the optimal masking stimulus onset asynchrony (SOAs) for each subject. These SOAs were then used in a second experiment, where participants indicated whether a target stimulus consisted of either two blue circles or two green circles on a computer screen. Each stimulus was primed using a mask with a color that was either congruent or incongruent to the color of the target. Half of these trials included only a metacontrast mask, while the other half presented both a metacontrast and a paracontrast mask. Although both conditions yielded an increase in reaction time from congruent to incongruent trials, the metacontrast mask only condition held a much greater difference between these two (Breitmeyer, et al., 2014). This indicates that a sole metacontrast mask is the better option when dealing with color priming. The second experiment was quite similar to the first, except shape, or form, was the subject of manipulation rather than color. No significant difference in mask type was found here. While the nature and methods of the color-in-

context theory have been examined, and a physical color priming effect has been found, little research has yet to examine unconscious conceptual color priming. Thus far, it has been shown by past research that conscious priming with the color red is likely to induce avoidance motivation thereby affecting cognitive performance within an achievement context.

Ego-Depletion

More recent research attempting to refine the theory of red color effects on cognitive performance have included the use of ego depletion (e.g. Bertrams et al., 2015). Ego depletion may be defined as a state in which an individual's self-control is limited due to relevant cognitive resources being used up in a task immediately prior. In Bertrams et al.'s study, three separate experiments assessed the potential effect of red color priming on cognitive performance after participants underwent ego depletion (Bertrams, et al., 2015). The first experiment had participants transcribe an article while leaving out the letters "e" and "n". This difficult task should have taxed the cognitive resources of the participants and thus created an ego depletion condition. A control group performed the much easier task of article transcription without leaving out letters. After article transcription, participants then completed an arithmetic task in which they performed triple by single digit multiplication. The booklet containing the multiplication task had a cover page displaying the word "Test" surrounded by either a red box or a grey box. This cover page served as a form of conceptual prime for performance of the multiplication task. Thus, this study had a 2 x 2 factorial design with the factors of ego depletion (present versus absent) and color priming condition (red versus grey). The results indicated that only those participants in the red color priming condition that had

also undergone ego depletion scored significantly lower on the arithmetic task (Bertrams et al., 2015). Bertrams et al. also reported two additional experiments utilizing the same design as the first experiment except that participants performed either a verbal IQ test (Experiment 2) or an arithmetic IQ test (Experiment 3) after the ego depletion task.

Experiment 3 also conceptually-primed the participants by presenting the words red or grey in black font on a white background screen, instead of actually presenting the color. These additional experiments revealed performance differences similar to those observed in Experiment 1 in that only those participants who had undergone ego depletion and experienced red color priming scored significantly lower in the second test of each design (Bertrams, et al., 2015). However, to date, no study has yet expanded these findings by testing the color-in-context effects with colored stimuli that are masked (Bertrams, et al., 2015).

Ego-Depletion Debate.

Ego depletion has recently become a topic of controversy. An alternate explanation has been offered by Kurzban, Duckworth, Kable, & Myers (2013), stating that the reduction in performance is based on an opportunity cost model. This model suggests that the decrease in performance is due to a redistribution in cognitive capacity rather than a depletion of cognitive capacity as a limited resource. Another study has pointed out inadequate statistical techniques in conducting a meta-analysis on ego-depletion research (Carter & McCullough, 2013). This study instead used a least squares regression model to check the data for publication bias. Publication bias was found to exist, indicating that the robustness of the results came from the lack of published experiments with null results (Carter & McCullough, 2013). Due to the inconsistencies of

past studies, more research is needed to determine if ego-depletion is the cause of the decrease in performance. Hence one rationale for the present study reported here.

CHAPTER III

THE PRESENT STUDY

The past research reviewed in Chapter II suggests that the conscious perception of color can induce avoidance motivation (Elliot, et al., 2007; Mehta & Zhu, 2009; Elliot & Meyer, 2014; Bertrams, et al., 2015; Brooker & Franklin, 2016). Moreover, these effects may be modulated by ego depletion (Bertrams, et al., 2015). However, research has yet to assess if such color-in-context effects would emerge with unconscious priming. This could be an important step in contributing robustness to the theory of red color effects on cognitive performance.

