COLOR-IN-CONTEXT

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in
Interdisciplinary Studies:
International Cognitive Visualization

by
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Summer 2016
COLOR-IN-CONTEXT

A Thesis

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Neil G. Jacobson

Summer 2016

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DEDICATION

I would like to dedicate this manuscript to my friends and family, for without them I would never have realized this goal, this dream. Things that we love take time to achieve, and some obstacles we cannot foresee. Thank you to my parents who have always supported me in all of my pursuits. And thank you to my adoring wife Eryka whose unconditional love and support are the truest things I know.
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I would like to thank Dr. Neil Schwartz for his unwavering guidance and engagement in both my present as well as my future. His tutelage and mentorship have allowed me to become who I am today. I would also like to thank Anna Bartel for her constant companionship, thank you.
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ABSTRACT

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by

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Master of Arts in Interdisciplinary Studies: International Cognitive Visualization

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Humans interact with text and graphic information on a daily basis. These interactions represent learning environments, people are reading to learn. In this investigation, we addressed how text and graphics can be constructed to influence the construction of an individual’s understanding about a topic. We situated our investigation in the legal context, an under-studied context that aligns well with both text and graphic manipulations.

Across three experiments we investigated the interaction of a framed text and a single graph on learners’ perceptions and decisions about the company. Results of Experiment 1 revealed that the presence of the gray graph decreased the effect of the framed texts on decisions of the company’s guilt.

Experiments 2 and 3 built upon Experiment 1. In Experiments 2 and 3 we used the colors red and green to color the success (Experiment 2) or failure (Experiment 3) portion of the bar graph. Results of Experiment 2 revealed that when success was
colored green compared to gray and the text was positive, learners’ had stronger arguments against the company.

Experiment 3 revealed that decisions were not influenced when failure was colored red, green or all gray. However, results revealed that learners’ discussed marginally more negative implications of the company’s actions when the text was negative and failure was colored in red compared to gray.

These results are provocative in that color is typically viewed as aesthetic only, however, our results support the growing literature that color is able to influence to human cognition.
CHAPTER I

INTRODUCTION

Text and graphic combinations are ubiquitous in modern society, and much is known about their effects in educational contexts. However, very little empirical work has investigated text and graphics’ influences on recall, impression formation, and decision-making in the legal context. In this investigation, we were interested in measuring learners’ concepts of a company named in a legal complaint. We defined learner concepts along three dimensions, 1) the amount of information recalled from the complaint, 2) perceptions of the company’s characteristics and opinions about the company and, 3) decisions to find the company guilty and purchase from the company in the future.

In educational settings, text and graphics have been found to enhance comprehension for science and education (Carney & Levin, 2002; Mayer, 2005), learning about social issues (Danielson, Schwartz & Lippmann, 2015), and complex systems (Mayer, 2001, 2003, Moreno & Mayer, 1999).

Whereas the educational context is widely researched, there are few empirically controlled investigations into the influence of text and graphic combinations in the legal setting (c.f. Feigenson, 2010 for a review). Park and Feigenson (2013) were the first to systematically investigate text and graphics in the legal setting by investigating how a PowerPoint presentation, used during opening statements, influenced recall of evidence, perceptions of lawyers, and responsibility of the company named in the suit. They found
that when the PowerPoint was paired with an opening statement, participants recalled more information and had more favorable evaluations of the lawyers—both of which influenced the participants’ decisions of the company’s responsibility. However, Park and Feigenson (2013) stated that their investigation was limited in two ways: 1) the graphics presented by each lawyer were not equivalent and, 2) the colors used in the graphics varied. Therefore, in the present investigation, we aimed to delineate the work of Park and Feigenson (2013) by controlling the presence and absence of a single experimental graphic, as well as the colors in that graphic.

Similar to Park and Feigenson’s (2013) operationalization of a legal context, we agree that in the legal setting competing perspectives of the same event or situation are presented. For example, in a product liability case, either the success or failure of a company’s product can be described. In this example, one party will likely focus on the failure (50%) of the company’s product, while the other party will likely focus on the relative success (50%) of the product. These competing perspectives are logically equivalent in that they describe the same condition, but merely frame perspectives on the condition antagonistically.

According to Entman (1993), framing “selects some aspects of perceived reality and makes them more salient in a communicating text in such a way as to promote a particular problem definition, casual interpretation, or moral evaluation”. This definition aligns with our argument that text and graphics can be used in a legal setting to influence the cognitive encoding and organization of learners’ cognitive concepts about a condition or situation. Referred to as attribute framing, Levin, Schneider and Gaeth (1998) argue
that framing represents the simplest form of a message and has been found to influence decision-making and evaluation in contexts, including consumer evaluation (Levin & Gaeth, 1988; Levin, Gaeth & Schreiber, 2002) financial decision-making (Duchon, Dunegan & Barton, 1989), health communication and politics (Bigman, Capella & Hornik, 2010), and law (Dunegan, 1996; Scurich & John, 2011).

In the context of law, Dunegan (1996) found that when an advertising company was described negatively, as knowing that their advertising was deceptive (by a value of 80%), they were evaluated as less ethical and were required by participants to pay a 97% higher damage award compared to when the company was described positively (by a value of 20%). Scurich and John (2011) also concluded that message framing was able to influence decision-making in the legal context. They found that when a psychiatric patient’s risk of future violence was framed positively compared to negatively, the patient was more likely to be released.

As Entman (1993) stated, framing attempts to make a perspective salient, so that incoming information is encoded and organized into a cognitive concept that matches the valence of a message. By valence, we mean the positive or negative perspective a lawyer presents of a situation. Levin et al. (1988) argued that the effects of attribute framing arise via the process of a “valence consistent shift”. Specifically, if a lawyer presents a positively valenced message, positive information is encoded and organized in mind resulting in a positively shifted concept that yields positive evaluations.

While attribute framing of messages in the legal context has been researched, investigations into the potential influence graphics levy in the legal setting are fewer.
Feigenson (2010) and Salerno and Bottoms (2009) reviewed the literature on graphics in the legal context and concluded that animations, videos, photographs, and brain images influenced recall, evaluation, and decision-making. For example, Hewson and Goodman-Delahunty (2008) and Park and Feigenson (2013) found that recall of evidence was greater when a PowerPoint containing either DNA sequencing techniques or graphs with statistical data were presented. Park and Feigenson (2013) also found that lawyers who used a PowerPoint during their opening statements were evaluated as more competent, credible, prepared, and persuasive. Finally, Dunn, Salovey and Feigenson (2006) found that presenting an animation of a car crash at trial influenced damage awards; and, Gurley and Marcus (2008) found that the mere presence of neuroimaging scans at trial resulted in more participants judging a defendant innocent on the grounds of insanity.

And yet, while general visual material has been found to influence recall, evaluations, and decisions, there is no evidence as to whether specific visual material—in our case, a single statistical graph—will influence the overall concept learners’ form about a company. Park and Feigenson’s (2013) investigation most closely addressed our research question; but in their investigation, their PowerPoint presentation included many statistical graphs that were inconsistently presented across conditions and were not controlled for color.

In the present investigation, we contend that principles of education, persuasion and communication operate on participants when learning about a case and making evaluations and decisions about it. Therefore, we adopted Petty and Cacioppo’s (1986) dual process Elaboration Likelihood Model (ELM) to explain the cognitive processing
involved that underlies these principles. The ELM proposes two routes for information processing—one central and one peripheral. The central route involves effortful cognitive processing of the information contained in the content of the message. The peripheral route is less effortful and involves processing the informational cues contained in the message context. Isberner et al. (2013) investigated the peripheral informational cues provided by a statistical graph on perceptions of a scientific text. Their results revealed that when the graph was present, the scientific text was evaluated as more plausible. The authors argued that the repeated pairing of graphs with science texts created a heuristic that graphs are scientific, and that when a graph is present in the message context, the message is more plausible.

While research has indicated that graphics provide both direct and peripheral informational cues, in our investigation we make no distinction between the specific informational cues provided by the graphic. Instead, we argue that a single statistical graph provides additional information that learner’s incorporate into their cognitive concept of the situation communicated by all information sources.

Interestingly, despite the wealth of research on message framing in legal contexts, and the growing interest in the influence of graphics, there has been a dearth of research as to how a single statistical graph may influence the framing effect of a message. There has been research on the interaction of framed messages and graphics in general, but this research has proven inconclusive. For example, whereas Park and Feigenson (2013) concluded that several statistical graphs enhanced the strength of a framed message, Garcia-Retamero and Galesic (2010) and Garcia-Retamero and Dhami (2013) concluded
that a statistical part-to-whole graph nullified the effect of the framed message. On the one hand, Park and Feigenson (2013) stated that the statistical graph provided peripheral informational cues that augmented the effect of the message frame; on the other hand, Garcia-Retamero and Galesic (2010) argued that the part-to-whole graph allowed learners to “see through” the message frame—a likely consequence of direct informational cues. It is these equivocal finding that we seek to clarify in the present research.

Graphs are composed of visual features that include lines, axes, titles, salience and color (Kosslyn, 2006), and each time a graph is produced, a designer must consider these features. Based on the fact that a graph’s visual features must be specified, we argue that certain visual features of a graph—specifically, salience and color—may provide direct and/or peripheral informational cues that influence the encoding and organization of a learner’s concept about a framed situation. Similar to Entman’s (1993) statement about message framing making information salient, the same rationale exists for creating visual salience.

Visual salience occurs when a piece of visual information is attended to first (Bertin, 1983; Kosslyn, 2006) and can be achieved by manipulations of size, shape and color (Hegarty, 2011; Kosslyn, 2006). Visual salience has been found to influence evaluations and decisions in contexts including consumer choice (Sun, Li, Bonini & Su, 2012) and risk communication (Ancker, Senathirajah, Kukafka, & Starren, 2006; Severtson & Henriques, 2009; Stone et al., 2003; Stone, Yates & Parker, 1997). Thus, we argue that content made salient in a graph may provide informational cues that influence the encoding and organization of a learner’s concept of a framed legal message.
As Hegarty (2011) and Kosslyn (2006) stated, salience can be achieved by manipulating size, shape or color. However, in the present investigation, we achieved salience through the use of color. Color is composed of the dimensions of lightness (brightness), chroma (saturation) and hue (Elliot & Maier, 2012)—the latter of which is the most researched dimension of color, although all dimensions have been found to influence human cognition and behavior (Elliot & Maier, 2012; Elliot, 2015).

Interestingly, most research on salience has ignored the differential use of color to make information salient; however, support for color’s influence exists (Moller, Elliot & Maier, 2009; Braun & Silver, 1995; Kuhbandner & Pekrun, 2013; Leonard, 1999). For example, Moller et al. (2009) found that participants were faster to classify failure related and negative words written in red compared to green, with the inverse being true for success related words. Elliot and Maier (2009) explained this finding by describing color as a, “nonlexical stimulus that can communicate information quickly, subtly, and across barriers of language, age, and even species” and does so by signaling information about the environment, giving rise to evaluative processes (Elliot & Maier, 2012). We believe that the targeted use of color will influence the concepts learners’ form about the framed situation of a message, beyond mere salience effects. If as Moller et al. (2009) state, color does signal information about the environment in which it is viewed, then we argue that differential color use will provide informational cues that guide the encoding and organization of learners’ cognitive concepts about a situation.

In addition to color providing information about the environment, or increasing perceived hazard for dangerous words (Braun & Silver, 1995), color has also been found
to influence the effectiveness of framed messages for health communication (Gerend & Sias, 2009). Specifically, Gerend and Sias (2009) found that a framed message focusing on the dangers of not being vaccinated was strengthened when participants were primed with the color red compared to gray. The authors argued that the color red provided a peripheral informational cue signaling threat or danger, and that it was this additional information that strengthened the framed message. While Gerend and Sias (2009) addressed gain versus loss framing instead of attribute framing, their finding still demonstrates that colors—specifically red—provides additional information that influences the construction of learners’ concepts about a situation.

The Present Investigation

In the present investigation, we were interested in whether learners’ concepts of a company named in a legal complaint would be influenced by: a) a message framing the performance of the company’s product, b) the presence of a single statistical graph and, c) the effect of a statistical graph on a framed message. We measured learners’ concepts across three dimensions, including recall, opinions, and decisions.

Thus, this investigation was comprised of three experiments—Experiment 1 was designed to investigate how the presence versus absence of a statistical graph will interact with a framed message to influence the construction of a learner’s cognitive concept about a company. Experiment 2 was designed to investigate how the presence of a graph making salient the success of the company’s product in either red or green compared to all gray, would interact with a framed message to influence the construction of a learner’s cognitive concept about a company. Finally, experiment 3 was designed to investigate
how the presence of a graph making salient the failure of the company’s product in either red or green compared to all gray, would interact with a framed message to influence the construction of a learner’s cognitive concept about a company.

In experiment one, we varied two levels of the presence of an achromatic graph—present versus absent—in order to determine if the graph would have an effect on the construction of a learner’s cognitive concept about the company. Due to the lack of research on the effect of a single statistical graph on evaluation and decisions, we approached the graph’s effect as an open question. However, in line with the Multimedia Principle (Mayer, 2005), we predicted that more information would be recalled when the graph is present compared to absent. We also varied two levels of message framing—positive versus negative—in order to determine the message’s effect on the construction of learners’ cognitive concepts about a company, expecting that, consistent with Levin, Schneider and Gaeth (1998), a positively framed message would lead to a more positive concept of the company, as well as to more positive evaluations and decisions of the company as a whole.

We were also interested in the effect that the presence versus absence of an achromatic graph would have on a framed message due to the equivocal findings of previous research. According to Park and Feigenson (2013), the presence of a graph enhances the effect of a framed message by providing additional informational cues. Therefore, we hypothesized that a positively or negatively framed message paired with an achromatic graph would result in the construction of a concept that is more positive or negative than when the framed message is presented alone. However, we also proposed a
competing hypothesis regarding the effect of a graph on a framed message. That is, according to Garcia-Retamero and Galesic (2010), the presence of a graph nullifies the effect of a framed message by allowing learners to “see through” the message frame. Therefore, we hypothesized that a positively or negatively framed message would result in the construction of a concept that is more positive or negative respectively, than when the same framed message is paired with an achromatic graph.
CHAPTER II

LITERATURE REVIEW

Introduction

The field of color psychology is experiencing a resurgence unparalleled in its 100-year history. From Goethe’s “Theory of Color” (Goethe, 1810, as cited in Elliot, 2015) to Yerkes and Dodson’s investigations into warm and cool colors, the study of color has been a constant. It is not until recently however, that the study of color effects has been done with theoretical and methodological rigor. At a most basic level, color is comprised of three characteristics; luminance, chroma and hue or what is commonly referred to as color. Historically, these three components have been confounded in investigations of color. Camgoz and Yener, (2011) highlight the consistent influences of each component on human cognition. Most of the color research conducted before the 1990’s, and much of the research today still suffers from these methodological shortcomings related to uncontrolled and confounded color parameters.

When each dimension is viewed singly, with the other two components held constant, researches are able to tease apart the influences that each component has on human cognition. For instance, Meier, Robinson and Clore, (2004) investigated the influence of luminance on evaluations of good and bad, concluding that white was associated with good, and black with bad. This finding highlights the control necessary to make generalizable conclusions that are able to inform the field.

In the remainder of this review we outline findings related to hue—specifically red—in various contexts. While color research is common, investigations has occurred under
myriad contexts. The breadth of color research, and concordant findings can all be seen to fit under Color in Context theory (Elliot & Maier, 2012). This overarching theory states as its final point, that color effects are context specific and therefore imparts context specific meanings. For this reason, results of color studies—especially red—can be either positive or negative depending on the context. It is for this reason that our literature review breaks down color effects and investigations into context specific categories.

Color in Achievement Contexts

The achievement context has received the most investigation in the color literature. Andrew Elliot, and colleagues, in addition to creating the “Color in Context” Theory (Elliot & Maier, 2012) have been the primary investigators of color effects in achievement contexts. According to these researchers, an achievement context is defined as a situation in which competence is evaluated. The classic example is education, specifically test taking scenarios. The authors argue that at a basic level, the repeated societal pairing of red with failure has resulted in a paired association of red with failure. This hypothesized relationship has led to many testable hypotheses and a rich body of literature regarding red effects in achievement contexts (Elliot, 2015).

In this section we review several articles recently published that outline conclusive findings regarding the color red in achievement contexts. However, we begin with a very informative and provocative study that has served as a pillar in the color literature. Mehta and Zhu, (2009) conducted six studies aimed at investigating the beneficial effects of the colors red and blue for two different types of tasks, creative, and detail-oriented.
Whereas the remainder of studies in this section discuss the inimical effects of red on cognitive performance, Mehta and Zhu aimed to uncover specific tasks that were benefitted by red compared to blue and white.

Mehta and Zhu (2009) sought to demonstrate that viewing the color red, due to the avoidance motivation it brings about in achievement settings may not always be negative. An achievement setting encompasses a range of tasks, and may be negative in some cases, however, the authors argue that the narrowing of focus brought about by avoidance motivation may be beneficial for certain detail-oriented tasks such as proofreading. Additionally, the authors argued that blue, and its association with happiness and tranquility may trigger approach motivation and provide a benefit for creative tasks. The authors conducted six studies aimed at providing support for these color hypotheses.

Study 1 tested the hypothesis that red was related to avoidance motivation and blue to approach motivation. In this study participants were asked to solve anagrams as quickly as possible. Anagram solutions were approach, neutral or avoidance oriented. Results indicated that approach motivation anagrams were solved more quickly in blue, and that avoidance anagrams were solved more quickly in red compared to blue and the neutral condition. Results of Study 1 supported the author’s hypotheses that red was associated with avoidance and blue with approach motivation.

Study 2 sought to expand the previous findings by using two new tasks. The new detail-oriented task was memory of a word list, and the creative task was to make creative uses from bricks. Red was hypothesized to improve performance on the memory task, and blue on the creativity task. Results indicated that overall the memory task was facilitated by the color red as evidenced by recall of more correct items and fewer
incorrect recalls compared to the blue condition. Regarding the creativity task, there was no difference in the overall number of brick uses, but there were significant differences regarding the average creativity of uses, and the number of creative uses.

Study 3 again changed the detail-oriented task to proofreading and the creative task to the Remote Associations Test, to reinforce the color driven hypotheses. Additionally measures of avoidance and approach motivation were included so that mediation analyses on the hypotheses could be conducted. Results again indicated that red increased performance on the proofreading task compared to blue and the neutral condition. For the Remote Associations Test, performance was greater in the blue compared to red or neutral condition. Mediation analyses indicated that motivation orientation was responsible for the observed effects, consistent with the author’s hypotheses.

Study 4 aimed to predict color effects within a single task that had components that would benefit from either red or blue. Participants were asked to make as many children’s toys as possible using 20 drawn figures. The figures were presented in either red or blue and the toys made were evaluated for their appropriateness and practicality (detail-oriented measures) and their originality and novelty (creativity measures). Results again indicated that red and blue facilitated task specific aspects. Red was found to result in higher ratings of appropriateness and practicality, while blue resulted in higher ratings of originality and novelty. These results indicated that within a single task, certain aspects could be facilitated by one color relative to another. If you were striving to make creative toys, then blue may be appropriate, but if you were aiming for practicality, red would be advisable.
Study 5 sought to expand the pattern of results by investigating the color red in a new task setting, persuasion of advertisements. Knowing that red results in more detail-oriented processing and blue more creative thinking, the authors argued that these effects might extend to and interact with advertisements. In this study, two advertisements for a camera were created, one focusing on specific aspects of the camera’s lens (detail-oriented), and one focusing on more remote associations with the camera such as roads and sign-posts (creative). Results indicated that the detail-oriented advertisement was more persuasive when red was present with the ad, and that the creative advertisement was more persuasive when viewed with blue. These findings extended the hypothesized color effects to an area outside of achievement, however via the same cognitive mechanism, creativity versus detail-orientation.

In their final study (Study 6), the authors investigated if individuals were aware of the potential benefits of using color when completing different types of tasks. In this study, participants were told that they would be performing either a creative or detail-oriented task, and were asked to select which color they would like to work with. Results indicated that for both tasks blue was preferred over red, indicating that individuals may not be aware of the potential benefits of the color red for specific tasks.

In sum, these six studies provide support for the hypothesis that red, due to avoidance motivation orientation is beneficial for tasks where detail-oriented thinking is necessary such as proofreading tasks. Additionally, results indicated that the color blue may be linked to increased creativity, at least when compared to the color red.

Whereas the previous study focused on creativity and detail-oriented task performance, the next study conducted by Elliot, Payen, Brisswalter, Cury and Thayer
Elliot et al. (2011) focused on the negative effects of the color red relative to blue and gray for an IQ test. The authors aimed to contribute to the development of this cognitive effect by including the physiological measure of High Frequency-Heart Rate Variability (HF-HRV). HF-HRV is a well-known physiological measure that has been found to validly represent anxiety. HF-HRV has been found to decrease in situations associated with stress, anxiety, fear and worry. It is this connection to the hypothesized effect of red—specifically avoidance motivation that prompted inclusion of the physiological measure. Red has been found to provide a threat cue in achievement contexts, and this measure would allow for additional support of the hypothesis.

In a single experiment, Elliot et al. (2011) tested the effect of red, blue and gray on HF-HRV at two points, once after individuals took an IQ test, and once after the experimental color was viewed on a binder containing self-report measures of mood and general activation. Performance on a parallel form of the IQ test was administered to serve as the cognitive outcome variable.

Results of the study provided support for the hypothesized effects of red on cognitive performance. Red was associated with lower performance on the second IQ test compared to both blue and gray. Additionally, null effects were found for the mood and activation measures consistent with the literature on implicit affective cues. Furthermore, for the focal measure in the study, red was associated with a decrease in HF-HRV, consistent with hypotheses, while blue and gray were associated with an increase in HF-HRV. Finally, HR-HRV was positively correlated with performance on the IQ test, demonstrating the hypothesized relationship between bodily response and test performance. In sum, this study contributed to the literature on red and achievement by
incorporating a valid physiological measure of anxiety, and stress. Additionally, results of the study support the growing body of research for the negative red effect while specifying the effect with a new physiological measure.

Recently Meier, Hill, Elliot and Barton (2015) authored a chapter overviewing the Color in Context theory and its findings for red in achievement contexts. The previous study in this section, while cited in this review article, is a “brick”, whereas this review article is the “structure” built from many such bricks. For our purposes here, we will structure our discussion around the 6 CiC premises.

We begin with premise 6 (context). This premise states that color effects are context specific and can result in different affective and cognitive responses. Achievement context are defined as, “settings in which competence is evaluated and both positive and negative outcomes are possible”. Premise 1 states that the color red activates psychologically relevant associations in the achievement setting. The societally based (premise 4) pairing of red and failure in educational and academic settings is thought to be the driving force behind the inimical effects of red on performance. Red has repeatedly been paired with failure, and this aversive stimuli influences psychological functioning (premise 2). Research has indicated that red influences psychological functioning including behavior, cognition and physiology. Behaviorally, red has been found to result in reduced knocking, increased distance from a red task, and selection of easier analogies. Cognitive influences include avoidance motivation and more specifically activation of local versus global processing. Finally, red influences physiology by reducing HF-HRV and increasing right relative to left prefrontal cortical activity, both indices of avoidance motivation. Interestingly, despite the well-
documented effects of red, red acts as an “implicit affective cue”, meaning that its effect occurs outside of conscious awareness (premise 3). This conclusion has been reached in many different laboratories. Premise 5 of the CiC theory states that color effects have reciprocal effects on human affect, cognition and behavior. This means that while color can change psychological functioning (premise 2) psychological functioning can also influence the meaning of color. Although, this premise has not received support in the achievement context, it is hypothesized that in other areas such as impression formation, the reciprocal nature may be uncovered.