The aim of the present research was to determine if 1) unconscious color priming can induce avoidance motivation, and 2) if ego-depletion can modulate the induction of avoidance motivation via color priming. The present study accomplished these goals by manipulating ego depletion prior to performance of an anagram task, where the presentations of the color primes were masked and thus the primes were perceived unconsciously. In addition, the present design eliminated many of the confounds present in past studies (see Chapter II, above). The specific design improvements implemented here included i) matching anagram length and difficulty across priming conditions, ii) ensuring that the anagrams have a single solution in the language presented (i.e. English), iii) ensuring that all participants are monolingual, and iv) using a more precise measure of RT by implementing the priming task on a computer, rather than via pen and paper.

CHAPTER IV

METHOD

Participants

Recruitment for this research took place on the Texas State University campus, in San Marcos, Texas. Participants were drawn from the introduction to psychology subject pool and received course credit for participating in this research. A total of 110 participants were recruited for this research. Of these participants, 90 were female and they ranged in ages from 18 to 43. Sixty-nine participants reported being classified as freshmen, 13 sophomores, 13 juniors, and 13 seniors. Of the participants, 18 reported as African American, 5 reported as Asian American, 28 reported as Latino, 54 reported as non-Hispanic white, and 5 reported as other. Only data from monolingual English speakers was obtained in order to avoid that possibility that anagrams could be solved to spell an unintended non-English word. It was found that all participants spoke English as their only fluent language. Fourteen participants were removed due to performance issues (see Statistical Analysis below). The final sample included 96 participants.

Materials

A recently published internet article of random psychological content was used in the ego depletion condition (Habes, et al., 2016). It is important that the article was a recent work as to avoid the circumstances of familiarity. This 9 page article discussed fMRI neurofeedback dealing with vision and perception and was of college reading level. The main task consisted of a series of 29 five-letter anagrams shown on a screen. The words used in the anagrams were taken from a list of 205 words with a single solution in

English and rated for difficulty (Gilhooly, 1978). The word list used consisted of all of the words that fall within the first standard deviation above the average rating for difficulty, except for 7 words that were left out due to a decline in their use in present day media or culture. A second brief survey was given after the test to assess whether or not the participant was aware of the prime as well as whether or not avoidance motivation was successfully induced. The questions asked on the survey were scored on a Likert scale from 1 to 7. Half of the questions were worded for approach motivation instead of avoidance motivation, so these scores were separated. This avoidance motivation test is an adaptation of the Approach-Avoidance Temperament Questionnaire (ATQ) used in previous research (Elliot & Thrash, 2010). The questions from the original measure were modified by changing any words indicating the type of task to line up with the anagram task given in the present study. The scores from the avoidance motivation survey were then added together to give each participant a total score for both avoidance motivation and approach motivation. The ego depletion task and surveys were done on paper, but the other task was created and run using E-Prime.

Procedure

Participants were randomly assigned to either take part in the ego depletion condition or a non-depletion condition. Participants that reported being able to see the color red had their data removed as the effect was no longer unconscious. Any anagrams that the participant could not solve were removed from the dataset. Before the data from the fourteen removed participants was taken out, there were 28 participants in both the red and grey no-ego depletion conditions, and 27 participants in each of the ego-depletion conditions for a total of 110 participants. In the ego depletion condition, participants were

required to transcribe an article without any instances of a vowel for exactly ten minutes (Bertrams, et al., 2015). The article was a paper copy and participants transcribed it onto a note pad with a pen. This task required great self-control, which according to the theory of ego-depletion should hinder self-control on the subsequent main task. Participants were instructed to keep focused on this task for the duration of the ten minutes. Those in the control condition did not perform a transcription task and went straight into the anagram task. Participants then underwent another random assignment into either a red color priming condition or a control condition (in which red was replaced with grey). Participants solved anagram puzzles using a computer-generated task created in and administered with E-Prime. The anagrams appeared the same to each person (i.e. AGONY always appeared mixed as NOAYG), but the order of anagram presentation was randomized across subjects. Following Bertrams et al. (2015), those in the red priming condition saw a slide before the task that reads “test” in black text inside of a red box, whereas participants in the control condition had the word “test” in black text inside of a grey box. This “test” box was presented before each anagram. Each “test” box appeared for 10ms followed by a mask that appeared for 10ms and then an ISI (e.g. a cross in the middle of the screen) appeared for 50 ms. The participants then began the anagram task and were given up to two minutes to solve each anagram before moving on by pressing the space bar. If a participant did not finish in two minutes they would be automatically moved forward by the program. The participant was then presented with a blank screen in which they typed their answer. Participants were instructed to type in “idk” as their answer if they gave up on solving the anagram before the two minutes were up. Four trials were removed for this reason. An ISI screen with a cross fixed in the center

appeared for 50 ms between each answer and the next anagram. Examples of the sequence of the task are shown below. The top row of Figure 1 shows the priming display sequence, whereas the bottom row of Figure 1 shows the anagram display sequence without the color presentation and mask. Once the task was complete, the second brief survey was given to check for the awareness of the prime and collect demographic information. The questions testing the induction of avoidance motivation were taken from past research on this topic (Elliot & McGregor, 2001). Then the participants were debriefed and dismissed.