In sum, the literature on red effects in achievement settings provides the most detailed overview of research into color. As stated, this context incorporates 5 of the 6 premises in the overarching color research theory, and provides a model for researchers beginning to understand the field.

Color in Physical Contexts

Color in physical contexts is a wide category, but for our review it deals with two studies. One study investigates the influence of color on eating behaviors while the other addresses the effect of viewing an environment with a predominant color profile. Together these studies address questions regarding how color when it is not the focal stimulus, influences evaluation, cognition, and behavior.

We begin with the investigation conducted by Akers et al. (2012). In this study the authors focused on the relationship between red and green and their effect on perception of exertion during a physical activity. The physical activity in this study was
cycling, and the experimental manipulation involved participants exercising until exhaustion while viewing either a red, green, or gray video of a forest.

The authors argued that the documented green exercise effect was partially due to the feelings of calmness induced when either blue or green were viewed. The Biophilia hypothesis states that humans are influenced by among other things, characteristics of their environment. Evidence for this claim comes from therapeutic studies where patients have been found to benefit from exposure to nature, even if only through a window. It is this supposition that led the authors to design a study where they tested the hypothesis that individuals who merely watched a video that was filtered in green would have greater perceived calmness and lower perceived exertion.

Results of the study provided partial support for the Biophilia hypothesis however, influences on the dependent measure did not match predictions. The Profile of Mood States questionnaire (POMS) was used to address, “overall feeling of mood and was calculated by subtracting the vigor subscale from the sum of tension, anger, depression, fatigue and confusion subscale scores”. Results indicated that only anger was significantly higher in the red condition. However, the authors hypothesized changes for specific portions of the subscale, with results indicating a generally more positive mood state when green was viewed compared to both red and gray. Results were interpreted to mean that green promoted a, “positive global affect”.

While results for affect were positive, the results for exertion were less positive. While the authors did report a significant difference in perceived exertion, with green being significantly different from both red and gray, the physiological measures failed to demonstrate the same effect. In sum, tentative support was provided for the “green
exercise” effect, but only on self-report indices; participants in this study reported a more positive mood and less perceived effort, however no effects were found for the physiological measures.

Whereas the previous study investigated color effects when individuals engaged in an activity in an environment, the study conducted by Genschow, Reutner and Wänke (2012) sought to understand the role of color when it was a peripheral aspect of the environment. The authors argued that the societally paired meaning of red with “stop” may extend to an informal snacking setting. Specifically, the authors hypothesized that the well-documented avoidance motivation caused by viewing red in an achievement setting may extend to a new context, namely—eating and drinking.

To investigate the influences of color on consummatory activities, the authors conducted two studies; Study 1 addressed consumption of three liquids poured into a cup with either a red or blue sticker. Study 2 investigated the consumption of salty snack food placed on either a white, blue or red plate. The authors hypothesized that the negative red effect, which has been found to produce avoidance motivation, would result in participants consuming fewer liquids as well as less salty snack foods. Results supported the hypothesis that less liquid would be consumed from a red cup compared to a blue cup. Analyses addressing likability as a function of liquid type and cup color failed to significantly interact. In sum, the results of Study 1 provided initial evidence that the cup in which a liquid is held may influence the consummatory behavior of drinking. Interestingly, the null effects for likability indicate that they participants were not aware of any biasing effects that the cup produced.
The researchers were further interested in the influence that a colored plate would have on eating behaviors. In Study 1, the researchers failed to include a control color, which barred them from stating that red acted as avoidance motivating, or blue as approach motivating. Therefore, to strengthen the interpretation of their results the authors included a control condition in the second experiment. So, in addition to red and blue, white was added as a control color.

Results of Study 2 indicated that significantly fewer pretzels were consumed when presented on a red plate compared to both a blue or white plate. Interestingly, the tastiness rating between pretzels for each condition did not differ; neither did the likability of the red or blue plates. However, the red plates were liked more than the white plates but results indicated that fewer pretzels were eaten on the plate that was better liked.

Together these results provide yet another context in which color effects have been documented. The authors argue that their study is different from the current body of literature in that the color manipulation in their study was unobtrusive and more readily represented a naturalistic setting. In addition, I would argue that a strength of the study was that the manipulations varied in some ways from previously demonstrated red effects. Current color research states that to meaningfully interpret color effects the colors must be rigorously controlled. However, in this investigation theoretically consistent effects were observed when the colors used were different. This may indicate that the color effects observed for a limited range of colors may still be present when the colors “red” or “green” are more broadly defined.
Color Related to Individual Cognitive Performance

This section of the review deals with research on the effect of color on cognitive performance and the cognitive mechanism responsible. Settings in which competence can be evaluated are termed achievement contexts, for they allow either positive or negative outcomes regarding competence evaluation. Much work has been done to uncover the mechanism responsible for the finding that red in achievement contexts results in lower performance compared to viewing a different color. In this section we review three experiments indicating that avoidance motivation mediates the observed effects on human cognition.

Elliot, Maier, Moller, Friedman and Meinhardt, (2007), in a series of six experiments outlined the deleterious effect of red on cognitive performance as well as providing evidence that avoidance motivation was responsible for the effect. Maier, Elliot and Lichtenfeld, (2008) built upon the previous study in a three-experiment investigation into the specific cognitive mechanism involved in the negative effect of red. Whereas the previous authors focus on avoidance motivation as a construct, Maier et al., (2008) focus on a specific aspect of this construct, namely local relative to global processing. Results of their study, using two techniques revealed the meditational role of red. Finally, Smajic, Merritt, Banister and Blinebry, (2014) investigated the aforementioned red effect in actual testing environments illuminating the possible disconnects between results obtained in laboratory and natural settings. Across two studies, Smajic et al., (2014) showed null results for color effects, indicating that results of laboratory investigations may not apply to actual university testing environments.
I begin with a description of the study conducted by Elliot et al., (2007). In this investigation the authors outlined an argument in which the socially reinforced pairing of red with failure triggered avoidance motivation for individuals engaged in a test setting. The first four experiments all reinforced the hypothesis that viewing red compared to green or black (Experiment 1), white or green (Experiments 2, 3 and 4) resulted in lower performance. Additionally, these experiments included dependent measures ranging from anagrams in Experiment 1 to analogies in Experiments 2 and 3 and numerical pattern tasks in Experiment 4. Finally, participants included German as well as American students in settings ranging from laboratory to classrooms.

In sum, the results of Experiments 1-4 indicated that viewing red relative to many other colors, reduced performance on a variety of tests. Additionally, nonsignificant results obtained for the measures of avoidance motivation indicated that the effects of color were outside of conscious awareness.

Failure to detect differences in measures of avoidance motivation provided the rationale for Experiments 5 and 6. In these experiments, behavioral and psychomotor measures of avoidance were included to detect differences due to color outside of self-report measures. In Experiment 5, individuals were asked to select how many easy and moderate anagrams they would like to solve. Color was manipulated by changing the color of the folder that held the paper participants wrote on. Avoidance motivation was measured by the amount of easy versus moderate anagrams individuals chose to solve. Results indicated that when the folder holding the anagrams was red, individuals chose to solve significantly more easy anagrams compared to the green or gray folder.
Experiment 6 aimed to show using an additional measure of avoidance motivation that viewing red compared to green or gray resulted in greater avoidance motivation. The dependent measure in this experiment was prefrontal cortical asymmetry, a measure of cortical activation that is a reliable and valid measure of avoidance motivation. Research indicates that a greater right to left activation is indicative of avoidance motivation. Individuals viewed a screen before an ostensible IQ test and this served as the focal manipulation in the investigation. Results supported the hypothesis that viewing red relative to green or gray resulted in greater right relative to left prefrontal cortical activation.

Whereas Elliot et al. (2007) invoked avoidance motivation to explain the effects of red on performance attainment, Maier et al. (2008) specified the cognitive mechanism within avoidance motivation that was responsible for the documented red effect. The authors argued that viewing red triggers avoidance motivation—specifically local processing compared to global processing. It is this local processing, this narrow scope of attention that is responsible for the red effect. To investigate their hypothesis the authors employed two techniques designed to show that local attentional processing mediated the relationship between red and decreased performance.

Experiments 1, 2a and 2b were constructed to test mediation via the causal chain approach. Experiment 1 was designed to show that viewing red relative to gray resulted in decreased performance on a test of IQ. Results supported the hypothesized relationship between red and decreased performance. Experiments 2a and 2b built upon this finding by independently associating local attentional focus with red (Experiment 2a) and attentional focus with decreased performance (Experiment 2b). Experiment 2a
showed that viewing red relative to gray resulted in more local processing on a matching task. Experiment 2b randomly assigned individuals to local versus global processing style and found that local processing resulted in significantly lower test performance. In sum, Experiments 1, 2a and 2b employed a causal chain approach to reveal that local processing mediates the relationship between viewing the color red and decreased performance on an IQ test.

Experiment 3 sought to document the meditational nature of local processing by employing a measurement of mediation approach. Experiment 3 allowed for the entirety of the theoretical model to be tested at one time using regression analyses. Separate regression analyses indicated that red versus gray resulted in decreased performance on the IQ test. Additionally, regression analyses indicated that significant relationships existed between color and local processing and between local processing and IQ test performance. Finally, when local processing was entered into a final regression model it indicated that local processing significantly mediated the relationship between color and test performance.

In sum, across three experiments Maier et al. (2008) demonstrated that a specific aspect of avoidance motivation was mediating the red color effect. Local processing the authors argued was induced by viewing the color red, and this local processing significantly decreased individuals’ performance on an IQ test relative to viewing the color gray.

Whereas Elliot et al. (2007) demonstrated that viewing red relative to black, green, white and gray in settings ranging from laboratory to in class, Maier et al. (2008) focused only on laboratory studies. The final study presented in this section investigated
the red effect in actual classroom settings. Smajic et al. (2014) argued that while the negative red effect may exist in laboratory settings there are a number of aspects of these settings that do not apply to actual classroom test taking scenarios. For instance, all studies documenting the red effect have used dependent measures that individuals have no way of preparing for, leaving the question regarding preparation unanswered. Furthermore, while students may receive extra credit for participating in psychological studies, this level of engagement and motivation pale in comparison to students motivation for testing in a graded course. Finally, Smajic et al. (2014) cite a study that indicated that blue resulted in lower test scores compared to red.

To investigate these unanswered questions Smajic et al. (2014) conducted two studies. In Study 1 test takers in an actual college course were given one of two parallel test forms that were identical aside from the difference in color. Results indicated no difference on test scores for either the red or green condition, as well as failing to document any effect on perceived anxiety. Study 2 built upon the results of Study 1, but included different courses of varying academic status (i.e. 1,000, vs. 2,000 vs. 3,000 level courses). Similar to Study 1, results failed to indicate a difference on test performance relative to color of the test.

In sum, across two studies Smajic et al., (2014) failed to replicate the well-documented effect of red on test performance. The authors stated that while not conclusive, the results indicate that the generalizability of color studies conducted in laboratory settings may not apply to actual testing environments. Student engagement, motivation and preparation may all influence test performance in ways that artificial experiments cannot replicate. However, the authors state that even if small effects of
color exist (in their investigation effect sizes ranged from .02 - .04) they may be meaningful when scaled to department or university levels.

In this section, we presented an overview of three studies investigating the influence of color on cognitive performance. Evidence exists supporting the hypothesis that viewing red is inimical to cognitive performance in laboratory settings and some classroom situations, while others failed to document the effect. The inconclusive nature of these results indicates that continued research into color effects is necessary for our continued understanding.

Basic Color Meanings

In this section we review literature spanning anthropology, cognitive psychology and evolutionary psychology. These studies were sampled to provide an overview of the types of investigative techniques used to uncover, a) the development of color terms in language (Kay & Maffi, 1999), b) the basic hue meaning associations (Moller, Elliot & Maier, 2009) and, c) evolutionary implications of color meaning constructed over our evolutionary history (Young, Elliot, Feltman & Ambady, 2013). While diverse, these studies can be used to triangulate and gain confidence in the conclusions reached regarding the development of color meanings.

Kay and Maffi, (1999) provided an overview of the anthropological perspective taken to understand the development of colors in human language. This work builds upon the well-known paper by Bertin and Kay (1969) (as cited in Kay and Maffi, 1999), by incorporating new findings from the World Color Survey (WCS). Kay and Maffi’s
(1999) paper provides a revision of the previous model proposed by Bertin and Kay (1969) by producing a cohesive explanation for 94% of the data collected in the WCS.

To begin, two predominant schools exist regarding the development of color terminology in human nature. William Gladstone argued that languages, which fail to make distinctions between colors, were simply not capable of recognizing the different colors, whereas B.L. Whorf argued that culture determined when and if a color required a term. Whorf argued that cultural relativity determined the need for a color term, and if the need did not exist then there was no reason to create a new word to describe a color.

In this paper, the authors argued that the color space as only defined when technology necessitated it. Human vision is capable of discrimination, which accounts for most of initial visual sensation. At early evolutionary stages of human development there were very few objects that could not be determined simply by shape recognition or other low level perceptual features. However, as technology within society increased, the need for differentiation occurred, objects began to occupy the same semantic space and therefore necessitated further discrimination. For example, if you were only capable of growing a single type of apple there would be no need to specify its color, however, if large scale farming or a new species were introduced, the easiest way to discriminate the two types of apple would be to refer to one as green and one as red. While this example fails to capture the nuance of the process, it serves as a brute force example.

This way of viewing color discrimination as a function of social technology can be paired with the finding that most languages developed color terminology in similar ways. Results indicated that black and white served as the foundational partitions of the color space. From there red typically developed next, followed by green and yellow,
which preceded blue. Finally, the colors brown, purple pink orange and gray were
introduced. As stated, the starting point for color terms were black and white, and as a
rule, languages gain color terms.

The remainder of this section details the rules, which were thought to dictate the
evolution of color terminology, at least for languages studied in the WCS. The
fundamental principle of the revised model proposed by Kay and Maffi (1999) was that
the color space is partitioned, meaning that as items occupy the color space, new words
were created to better partition the space. The partitioning of the color space was limited
by the basic achromatic constraints of black and white, as well as the four colors involved
in the opponent process human color vision system. Therefore, partitioning of the color
space occurred initially for white and black, with all changes beginning from this point.
The second principle involved in the evolution of color terminology is the divide between
warm and cool colors. Long wavelength colors such as red, orange and yellow are warm,
whereas short wavelength colors such as blue and green are cool. When asked to sort
colors, individuals typically separate colors relative to the warm/cool distinction.
Interestingly however, white is typically assigned to the warm colors and black to the
cool colors. This natural tendency for white to be warm and black to be cool serves as
the starting point for the incremental partitioning of the color space, a point we return to
later. The final principle in the revised model is that the color red typically develops first
in the color space after both black and white, but before any other color terms. For
German, Spanish, Russian, Italian, Mayan, Bantu and Polynesian the color red is
acquired first.
Based on these three principles, language development was tracked for the 110 languages included in the WCS. In this article language development was described in 5 stages. Stage 1 corresponded to the partitioning of the color space relative to white and black, further grouped with the warm/cool distinction. White, red and yellow (warm colors) occupied one space and blue, green and black the other. The initial changes in Stage 1 invoke Principle 3 indirectly due to the special nature of the color red. In Stage 1 white is separated from the other warm color, red and white because separation of white promotes the later emergence of red. By beginning with white, separation from Stage 1 to 2, red will emerge sooner in the later stage. The transition from Stage 2 to 3 is dictated by Principle 1, because if white is partitioned, black is immediately partitioned next. After Stage 3, we are left with a separate partition for white and black, and the groupings based on warm and cool colors, red and yellow and blue and green respectively. Principle 3 dictates the stage 3 to 4 transition, or the preferential treatment of red compared to other colors. Therefore, in this transition, red is partitioned from yellow. The transition from Stage 4 to 5 is dictated by the principle of partitioning; the only nonpartitioned color pair being blue and green, in that all others have been separated. Therefore, after five stages of development the color space is partitioned into white, black, red, yellow, green and blue. This pattern of color language development summarizes 101 of the 110 languages sampled in the WCS.

The study conducted by Moller, Elliot and Maier, (2009) provided an interesting jump in theoretical approach and methodology. Whereas Kay and Maffi (1999) used ethnographic techniques, Moller et al.’s study used reaction time to assess differences in color meanings. Moller et al. sought to understand the inherent relationships between
colors and words of different contextual valence. In two experiments, the authors measured the time necessary to classify a word relative to its success or failure orientation (Experiment 1) or general valence (Experiment 2). The authors argued that red has been systematically paired with failure in achievement contexts due to its repeated pairings with failure and red marks. They argued that it would be easier to classify failure words presented in red, specifically, that red would facilitate recognition of the words as failure related compared to the same words presented in green. Results of Experiment 1 indicated that indeed failure related words such as, “worse, wrong or inaccurate” were categorized as failure more quickly when presented in red compared to green. Additionally, success words presented in green were categorized more quickly than the same words presented in red. Despite the theoretically relevant findings the authors were unable to determine if red facilitated or inhibited the reaction times because there was no control condition.

To address this limitation, a second experiment was conducted in which the words from Experiment 1 were also presented in white. The authors were also interested in whether the basic hue meaning relationships found in Experiment 1 extended to generally positive and negative words. Results of Experiment 2 reinforced those of Experiment 1, viewing failure words in red resulted in more rapid categorization compared to both white and green. Additionally, categorization of success words was facilitated by presentation in green compared to red and white. These results demonstrated that red was associated with failure and green with success. Regarding the generally positive and negative words, significant differences were found for red and negative words only. When general negative words were viewed in red it sped categorization of negative
words compared to green and white. There were no significant differences for green and general positive words; however, positive words were categorized more slowly when viewed in red compared to white. The results of this study can be seen to support the evolutionary development hypothesized by Kay and Maffi, (1999). Richer connections were found for red compared to green, and as indicated by Kay and Maffi, red develops significantly earlier in language than does green.

The final investigation presented in this section investigated the influence that the color red had on the processing of angry facial expressions. As evidenced, red has a biased evolutionary effect, and may have developed due to environmental pressures. Young, Elliot, Feltman and Ambady, (2013) argued that the color red would trigger threat appraisals and avoidance motivation, and that this cognitive state would result in more rapid categorization of a face as angry compared to happy. Happy faces were chosen because of literature stating that happy faces are processed more quickly compared to other expressions.

Experiment 1 tested the hypothesis that faces viewed with red would be categorized more quickly than the same faces viewed with green or gray. Results indicated that consistent with the literature, happy faces were categorized more quickly than angry faces. However an interaction qualified this effect, specifically, it was found that red sped categorization of angry faces compared to gray or green, and that red inhibited identification of happy faces compared with green.

Experiment 2 was conducted to test the boundaries of the effect found in the previous experiment. In this experiment the chromatic control color was changed from green to blue, and the happy facial expressions were changed to another high arousal
negative stimuli, fear. The authors hypothesized that red would not facilitate the processing of fearful faces, only angry faces due to the threat cue and avoidance motivational state. Results supported the author’s hypotheses, in that only an interaction between color and facial expression was found. Red facilitated the categorization of angry faces compared to blue and gray. No differences were found for the fearful faces, indicating that another high arousal negative stimuli did not benefit from the red effect.

In sum, these three investigations demonstrated that color terms develop not in parallel but instead develop as environmental factors dictate. Kay and Maffi, (1999) provided support for the color red being evolutionarily old, which supports the robust findings regarding red effects shown here. Moller et al., (2009) concluded that the color red has rich evaluative meanings, by specifically documenting a positive association with failure and general negative words, and a negative relationship with success and general positive words, compared to green being positively associated with success words. Finally, Young et al., (2013) showed that detection of threatening faces was facilitated by the presence of the color red compared to green, blue and gray. This finding further demonstrated the evolutionary function red has played in human history. Red is one of first chromatic colors to be defined across the majority of languages, it has rich associations with negativity and failure, and provides additional information compared to other colors regarding the detection of threat.

Color in Marketing

The Color in Context Theory proffered by Elliot and Maier has proven useful for various contexts of color research. Due to the generality of the theory, researchers are
able to address specific facets of the theory relative to their research interests. Thus far, we have investigated color effects in domains including achievement, physical and competitive contexts; we will now review some of the work done on color effects in the context of marketing.

Labrecque and Milne (2011) provided a strong overview of the type of research questions being asked in the domain of marketing. In their study the researchers wanted to address the foundational questions of whether the components of color—namely hue, saturation and value independently influence brand personality.

The description of the measures of interesting the investigation is secondary to the role that color played in their investigations. Whereas, Color in Context Theory requires biological and societal evidence for the assumed meaning of a color, in marketing, the authors argue, the meanings arise from existing color pairings.

Piotrwiski and Armstrong, (2012) further elaborate the role of color in applied marketing situations. Where the previous study aimed to investigate color when it represented a brand, Piotrwski and Armstrong (2012) sought to use color as a way to measure the evaluative response to a concept. In their investigation the authors presented individuals with a construct, either the IRS or a TARP bailout plan. It is important to mention that these issues had previously been investigated so that the issues were known to produce negative evaluations. Using the knowledge regarding the valence of the issues, the authors argued that a semantic differential scale using color and not adjectives could prove a useful metric for understanding conceptions of the issue. Borrowing from the extant literature on color meanings and influences, the authors argued that red has negative connotations and represents negativity. The converse finding that green is
typically positive served as the rationale for it anchoring the opposite end of the scale. From this theoretical basis, that red is negative and green is positive, the authors asked participants to rate their conception of a construct, either the IRS or TARP program using the red/green scale.

Results indicated that the semantic differential scale produced significant differences between ratings of red compared to the neutral 4 point on the 7-point scale. These results did not extend to ratings for the TARP bailout program. It is interesting to note that the IRS is an entity, whereas the TARP initiative is a specific program. In that regard, evaluations using the semantic differential scales may differ depending on if the evaluation is of a company, or an isolated program.

This study while novel and relatively unsupported in the literature, poses an interesting perspective to view color as it relates to evaluation. According to Color in Context theory, color has a reciprocal relationship to affect, cognition and behavior. This dual relationship supports the research question addressed by Pitrowski and Armstrong (2012). If viewing a color produces an evaluative response, one could argue that a color can also represent an evaluative response. It brings into question the confounded nature of luminance chroma and hue, but if the hue dimension is the only variable to change, the scale may provide a meaningful index of an individual’s conception.

This study leads nicely to research conducted by Labrecque and Milne (2011), and (2013). This line of research investigated the concept of brand identity (Aakers, 1997). Brand personality, according to Akers, (1997) is the, “set of human characteristics associated with a brand”. Aker constructed a brand personality scale containing 42 items
with characteristics such as “sincere, competent, and sophisticated”. These characteristics have been adapted from research on human personality characteristics.

Labrecque and Milne (2011) conducted a study wherein specific aspects of luminance, chroma and hue were systematically investigated over the course of three studies to illuminate the relative effects of each component on evaluations of a product. Whereas typical research investigates the perceptions of a company holistically, in this study only a single company’s product was analyzed. Hypotheses were created relative to items on the brand identity scale and were partially supported by the results of the various studies. Across each study, the investigators revealed effects of hue (Study 1) chroma and luminance (Study 2) and combinations of luminance, chroma and hue (Study 3). For the purposes of this review we focus on studies 1 and 3. In Study 1, various company logos were presented in one of 10 experimental colors. The colors included white, yellow, pink, blue, red, orange, brown, black, purple and green. These colors were selected due to previous findings in the literature, and their ability to create theoretically relevant hypotheses.