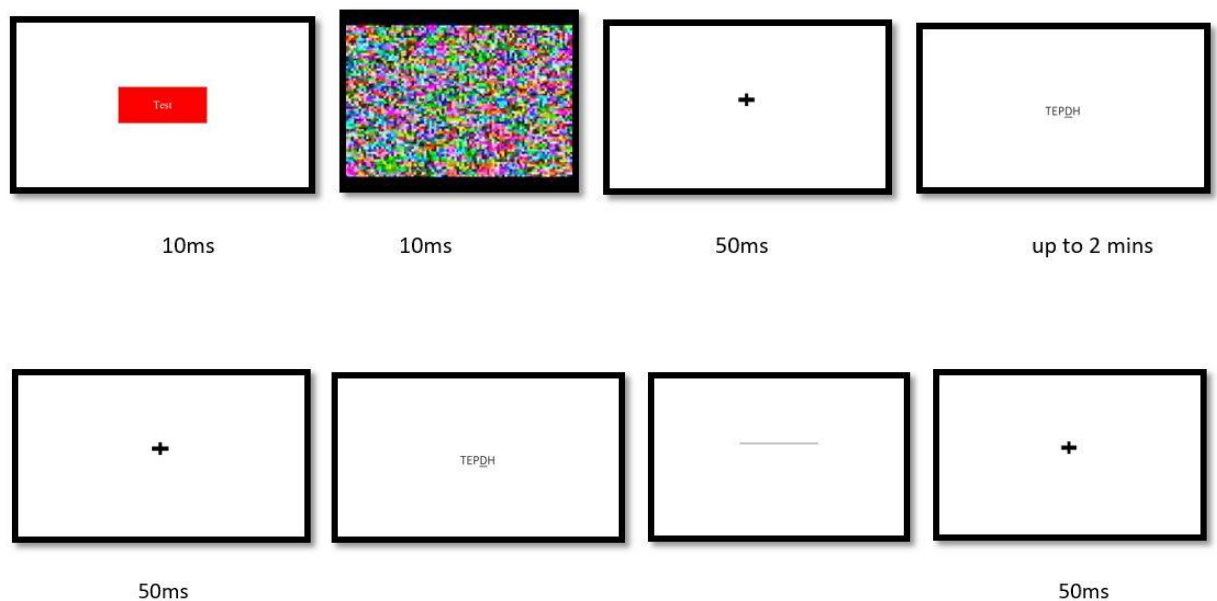


Figure 1. (top row). The sequence of the prime, followed by the mask, and the start of the anagram task. *(bottom row)* The sequence of slides for each anagram to be solved in the main task. The first and last slides are the ISI slides, with the second slide as the words to be solved and the third slide serving as an answer slide to type in the anagram solution.

Statistical Analysis

The data from the present study was analyzed using a two-way between-subjects ANOVA. Four group levels were formed for this ANOVA from the combination of the two independent variables of color priming condition (red color, no color) and ego-depletion (present, absent). The dependent variable was the mean reaction time of the participants to solve the anagrams. Participants who saw the test box, as well as trials with where participant could not solve the anagram, were removed before averaging. Fourteen participants were removed from the dataset for this reason. A two-way between subjects ANOVA was also performed on the avoidance motivation questionnaire scores, as well as a two-way ANOVA on the approach motivation scores, with treatment condition as the independent variable in order to assess the induction of avoidance motivation.

CHAPTER V

RESULTS

The results of this experiment yielded no support for a significant effect of color on anagram solution time, $F(1, 92) = .297$, $p = .587$, $\eta^2 = .003$. No significant effect of ego depletion on anagram solution time was found, $F(1, 92) = .002$, $p = .961$, $\eta^2 = .000$. There was also no interaction effect found between color priming or ego depletion on anagram solution times, $F(1, 92) = 2.76$, $p = .100$, $\eta^2 = .029$. Below is a graph representing the differences in these means in Table 1.

Table 1

Reaction Time Descriptive Statistics

	N	Mean (seconds)	Std. Dev.	Std. Error
Grey No-Ego	26	19.177278000	8.8640182180	1.7383769950
Grey Ego	26	23.517486600	18.9649904600	3.7193406320
Red No-Ego	24	22.183418440	12.8135553800	2.6155560400
Red Ego	20	17.579423330	7.5565729630	1.6897010820

This is a table containing the descriptive statistics for anagram reaction times between the four different treatment conditions.

The avoidance motivation scores indicated no difference in avoidance motivation across any of the four groups. The effect of color priming on avoidance motivation scores was not significant, $F(1, 92) = .008$, $p = .928$, $\eta^2 = .000$. The effect of ego depletion was not found to be significant, $F(1, 92) = 2.281$, $p = .134$, $\eta^2 = .024$. There was no significant effect found for the interaction of a color priming and ego depletion on avoidance

motivation, $F(1, 92) = .004$, $p = .949$, $\eta^2 = .000$. Below is a table containing all the descriptive statistics for avoidance motivation scores in Table 2.

Table 2

Avoidance Motivation Scores Descriptive Statistics

	N	Mean	Std. Dev.
Grey No-Ego	26	31.46	6.313
Grey Ego	26	29.23	6.629
Red No-Ego	24	31.50	6.795
Red Ego	20	29.45	8.036

This is a table containing the descriptive statistics for avoidance motivation scores between the four different treatment conditions.

The approach motivation scores showed no significant difference in approach motivation between the four groups. There was no significant effect of color priming on approach motivation, $F(1, 92) = .283$, $p = .596$, $\alpha = .003$. There was no significant effect of ego-depletion on approach motivation, $F(1, 92) = .336$, $p = .564$, $\alpha = .004$. There was also no significant interaction effect between color priming and ego-depletion on approach motivation, $F(1, 92) = .037$, $p = .849$, $\alpha = .000$. Below is a table containing all the descriptive statistics for approach motivation scores in Table 3.

Table 3

Approach Motivation Scores Descriptive Statistics

	N	Mean	Std. Dev.
Grey No-Ego	26	31.23	6.507
Grey Ego	26	30.73	6.803
Red No-Ego	24	30.79	4.293
Red Ego	20	29.80	7.157

This is a table containing the descriptive statistics for approach motivation scores between the four different treatment conditions.

Additional analyses were conducted to check for correlations between reaction time and avoidance motivation scores, as well as reaction time and approach motivation scores, across all participants using Pearson's r . There was no significant correlation between reaction time and avoidance motivation across participants, $r = .000$, $p = .999$. There was no significant correlation between reaction time and approach motivation across participants, $r = -.122$, $p = .237$. An analysis was also run to check for reliability of the avoidance motivation and approach motivation measures that produced Cronbach's alphas of $\alpha = .741$ for avoidance motivation and $\alpha = .781$ for approach motivation, indicating that this was a good measure of both avoidance motivation and approach motivation.

CHAPTER VI

DISCUSSION

The goal of this study was to determine if avoidance motivation during performance of a simple anagram task could be induced via unconscious color priming, and if such an effect would be modulated by ego-depletion on cognitive performance. It was hypothesized that participants in the red priming condition would undergo a process of avoidance motivation that would hinder their performance on the anagram task. It was also expected that ego-depletion would further diminish performance on the anagram task. This led to the prediction that participants in the gray color group with no ego-depletion would perform the best, while those in the red color group with ego-depletion would perform the worst. The results of this research do not support the hypothesis that both ego depletion and red color masked priming have a negative effect on cognitive performance or anagram reaction time, as no major differences occurred between any of the experimental groups.

There may be several reasons why an effect of avoidance motivation was not observed here. First, it could be that this effect can only occur if the color red is consciously processed. Similar results were found in the research conducted by Avneon & Lamy (2018). This study found looked at both conscious and unconscious priming, and found that response priming is strongly modulated by conscious perception rather than unconscious perception. Second, it may be the case that exposure durations of the color primes was insufficient to induce priming effects, although 10 ms was shown to be enough to unconsciously process information in other paradigms, that may not be the case here (Bertrams, et al., 2015). This could be tested in a future study by increasing the