Results indicated that white and pink were significantly related to the construct of sincerity, consistent with the literature, while yellow was also marginally related to sincerity. Results also indicated that only the longest wavelength color—red was associated with excitement while orange and yellow failed to be associated with excitement. Regarding competence, only blue was found to be a significant predictor of competence, while brown failed to demonstrate a significant relationship with the characteristic. Additionally, the characteristic sophistication was investigated. Results indicated that black and purple were significantly related to this characteristic.
Furthermore, it was found that orange was negatively related to sophistication. Finally, the characteristic ruggedness was investigated. Results indicated that brown was significantly related to the characteristic, whereas green was not. Further results indicated that pink was negatively related to ruggedness as was purple. Together, these results indicated that various hues were differentially related to various brand identity characteristics including, sophistication, competence, excitement and ruggedness. These findings provided the rationale for the importance of controlling certain aspects of color in order to isolate their relative effects.

Experiment 3 was conducted to investigate specifically whether specific combinations of luminance, chroma and hue could produce a priori evaluations of the product. Study 1, combined with the results of Study 2, in which luminance and chroma were systematically varied further supported that the three components of color all influence evaluation. Study 3 sought to match specific color characteristics to produce an a priori brand identity. Two experimental packages were created and tailored to match a specific package characteristic. For example, a rugged package was created which featured a high saturation, low value red hue. This was compared to a low saturation, high value purple hue, which was though to produce higher ratings of sophistication. Participants were presented with a brief text asking them to choose a product that was classy, attractive and refined, or durable, strong and well built. Results supported the hypotheses in that a rugged package was related to higher purchase intent, when a rugged product was sought, and a sophisticated package when a sophisticated product was sought. Results of this study indicated that depending on the target placement of a product, a specific package type can and should be constructed to support it. At least for
certain product characteristics there are high quality and low quality choices. This qualification is necessary because the opposing package designs were created to show differences between packages. It is yet to be seen if other package color combinations would produce different results.

Labrecque and Milne also conducted an investigation not into the manipulation of colors but into the existing application of colors in logo design (Labrecque & Milne, 2013). The authors sought to investigate how current companies implement colors in their logo. To conduct this investigation Labrecque and Milne (2013) used an existing yearly report from Brandweek. The annual 2009 Superbrands report was used as the data set. This report detailed 281 brands in 15 product categories and 40 subcategories. The report also detailed a brand equity measure, which is derived from consumer ratings, media expenditures and sales.

In this investigation, the authors aimed to understand the current use of colors for companies that were know to be successful. Furthermore, the dataset allowed for comparisons of brands that exist within a dominated or open category. For example, McDonalds is a dominant brand in the category of food service, with Subway being the second most successful company in the category with sales trailing by over 300%. This can be contrasted with the category of insurance companies, where there is no clear market leader but instead a small collection of nearly equal companies.

The authors argued that dominant brands function as a category prototype that provides visual signaling to prospective customers. Due to the increased fluency of accessing a well-established schema, it is argued that some companies could borrow the schema activated by a dominant product.
To determine the relative differentiation or homogeneity of brand logos, independent coders rated the 281 company logos. Results indicated that the most frequently used color in logo design was blue (48.2%), followed by white (39.3%), red (31.4%) and black (26.1%). The least frequently used colors included; gray (1.1%) brown (2.1%), and pink (2.1%). An interesting range of color can be seen in the usage of blue. On the low end is blue, which is used 20% of the time in fast food compared to 76.9% for credit cards. Red was used 0% for apparel, and 62.5% in retail brands. Furthermore, apparel was found to be the most homogenous of the product categories and pharmaceuticals the least.

Results indicated that being different from the dominant category brand was beneficial for companies including airlines (r = .843), cold and allergy medicine (r = .992), insurance (r = .947) and shampoo (r = 1.00), with all values below p = .05. However, differentiation was negative for products including toothpaste (r = -1.00), compact cars (r = -.994) and luxury cars (r = -797), again with all results being statistically significant at the .05 level.

These results were further qualified by accounting for dominance in brands. This was determined by looking at market share for a given category. A brand with a market share 1.5 times greater than the nearest competitor was included in the analyses. Eighteen brands qualified for inclusion with this criterion. As one would expect, the vast majority of brands included in these analyses contained the top color for the brand category analyses. Of these dominant brands, 8 correlations were significant. The results indicated that deviation from a market leader could have negative effects on brand equity.
However, as just stated, only half of the correlations were significant, indicating that deviation from the norms may not necessarily be negative for brand equity.

The authors interpreted their results as indicating that color differentiation may have different effects on a brand, depending on the category of their products as well as their placement within a product category. If the category is dominated by one brand and the brand is well established the effects can often be negative. The authors argued that the results come from the increase in processing fluency for a product that accesses and existing brand schema. By activating an existing schema a less dominant brand can access and borrow the equity from an established brand. These results while preliminary in nature provided additional evidence that color decisions made in logo design have strong implications on brand equity. While one may argue that the colors themselves do not carry evaluative meaning, colors would still result in brands establishing the relative color meanings for their categories.

These three studies provide only a glimpse into the possibilities of color effects in marketing, however they do indicate that the area is productive for continued investigation.

The Role of Color in Web Settings

Research has also been conducted on color choice in online settings. Strong evidence exists supporting the hypothesis that color influences human decision-making and evaluation in educational, and achievement contexts. However, little research exists on color effects in more applied areas. This section focuses on color effects as they relate to impression formation in online, or mock online settings. These investigations involve
the manipulation of online web materials in a controlled laboratory setting. While not ideal for ecological validity they represent the first questions of a new context, online impression formation.

Alberts and Geest (2011) conducted a study investigating the influence of color on evaluations of three fictitious websites, legal, financial and medical. The authors were interested in how color choice—specifically red, blue, green and black would be evaluated across each of the three domains. Of interest were evaluations of perceived trust. The authors defined trust as a, “general belief that the other party can be trusted, and to specific beliefs that a trustor holds about the integrity, benevolence, ability, and predictability of the party to be trusted”.

The authors argued that individuals process the website and that this processing results in interaction and viewing of the design employed in the site. This interaction provides learners the ability to derive a concept of the company according to the visual elements they encounter. The website is in fact one of the first components potential customers interact with, and will accordingly be one of the first informational sources that allow for trustworthiness evaluations. Research conducted by Robins and Holmes’ (2008) (as cited in Alberts & Geest, 2011) stated that after a brief exposure of 750 milliseconds individuals were able to derive a “first” impression of a company. This initial impression lead to predictions of informational quality, with more visually appealing websites being expected to have higher informational quality than less visually appealing websites.

The authors argued that the Elaboration Likelihood Model propose by Petty and Cacioppo, (1986) can be used to explain the role of color perception in evaluations of
website trustworthiness. One possible mechanism is the halo effect, which states that first impressions are carried over to other attributes of an evaluated target. A second mechanism is that aesthetics may prompt affective, non-rational responses. A final hypothesis states that congruency between color and context allow for increased processing fluency due to appropriateness, compared to incongruent combinations.

Results indicated that across all contexts the blue website received the highest trustworthiness ratings. Blue was rated as more trustworthy that black, red or green. The green website was rated more trustworthy that either the black or the red website, and finally the red website was rated as more trustworthy that the black website. The authors reported an effect size of approximately 7%, indicating that color has a small but significant influence on evaluations of a fictitious website despite a brief exposure.

Additionally, the researchers investigated gender differences for evaluations of trustworthiness. Results indicated that females attributed more weight to the color of the website, compared to males, as evidenced by a 7.4% compared to 6.3% effect size. As previously mentioned, context was a variable of interest. The authors argued that the appropriateness of a color to a given situation might lead to elevated trustworthiness evaluations. Results partially supported this hypothesis, for legal and financial contexts red and black failed to produce reliably different results. However, blue and green were significantly different across all contexts, although the effect sizes were low (0.1-0.4 %). Follow-up analyses revealed that color effects were greatest for the financial context (11.2%) compared to legal (4.3%) or medical (5.8%). These results all contribute to the belief that color effects are context specific and that color plays a different role in each context.
To investigate the hypothesis of color appropriateness, the investigators asked participants to choose a color for a context that was most trustworthy. Across all contexts blue was the most preferred color, consistent with the observed pattern of results; however, differences emerged regarding the second most appropriate color. The most preferred color was green for the finance and medical contexts, whereas for legal it was black. Again, these results reinforce the belief that context dictates color appropriateness. Furthermore, these results support the continued research of color interactions in online websites.

Magee (2012) also aligned with the Elaboration Likelihood Model to investigate color effects in a different light. Here, Magee was interested in how an individual’s need for cognition, or their desire to deeply process information would interact with color and sensations of physical cold or warm. Research indicates that under low-thinking conditions individuals are more likely to misattribute informational cues to a target, however, the effect disappears when individuals are made aware of the informational cues. This finding provides the rationale for the mechanism by which peripheral informational cues may be incorrectly mapped onto a target.

Impression formation in online settings was the context in this study. The authors entertained the question of whether or not an individual browsing the Internet in a coffee shop would evaluate a website differently if the only thing that differed was the relative temperature of the drink they were consuming. Would an iced drink lead to more icy evaluations of the website, and would a piping hot beverage lead to more positive evaluations of the websites warmth? Hot versus cold were the peripheral informational
cues in this study, and the authors argue that the misattribution of these cues would happen for low NFC individuals.

For online websites, credibility and trustworthiness are the focal measures, however Magee argued that there might be two separate but parallel dimensions to online impression formation. Magee identifies warmth and competence as two dimensions that may be more informative than a single construct such as credibility. Therefore, both warmth and competence were measured in this study.

In this study, beverage temperature was the focal informational cue; color was only included due to hypothesized interactions with temperature. The authors provided evidence that viewing the color red could prompt more elaborated cognitive processing thereby negating the misattribution of the beverage cue to the target website. Therefore, no interaction effects were hypothesized when a red website was viewed, due to the influence red has on cognitive processing. However, the authors did hypothesize that viewing a blue website would allow for differences between beverage temperatures to be detected—specifically, that the warm beverage would produce higher ratings on the warmth dimension compared to the cold beverage, but that no differences would exist for the competence measure.

Results indicated the individuals exposed to the blue website spent significantly less time viewing the content, supporting the authors claim that viewing red prompted elaborated processing. Furthermore, support was found for the hypothesized interaction between the blue website and the temperature of the beverage. Results indicated that individuals who had a source of warmth rated the target website as significantly warmer compared to the cold group. Additionally, no difference was detected for competence
ratings, indicating that the two-dimension scale proposed by the authors may be a useful way to disentangle impression formation findings.

Together these two studies provide a brief glimpse into the myriad questions being addressed in the role of color in web settings. With the ubiquity of online informational sources and the proliferation of new businesses, investigations into how color influences new customers is a valuable field of research. Not only is color aesthetically appealing or not, the message sent by a company’s website can influence perceptions of that organization in many ways. Not only are credibility and trustworthiness important, but also warmth and competence. In a previous section we discussed brand identity, which is comprised of many factors and modeled after a human personality. It would be naïve to think that color choice in online settings does not have meaningful impacts on these perceptions. Color in web settings must continue to be investigated for a deeper understanding of context specific effects to be known.

Extended Color Stimuli

Extended color stimuli serves as the category in this review that focuses on factors that influence either the dual nature of color effects (Roberts, Craig, Owen & Havlicek, 2010) or the strength of color effects (Buechner, Maier, Lichtenfeld & Elliot, 2014; Maier et al., 2013). This section aims to elaborate on the situational influences that contribute to the influence of color.

Robert, Crain, Owen and Havlicek (2010) focused on the dual roles of color using humans. In this study, the researchers aimed to continue the research on evaluation of individuals wearing red. Their study differed in two key ways, 1) they included many
color comparisons within the same study and, 2) they focused not only on the perceiver but also on the wearer of clothing. The established research claims that individuals are evaluated more positively, specifically in regard to attraction when they are seen wearing red. The authors of this study attempted to elaborate on this finding by including the colors blue, green, black, yellow, red and white.