amount of time the red stimulus was presented by a small amount to increase the degree of stimulus processing without leading to a conscious experience of the prime. Third, a possible reason for the present absence of avoidance motivation could be that there was insufficient conceptual priming due to the prime being presented unconsciously. An increase in conceptual priming might be achieved by using the words “red” or “grey” inside the prime box instead of the word “Test”, as demonstrated in the previous research done by Bertrams et al. (2015). Fourth, it is also possible that using more red, such as a flash of the whole screen as red, would be more likely to induce avoidance motivation, as there is a greater probability of enhancing conceptual priming. Lastly, a lack of statistical power could be the cause of not finding any effect. If the phenomenon of avoidance motivation does exist, then more research will be required to find better, more reliable ways of inducing such a thought process. Future research could improve upon this study by attempting to enhance the prime either perceptually by increasing the surface area of the amount of red shown, or conceptually by replacing the word “Test” with the word “Red”. Furthermore, including more participants per condition could yield higher statistical power, increasing the chances of finding significant results. Moreover, avoidance motivation may not be as prominent of a thinking style as has been hypothesized (Mehta & Zhu, 2009). It could also be that an avoidance motivation style of thinking can be induced, but simply that red color priming done unconsciously is not enough to alter major thought processes during a focused task. This could mean that in order for the color in context phenomenon to occur there must be a conscious processing of the color in question.

The present study also found that ego depletion had no effect on anagram performance as well. It is possible that the task used in the experiment was not sufficient to create a situation with ego depletion. This could be due to a need to create either a longer ego depletion task, or a much more difficult one. This might produce a greater strain on the cognitive capacity of the individual completing the task and induce a greater state of ego-depletion. Indeed, some participants in the study did seem to accomplish more than others during the ten minutes of this task, which could lead to varying levels of ego depletion between participants. This could certainly affect performance on the subsequent task. It is also important to note that the lack of significant differences between the treatment groups could be due to lack of existence of the ego depletion phenomenon in question, similar to the results of the research conducted by Etherton, Osborne, Stephenson, Grace, Jones, & De Nadai (2018). Here it was found that between three ego-depletion protocols with three different subsequent tasks, the null hypothesis was supported in each situation. Lastly, it should be noted that the lack of evidence against the ego-depletion phenomenon found when conducting background research could indicate a possibility of publication bias in this specific line of research against studies that yielded null results (Etherton et al., 2018). It has been suggested that ego-depletion is not a phenomenon in which a decrease in performance is due to a depletion of cognitive resources, but a reallocation of those resources to unconscious thought processes.

In conclusion, this study examined both the effects of avoidance motivation and ego-depletion on cognitive performance through the use of a red color prime to induce avoidance motivation and a transcription task to place participants in a state of ego-

depletion. Although no effects of these proposed phenomenon were observed on cognitive performance, such effects may emerge in future studies that pair red color priming with a more cognitively-intensive ego depletion task. Nevertheless, the findings from this research suggest that unconscious red color priming may not be enough to induce avoidance motivation, nor is ego-depletion alone enough to hinder cognitive performance.

APPENDIX SECTION

APPENDIX A

Please answer each question truthfully and to the best of your ability.

How old are you? ____

What race/ethnicity do you identify with:

- African American
- Asian American
- Latino or Hispanic American
- Middle Eastern
- Native American
- Non-Hispanic white
- Other

What is your biological gender?

- Male
- Female

What is your college classification?

- Freshman
- Sophomore
- Junior
- Senior
- Graduate Student

How many languages do you speak fluently? ____

Is English your first language?

- Yes
- No

Did your knowledge of any languages other than English interfere with your ability to complete this set of anagrams in English?

- Yes
- No

Was there an image(s) presented before the first anagram?

- Yes
- No

If an image was presented, what did it contain?

APPENDIX B

Please answer all questions to the best of your ability. Questions are to be answered on a scale of 1(not at all true of me) – 7(very true of me).

It was important for me to do better than others on these anagrams.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

It was important for me to do well compared to others on the anagrams.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

My goal for this task was to perform better than most of the other participants.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

I worry that I may not answer all the anagrams that I possibly could.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

Sometimes I was afraid that I may not solve the anagrams as quickly as I'd like.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

While solving the anagrams, my goal was to miss as few of the answers as I possibly could.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

I wanted to solve the anagrams as fast as possible.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

While solving anagrams, my goal was to get as many answers right as I possibly could.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

I desire to completely answer every anagram correctly.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

I just want to avoid doing poorly on this task.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

While solving the anagrams, my goal was to avoid performing worse than others on this task.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

My fear of performing poorly on this task is what motivated me.

Not at all true of me 1 2 3 4 5 6 7 Very true of me

**Questions 1-3 and 7-9 are approach motivation questions while 4-6 and 10-12 are avoidance motivation questions.

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