The inclusion of additional colors in a single experiment allowed for a deeper understanding of the relative differences between colors. Typically only one or at most two colors are compared in a given experiment with additional colors being incorporated in later experiments. This experiment allowed for the conclusion that red and black resulted in the highest attractiveness ratings compared to the other four colors. This finding persisted across multiple analyses including gender of rater and gender of individual being rated.

The other key finding from this study was the conclusion that the influences of color extended to both the perceiver and the wearer. Typically, research focuses on the influence a color has on the individual being evaluated, specifically how color changes the evaluation of the person wearing it. This study employed a methodology that allowed for investigation into whether wearing a specific color changes how the wearers perceive themselves. In this study, the color of the shirt being worn was created two different ways. One set of materials was created by asking undergraduate participants to wear the experimentally colored shirt. An additional set of materials was created using Photoshop to, after the fact, change the shirt color of the wearer.

These two sets of experimental materials allowed for comparison of the attractiveness ratings of the same model when the only thing to change was the color of
the shirt. Individuals were asked to evaluate the attractiveness of a model when their shirt was covered, thereby controlling for the influence of color. Results indicated that models were evaluated most positively when they were knew they were wearing a red shirt, compared to when they were wearing a white shirt that was then changed to red. This finding indicates that the attractiveness of the model was changed before the perceiver evaluated the model. The color also exerted an influence on the person wearing it. This finding indicated that color effects are not only on perceivers but also on the wearer of the color red. This finding is similar to research focusing on the perceptions of dominance and aggression in physical contexts.

In sum, this study provided support for the dual nature of color effects. According to Elliot and Maier (2014) color can exert a reciprocal influence on behavior and cognition. This study is the first to demonstrate the dual sided influence of color on evaluations.

The category of extended color effects also pertains to secondary influences of color, or their interactions with additional variables. For example, research by Buechner, Maier, Lichtenfeld and Elliot, (2014) investigated the interaction of color across gender and emotional display. In this study, males and females were asked to evaluate the attractiveness of a male displaying a prideful or shameful emotional state. The image depicting the emotional state was further crossed with the colors red and blue. Each image presented either a red or blue circle on the male’s shirt.

The variables were crossed to investigate the differences in evaluation of dominance, social standing and attractiveness for males and females. Of further interest was the interaction of color and emotional expression. In regard to mate selection,
approach and avoidance motivational forces were thought to exist. For example, females were thought to engage in approach motivation if they are attracted to a male mate. Inversely, females were thought to exhibit avoidance motivation if they encountered an aversive mate.

The authors hypothesized that the colors red or blue would, “establish a valenced motivational tendency that is modulated by color cues”. This argument posits that color should interact with the emotion being expressed and thereby produce systematic patterns of responding. A prideful emotional display was thought to be appetitive to females compared to a shameful emotional display. This finding was supported by the results of the study. But of greatest interest was the significant three-way interaction between gender, color and emotional display.

For males, there was no interaction between color and emotional display for attractiveness. However, for females results indicated that when a prideful emotional expression was viewed, attractiveness was higher when red was viewed. Additionally, when a female viewed a male engaging in a shameful emotional expression and the color red was viewed evaluations of attractiveness were lower than for blue. This pattern of results indicated that the color red reinforced the emotional expression. Red was positive when the emotional expression was positive, and it was negative when the emotional expression was negative. This finding supported the contention that red, “accentuates the existing response tendency”.

In addition to investigating attractiveness, this study also addressed perceptions of dominance. Results indicated that male’s evaluations of dominance were significantly influenced by color. When red was viewed in a shameful emotional display, evaluations
of dominance were greater. Interestingly, no effect of red was found for the prideful emotional expression.

In sum, the results of this study indicated that perceptions of attractiveness and dominance were not fixed, but were qualified by a great number of variables and interactions. The findings of this study are novel in that they show interactions of focal variables within a context. In this study, color and emotional expressions interacted for women to produce different responses to a color. Red was found to accentuate the primary informational source. When the display was positive (prideful) red resulted in higher ratings of attractiveness, but when the display was negative (shameful) the effect of red was negative.

Maier, Elliot, Lee, Lichtenfeld, Barchfeld and Pekrun (2013) provided further elaboration for red effects on evaluations and perceptions. In their investigation, red was compared with blue and green across three experiments. Of focal interest was the influence of red on competence, earning potential, leadership potential and likelihood of being hired.

Similar to the previous study by Buecher et al. (2014) here we focus on differences within a given context, and therefore focus on Experiment 1. In Experiment 1, Maier et al. manipulated the evaluative state of the viewer by defining the setting as affiliation, limited information or job application. This was the first study to overtly vary context in a single experiment. While the main effect failed to reach a reliable level of significance, trend tests indicated that the influence of the color red decreased across the contexts, with contexts requiring evaluation of competence having the strongest effects. However, results of the study reinforced the finding that viewing red on an individual
who is being evaluated for their competence results in a negative evaluation of their skills.

These three studies address additional aspects of color effects in psychological research by focusing on factors that outline boundaries for color effects. Despite color research being a relatively new field, much work has been done allowing for general findings. These general findings do however have boundaries and interact with other variables. These three studies are examples of the work being done to delineate the specific effects of the color red. Roberts et al. (2010) showed that color not only influences the perceiver but also the wearer of a color in a way the systematically influences evaluations of attractiveness. Beuchner et al., (2014) provided insight into how color interacted with displays of emotion by investigating the interaction of color and emotional displays on attractiveness and dominance. Their results specified the red effect and pointed to not a fixed meaning of red but a meaning that is shaped by the other information in the evaluative context. Finally Maier et al., (2012), showed that even within a single experiment context effects exist, and that red has a more pronounced effect in situations where competence is evaluated.

Color in Competitive Contexts

Research into the effects on color in competitive contexts has focused on the effects of the color red compared to green, blue, and white. The rationale underlying investigations into this context is that red has a biologically relevant signaling function. Investigations into non-human primates have revealed that males who possess the most red, whether that be in their plumage or faces, during interaction with other males are
typically more dominant. This basic finding, that red demonstrates aggression and
dominance has been repeatedly found for animals and more recently humans. This
biological and evolutionary finding has been reinforced by societal pairings of red with
aggression and has been found to influence affect, cognition and behavior.

In this section of the review we focus on three studies that represent research
questions in the area of red effects in competitive environments. Hill and Barton (2005)
used existing data from the Olympics to investigate the benefits of wearing red in
competitive contexts. Feltman and Elliot (2011) investigated the effects of wearing the
color red on evaluations of oneself and a competitor in a physical setting. Finally, Ten
Velden, Baas, Shalvi, Preenen and De Dreu (2012) investigated the influence of the color
red, not in a physical setting but when red is a peripheral aspect of the competitive
environment, specifically the color of poker chips. Despite differences in
operationalization of the competitive domain, all results indicated that red was capable of
influencing human cognition and behavior.

Hill and Barton (2005) conducted an investigation into the results of Olympic
events including, Boxing, Tae Kwon Do, Greco-Roman Wrestling and Free Wrestling.
In the Olympic setting uniform or jersey colors are randomly assigned to aid in the ease
of scoring the bouts. Participants receive either a red or blue colored garment to compete
in. Results of the author’s investigations into the proportion of bouts won across all the
aforementioned sports indicated that wearing red compared to blue resulted in
significantly different likelihoods of winning the bout. Overall, across sports, wearing
red resulted in winning around 55% of the time compared to 45% for blue. This striking
difference disappeared however when the symmetry between competitors was included.
Only when competitors were of similar ability was the red effect found. Even a small difference in the difference of skill between competitors was enough to overcome the red effect. This difference is striking when one thinks of the stakes at play in Olympic competitions. If indeed a systematic bias exists when competitors are evenly matched and one is randomly assigned to wear red clothing, it must be remedied to balance the competitive environment.

The next study presented in our discussion of color effects in competitive settings was a laboratory study whereas the previous used existing data. In this investigation, Feltman and Elliot (2011) aimed to understand the bidirectional effects of the color red on dominance and intimidation. By bidirectional effects we mean the dual effects that colors can have, specifically influencing the wearer or perceiver of the color. To address these questions, the authors conducted two experiments, one investigating the effects of wearing a colored uniform, and another investigating the effect of competing against an individual wearing a colored uniform. The authors argued that due to biologically and evolutionary differences in male and female roles, only males would be susceptible to the red effect, however across both experiments no gender differences were detected.

Experiment 1 sought to understand the influence of uniform color (red vs. blue) on perceptions of dominance and threat. Individuals in this experiment were asked to imagine that they were going to compete against another person in a Taekwondo bout. Individuals were described the scenario and then randomly assigned to view their uniform, either red or blue. Results indicated that individuals perceived themselves as more dominant and threatening when wearing a red uniform compared to a blue uniform. Furthermore, individuals attributed more weight to the imagination of the scenario and
description of the sport than the color of the uniform, indicating that individuals were not aware of the influence of color on their ratings.

To investigate the alternative perspective in a competitive context, the authors conducted a second experiment to understand the effects of viewing a red uniform on dominance and threat perception. Using an identical methodology to Experiment 1, the authors randomly assigned individuals to view their opponent wearing either a red or blue uniform, when they themselves wore a white uniform. Results indicated that individuals perceived their competitor to be significantly more threatening and dominant when wearing a red compared to blue uniform. Similar to Experiment 1, results indicated that color of uniform was thought by participants to have less of an effect on their perceptions than either the imagination exercise or description of the sport.

These bidirectional findings reinforce the notion that red carries meaning in competitive contexts compared to blue and white. Results showed that either viewing or wearing red resulted in stable effects regarding perceived dominance and threat, and that individuals were relatively unaware of the color’s influence. The authors argue that their failure to detect differences between genders indicated that the repeated societal pairings of red with dominance were operating in a way that rendered the biological meaning moot.

The final study presented in this section investigated not the color of uniform worn in a competitive setting but instead to a proximal part of the competitive context. Ten Velden et al. (2012) in a series of three experiments investigated the influence of colored poker chips on perceived intimidation and behavioral indices of competitive withdrawal or approach for a card hand that was equally likely to result in winning or
losing. Whereas perceived intimidation was a self-report variable, competitive approach vs. withdrawal was operationalized as the percent change in folding, calling or raising behavior.

Experiment 1 sought to understand the effects of playing against a player who was betting using red compared to blue or white poker chips. Results indicated that individuals were more intimidated by a player betting with red compared to blue or white chips. Additionally, the behavioral indices of competitive approach vs. withdrawal indicated that players were significantly more likely to fold and less likely to call when competing against red chips compared to either blue or white. Mediation analyses indicated the differences in perceptions of intimidation were responsible for the differences in competitive behavior.

Experiment 2 sought to expand on the red effect documented in Experiment 1 by focusing on the number of red chips that were in play during a given betting sequence. Experiment 2 employed a 2 (chips’ color: red vs. white) x 2 (number of chips: 5 vs. 10) between subjects design. Results indicated a significant effect of color, with red chips being perceived as more intimidating, and resulting in more folding and less calling than white chips. An additional main effect was found for the number of chips, with 10 chips being perceived as significantly more intimidating than 5 chips. These results were qualified by a significant interaction. For red but not white chips, 10 chips were perceived as more intimidating and resulted in more folding and less calling than 5 red chips. Finally, similar to Experiment 1, perceptions of intimidation mediated the behavioral indices, indicating that perceived intimidation is responsible for the changes in competitive strategy.
Finally, in Experiment 3, the authors investigated the effect that betting with red vs. white chips had on participants betting behaviors. Results indicated that participants felt more dominant when betting with red chips and in fact bet more aggressively, as indicated by increased betting.

The results of this study are among the first to investigate how colored objects involved in a competitive context influence perceptions and ultimately behavior. Across three experiments the authors demonstrated that playing against red poker chips intimidated players and that this intimidation changed their betting behaviors. Experiment 2 elaborated on this finding by showing that the amount of red chips further influenced perceptions of their competitor. Interestingly, 10 chips compared to 5 chips, even though they represented the same currency, magnified the effect of the color red. Finally, the authors demonstrated the bidirectional effects of color on perceptions and behavior. When individuals bet with red poker chips they felt more dominant and bet more aggressively.

In sum, this collection of studies demonstrates effects of colors, specifically red, in competitive settings. Based on biological and evolutionary factors the color red, but not blue, green or white were thought to represent aggression and dominance thereby influencing both perceivers and wearers of the color red. In addition, these studies demonstrated that the societal pairing of red with dominance might augment the biological meanings of color. This societal pairing would provide the rationale for why color effects are not gender specific but apply to both males and females equally. What these studies have demonstrated however is that in competitive settings the color red carries important information not possessed by other colors, and that this additional
information is capable of influencing cognition and behavior across several unique competitive events.

Color and Message Framing

This line of research aims to understand how color can be used to increase the persuasive effect of message framing. Message framing arose from Prospect Theory, work conducted by Kahneman and Tyversky. Their research indicated that the phrasing of outcomes influenced the decisions made by learners. Relevant to our discussion here is gain vs. loss framing discovered by Kahneman and Tyversky. Gain and loss framing presents equivalent information but focuses on either benefits (gains) or consequences (losses) of engaging in a given behavior. For example, applying sunscreen can be presented in two distinct ways. A learner could be confronted with the statement that using sunscreen will keep your skin healthy and protect you from skin cancer. Or the use of sunscreen can be presented in a loss-focused fashion. For example by stating that failure to use sunscreen might result in sunburn skin and cancer.

Research has indicated that in decisions involving risk, such as skin cancer or vaccination against STD’s, presenting a loss framed message yields higher intentions to receive a vaccination or apply sunscreen. The benefit of the loss-framed message is thought to be the focusing on the negatives of not engaging in the behavior and the risk associated with not engaging in the behavior.

This focus on risk provides the theoretical link to studying message framing and color. Colors, especially red have been found to be associated with risk or danger via their repeated societal pairings with stop, or danger, and the biological signs of blood and
aggression. Therefore researchers argue that the combination of a loss-framed message in the presence of the color red will produce greater intentions to engage in the behavior. Despite the strong theoretical foundation, little work has addressed the interaction between framed messages and color. Further difficulties due to inconsistent findings also make interpretations and generalizations difficult.

Gerend and Sias (2009) conducted an investigation into the interaction of framed messages and the colors red and grey regarding intentions to receive vaccination against Human Papilloma Virus. Previous work had demonstrated that a loss-framed message resulted in higher vaccination intentions due to an explicit mention of the risks. This, the authors argued could be amplified by including an additional cue that made risk and danger more apparent. This cue the authors argued was the color red.

Results indicated that vaccination intentions were highest when a loss-framed message was primed with the color red. This pairing of red and a loss-framed message was the only circumstance in which intentions were higher. Interestingly, no main effect was discovered for the message framing manipulation, only an interaction.

While the results of this study are interesting a major limitation of the study is the design, specifically the conditions of color. Gray was chosen as the control color, but gray is an achromatic color, it can be equated with red on luminance and chroma but it inherently lacks a chroma. Therefore, results are limited because we do not know if the finding on the study is simply a chroma effect. Stated another way, we do not know if the observed interaction would result from any other chromatic color (i.e. blue or green). This limitation is rebutted by the theoretical rationale for the interaction, specifically that red provides and additional danger cue, but it still must be addressed. For this reason,
even the promising results reported here are only the beginning of the research necessary to uncover the interactions of framed messages and color. Chien (2011a; 2011b) provide further doubt about findings relating to framed messages and color. These two studies typify the inconclusive findings of color and framed messages interaction. Chien (2011a) examined individuals’ likelihood of receiving vaccination for the H1N1 flu. By crossing two levels of framed messages (gain vs. loss) and having the text presented two ways (white characters on a black background vs. white characters on a red background), the authors were able to address the interaction of color and frame. Results indicated that the loss-framed message was more believable, more interesting and easier to understand. However, message framing alone was not adequate to increase vaccination intentions. Vaccination intentions were only significantly different when a loss-framed message was paired with white characters on a black background, not when red was viewed. These results failed to support the findings of Gerend and Sias (2009) but nonetheless show that certain color combinations and text frames are capable of influencing decision-making in real world settings.

Chien (2011b) used the same experimental design and only changed one factor, instead of white characters on a black background; they instead used white text on a blue background. The resulting design crossed two framed messages (gain vs. loss) and two background colors with white text (red vs. blue). Results indicated that the framing of the message failed to reliably influence vaccination intentions or willingness. However, when a loss-framed message was presented to individuals viewing a red background they were significantly more persuaded and more likely to be vaccinated.
In sum, these three studies show the promise in continuing to investigate framed messages and color combinations for serious health issues, but also highlight the methodological errors in their approach. For example, in no study were both a chromatic and achromatic color included in the design. This results in the implications of the two Chien (2011) studies being clouded. If however, either study included the other color manipulations (blue and black) in one study, much more could be gleaned from the results.

Color in Knowledge Testing

Research discussed in this section of our review is seemingly disparate but is united by the theoretical alignments with affect and their influence on knowledge testing situations. While the first two studies Gnambs, Appel and Batinic, (2010) and Kumi, Conway, Limayem and Goyal, (2013) are united by their discussions of motivational states, specifically avoidance motivation, the third study by Küller, Mikellides and Janssens (2009) is connected by its discussion of affective states and color. It is with this shared connection regarding affective states and color that we begin our overview, moving onto affect and motivational orientation.

The work of Küller et al. (2009) deviates from the other two studies in our review due to the experimental setting in which the investigation occurred. In this study, the manipulation of color was operationalized as the actual wall color of the room in which participants participated in the experiment. Here, a single wall was colored either red, or blue, with the achromatic control being present in a previous experiment. The aim of our review and specifically this section applies to the influence of color in knowledge testing
environments, and in this study was operationalized as performance on a proofreading task and creativity of a written essay. While these are not tests of prior knowledge they can still be viewed as environments that are testing knowledge.

Despite the differences between this study and those to follow, the role that affects plays in the eventual performance of participants is similar. In this investigation, the authors argued that exposure to differently colored walls would result in a different emotional reactions, citing research on the arousing nature of long wavelength colors such as red and orange compared to short wavelength colors such as blue or green. While the authors exact hypotheses failed to emerge (i.e. red would yield the best performance on a proofreading task and blue would produce the most creatively written essays) results indicated that the emotional state elicited by the colors on the wall influenced cognitive performance. Specifically, results revealed that individuals who were in a more negative mood processed the proofreading task more quickly and with a greater number of errors when in the red room. Interestingly, results indicated that overall individuals were in a more positive mood when in the red compared to blue room. Results also indicated that there was no difference between the red and blue rooms regarding performance on the creative writing assignment. However, when again separated by emotional state in each room, results indicated that a more negative mood in the red room resulted in significantly longer essays, whereas no differences were detected for the blue room.

This study served as a useful primer to the continued investigation of this domain of color effects. The next two studies applied a more rigorous theoretical outline of proposed color effects by searching for mediation between affect and motivational
orientation induced by color manipulations. Additionally, the following studies took place in online environments where individuals were tested for general knowledge across domains.

Much of color research focuses on the affective reactions to color and ultimately their influence on motivation. Gnambs et al. (2010) focused on this relationship in their investigation regarding gender differences in knowledge testing. The authors argued that affective states could be induced by specific colors; in this investigation blue and yellow were of interest. The authors argued that the positive (to blue) and negative (to yellow) affective reactions might result in a difference in motivational orientation. The authors however argued that the link from affect to motivational orientation differs between men and women in this context. Specifically, the authors argued that “knowledge testing environments” are inherently biased, in that males tend to perform better than females. It is this documented difference that leads to the difference in hypotheses regarding the influence of color on an individual’s motivational orientation. The authors argued that females, simply by engaging in this context are subject to situational avoidance motivation thereby insulating them from the influence of color. This situational avoidance motivation is not present for males. For this reason, the authors argued that males but not females would be susceptible to the influence of red on their performance in a knowledge-testing environment.

To test their hypotheses, the authors conducted two experiments to elucidate the interaction of gender and color on performance of standardized tests of general knowledge. Experiment 1 tested if males and females were influenced by the presence of a colored progress bar in their online environment. Males and females were randomly
assigned to view a progress bar in either red or green. A main effect was found for color, specifically that the green condition produced higher overall scores compared to red. However, this main effect was qualified by a significant interaction between gender and color. Results indicated that females were not influenced by the color manipulations consistent with hypotheses. However, the author’s hypothesis that males would be susceptible to the influence of color was supported. Males who viewed a red compared to blue progress bar performed significantly poorer on the test of general knowledge.

The authors conducted an additional experiment in which they changed the color from green to blue, and also included a condition where red and blue were present. To further expand their findings, the authors moved the color manipulation from the progress bar to the forward button, which advanced participants through the investigation. The authors argued that both of these visual design features were commonly colored and therefore better represent color effects. Consistent with hypotheses, the authors concluded that viewing a red “forward” button resulted in significantly lower performance on their tests of general knowledge than the blue button. No significant differences emerged for the red/blue condition compared to the all red or all blue conditions.

In sum, the final investigation in my review supported the hypothesis that males and females differed in their susceptibility to the effects of red in knowledge testing environments. Furthermore, the authors demonstrated that in a relatively uncontrolled environment (online), color effects persist. Even when individuals use their own computer, the influence of one color relative to another is systematic, and that red consistently undermines performance for males compared to the colors green and blue.
The final study in this section sought to model the influence of color from affect, to motivational orientation to recall. Kumi et al. (2013) argued that colors (blue and yellow) were able to elicit different affective responses. These affective responses would then lead to differences in motivational orientation, specifically mastery goal motivation and performance goal orientation. Mastery goal motivation is a state in which an individual values the process of acquiring a new skill. Performance goal motivation is the state in which individuals seeks to demonstrate ability and a favorable evaluation of ability.

The authors hypothesized a link between affect and motivational orientation, specifically that as negative affect decreases, performance and mastery avoidance motivation would also decrease. Said a different way, the authors argued that a negative mood or affect would result in individuals orienting less to performance motivation or mastery motivation. From here the connection to performance is straightforward. If individuals experience an increase in mastery avoidance motivation they will perform better at recall. If individuals are not trying to avoid failing they will perform better than if they are not trying to avoid failing. The same relationship was hypothesized for performance avoidance motivation.

To test their hypotheses, the authors conducted a one-way design in which a lecture was presented to participants with either a blue or yellow background. Results indicated that blue resulted in a more positive affect than yellow, consistent with hypotheses. The link from affect to motivational orientation received partial support. While a significant relationship between mastery avoidance motivation and negative affect was found, the relationship between negative affect and performance avoidance
motivation failed to reach a reliable level of significance. The relationship between negative affect and mastery avoidance motivation was such that an increase in negative affect was associated with a decrease in mastery avoidance motivation. As individuals developed a more negative affect they experienced an increase in their avoidance motivation as it related to mastery. Finally, this significant relationship between negative affect and mastery avoidance motivation resulted in significantly lower performance on the recall test. As individuals’ mastery avoidance increased they experienced an increase in their recall of the presented information.

In sum, this final investigation in our review sought to model the influence of color from initial affect to the cognitive mechanism responsible for an observable behavior. This modeling of the mediation between color stimuli and performance is the current goal of color research, in that it goes beyond input output explanations. While indicating that motivation orientations are partially responsible for performance on recall, the authors take great care in stating that the proportion of variance accounted for by the motivational states is not representative of the total influence of color. This means that while motivation is an aspect of colors’ influence, it is not the only variable involved.

The work conducted on the influence of color in knowledge testing environments is broad and encompasses many research questions. However, in this review the domain is united by the focus on the influence of affect on outcome variables including proofreading, creative writing, general a knowledge testing and recall of presented materials. Testing domains extend beyond laboratory studies and as shown in this section can be found in online studies lacking the experimental rigor of laboratory settings.
Scene Perception and Green

This section of the review addresses two different aspects of color. The investigation conducted by Castelhano and Henderson (2008) addresses how colors generally influence the perception of a scene’s gist while the investigation by Lichtenfeld, Elliot, Maier and Pekrun, (2012) focuses primarily on the color green compared to red. Both of these studies are different due to their relative focus. The study by Lichtenfeld et al. (2012) presents a theoretical rationale for how the color green is related to creativity and elaborates on it in four experiments. The study by Castelhano and Henderson, (2008) addresses how colored photographs are processed compared to monochromatic photos.

Lichtenfeld et al. (2012) conducted a series of experiments with the goal of supporting their hypothesis that viewing the color green results in higher scores of creativity compared to other colors. The authors used multiple instruments to operationalize creativity, and featured different chromatic and achromatic control colors. The authors argued that the color green, due to its societally based meanings of growth, fertility, fecundity and reproduction provide a link to creativity. More specifically, the authors argued that the color green is an appetitive cue that fosters approach motivation behaviors and cognitions. Evolutionarily, the authors argued individuals who viewed green and engage in approach type behaviors (i.e. walking toward the source of green) were at an advantage compared to those who did not walk toward green. It is this relationship, of green with growth and approach motivation that provides the rationale for the effect of color. The authors also hypothesized that green would prompt approach oriented processing, and believe that it may only trigger mastery oriented approach
behaviors and not performance oriented behaviors. Mastery approach orientation has been linked to creative performance whereas performance approach orientation has not. However, there is currently no measure to separate these two types of approach orientation, and therefore no way to support the hypothesis theoretically. Despite these limitations the authors over the course of 4 experiments significantly expanded on color findings by establishing a new context (creativity), supporting a new methodology (online), and finding null effects for the color red (Experiment 3).

In Experiment 1, the authors tested the hypothesis that viewing the color green compared to white would result in higher creativity ratings and that there would be no differences between the amount of creative uses each individual produced. This latter hypothesis relates to the type of approach orientation. Again, the authors argued that mastery approach orientation is elicited by the color green, and that this orientation will change the creativity of answers but not the volume of answers. Results indicated there were no differences between the color conditions regarding the amount of creative uses, providing support for one of the hypotheses. Furthermore, a significant difference was found between colors, indicating that exposure to the color green resulted in higher creativity ratings that did those who viewed the color white.

Experiment 2 was conducted in a laboratory setting compared to an online venue, used gray as an achromatic control color, and employed a different measure of creativity. Despite these changes, results indicated that viewing green relative to gray resulted in higher ratings of creativity but no differences for the number of creative responses.

Experiment 3 included other chromatic control colors, specifically red, a color known to have deleterious effects on performance. Therefore the authors hypothesized
that green would improve creativity relative to both red and gray, and that red would have deleterious effects on performance compared to gray. Results provided partial support for the author’s hypotheses. Green was found to result in significantly higher ratings of creativity compared to both red and gray, consistent with hypotheses, however, there were no differences between the gray and red condition. Results provided partial support for the hypothesized green effect, but failed to support the negative effect of red. The authors argued that because the context constructed for this experiment was not overtly evaluative the negative effects of red failed to materialize. It may be that the contextual tone must be strong to elicit the negative effect of red and that in this investigation the context was too positive.

Finally, in Experiment 4, the authors addressed conflicting results regarding color and creativity in the psychological literature. A previous study by Mehta and Zhu (2009) concluded that blue resulted in more creativity than red. However, the authors argued that these results were obtained without controlling for non-hue properties of color and therefore could not be interpreted. To resolve this issue, the authors in Experiment 4 compared creativity when individuals were exposed to green, blue or gray. Results supported the current authors’ hypothesis that viewing green and not blue increases creativity. When individuals were exposed to the color green but not blue or gray, they exhibited more creativity.

In sum, this investigation indicated that the color green is linked to an increase in creativity compared to white, gray, red and blue. The authors argued that green was not a general appetitive cue, but instead acted as a growth-oriented cue as a part of mastery approach motivation. However, this hypothesis was unsubstantiated as there were no
measures currently available to separate performance and mastery approach motivation. Despite this limitation, this investigation demonstrated that the color green and not blue resulted in increased creativity, and that red may not function in creative contexts.

Castelhano and Henderson (2008) conducted the final investigation in this section to accomplish two goals, 1) demonstrate that the conceptual bias paradigm is capable of detecting differences in scene gist perception and, 2) demonstrate that color influences the processing of scene gist. To accomplish these goals the authors conducted three experiments.

Experiment 1 investigated the utility of the conceptual bias paradigm. This technique compares the proportion yes responses for consistent target objects versus inconsistent target objects. This technique is a measure of an individual’s ability to process a scenes’ gist and make a decision regarding the presence of an object that is consistent or inconsistent with the scene, but never actually present. Previous work on scene perception states that scene gist can be processed in approximately 100ms, however in Experiment 1 exposure times were less than 100ms to understand if in fact scene gist can be derived in less time. Results of Experiment 1 indicated that at durations of 250 MS, 100 MS, 50 MS and 42 MS individuals’ responses to consistent versus inconsistent objects in the scene were significantly different. These results were taken to mean that scene gist perception could occur in as little as 42 MS, but no sooner. In sum, these results support the conceptual bias paradigm as a tool to measure scene gist perception, and significantly reduce the time necessary to process a scene (42ms compared to 100ms).
Experiment 2 aimed to investigate whether color was involved in the processing of a scene’s gist. To address this question the researchers manipulated the color of photographs (color vs. monochrome) and the quality of the images (blurred vs. not blurred). The design of Experiment 2 built upon Experiment 1, in that duration and target were the same. Color of the scene images served as the focal variable in Experiment 2 however, the authors argued that color might simply provide information to individuals in the form of segmentation. Color may simply make photographs easier to process by sharpening outlines, and establishing additional contrast. Therefore, the tease apart the differences the authors included a manipulation of image quality with blurred and non-blurred images. They argued that if color provided segmentation information only, then there should be no difference between the blurred and non-blurred photos. If however, color does contribute semantic information in addition to segmentation then there should be a difference for the blurred images because of the increase in information afforded by the color.

Results of Experiment 2 indicated that there was a significant four-way interaction between image quality, duration, consistency and color. Results indicated that for images with no blur, there was no difference for monochrome or normal images for all exposure durations. However, when the images were blurred there was a significant difference for color at durations of 80ms and 100ms. These results were taken to mean that at durations of at least 80 MS (no differences were detected at 50ms) color provided additional information in the process of detecting scene gist. In sum, these results revealed that color was able to influence scene gist perception when the quality of images was degraded and exposure time was greater that 80ms. Despite this promising finding,
the specific role of color could not be established. Color may either contribute directly to
scene gist perception or color may still simply aid in segmentation.

These limitations provided the basis for Experiment 3. In this Experiment the
authors manipulated the colors used in the images as a way to disentangle the role that
color had in scene gist perception. The authors used the image’s actual colors or
abnormal coloring as measured via a separate study. If color simply provided
segmentation information then there should be no difference for the abnormal vs. normal
images. However, if color contributed to gist perception then a normally colored image
should result in a higher response bias.

Results indicated that at certain exposure durations differences emerged for
abnormal and normal color conditions. For exposure durations greater than 80ms
response bias was greater for normal color photos than abnormally colored photos. This
significant difference indicated that the specific colors in an image provided associative
meaning to the processing of gist perception. Abnormally colored photos were processed
differently than normal photos indicating that color provided more than segmentation
information. A further analysis indicated that when the photos were very abnormally
colored compared to less abnormally colored, the effect on response bias was lessened,
indicating that as the abnormality of color in an image increases, an individual’s ability to
process the scenes’ gist decreases.

In sum, this investigation provided a new and useful method to detect scene gist
and showed that scene gist can actually be derived in 42ms. Furthermore, the
investigation revealed that color plays a role in scene gist perception, and that the effect is
magnified when the structural information in the image is reduced. Finally, the
investigation provided support for the color association hypothesis, which states that color provides associative meaning that decreases the time necessary to process a scene's gist. Results supported the color association hypothesis compared to the segmentation hypothesis due to the significant differences in response bias for different types of colored images.

Whereas the previous sections of this review dealt with color effects in specific domains, or dealt with color in certain contexts these two studies were included to indicate the broad reach of color investigations. Castelhano and Henderson (2008) addressed a fundamental question often taken for granted in color research, namely, that color does contribute to the meaning making process. This assumption is at the root of all color studies, however, this investigation is fundamental to the argument that color provides associative meaning, and that this meaning contributes to the perception of a scene’s gist. Lichtenfeld et al. (2012) further expand the boundaries of color investigations by building a theoretical rationale for the color green in creative contexts. Whereas research on the color red has sought to show context specific meanings on a large scale, the results of Lichtenfeld et al. (2012) show that color effects may be constrained and small, only operating under specific circumstances. Interestingly, the null findings regarding red further reinforce this statement. Red has been found to undermine cognitive performance by prompting avoidance motivation, but in this investigation this finding was not present. Research on color, and colors other than red are in a nascent state, there are many more questions unanswered than answered but what is known indicates that the effects we are searching for are context specific and subtle.
Carefully designed and controlled investigations are the only way to build a body of literature regarding color effects.

Conclusion

This literature review has focused on red color effects across a wide range of contexts including marketing, competition and intellectual performance. Despite the wide range of color effects documented here and beyond, there are fundamental issues plaguing the field of color research. A recent review article written by Andrew Elliot (Elliot, 2015) (co-author of the Color in Context theory) evaluated the field of color research regarding theoretical and empirical results. I believe it serves as the most appropriate conclusion for the review, in that it has incorporated findings from a wider range or studies.

Elliot urges researchers to slow down, he stresses that the field of color research is in its infancy despite its long history. While color effects are interesting and exciting for media and lay audiences, reaching definitive conclusions at this state is naïve and potentially dangerous to the continued advancement of the field. For color research theory Elliot provides three recommendations. First, he asks for studies to employ “mid-level frameworks”. He states that researchers should aim to not use very small predictions only, or broad frameworks such as Color in Context, but work to craft frameworks capable of providing a rationale independently. Secondly, he asks for broader investigations of the color space (i.e. hues other than red, or colors that are at the edge of “red” or “blue”). Finally, he implores the field to move from “if” questions to
questions of “when” or “under what circumstances”. Investigations should begin to address moderation, not simply the presence of an effect.

Regarding the empirical state of color research Elliot again provides three recommendations. Firstly, he implores color researchers to control the focal color properties of luminance, chroma and hue, for when these color properties are not controlled interpretation is ambiguous. Secondly, he states that in addition to color properties, environmental factors such as room illumination, ambient colors and viewing angle should be accounted for. Finally, he recommends that studies employ larger sample sizes in order to reduce the Type I and II errors inherent to psychological investigations. Small sample sizes make interpretation tenuous and provide inaccurate indices of effect sizes resulting in confusion and obfuscation of meaningful findings.

In conclusion, color, especially the color red has received much theoretical and empirical attention and has proven a fruitful avenue of research. Despite the preliminary results thus far obtained, broad and specific conclusions must be tempered by the knowledge that this current generation of color research is only a decade old.
CHAPTER III

METHODOLOGY

Participants

Seventy participants (55.7% female, mean age=38, SD=13.7 years) were recruited from the United States using the Amazon Mechanical Turk platform, and were randomly assigned to one of four between-subjects experimental conditions. Demographic data revealed the participants lived in 31 states with the greatest frequencies residing in Florida (N=8), California (N=6) and, New Jersey (N=6).

Ethnically, seventy-five percent of participants identified as white/Caucasian, 12.9% as Latino, 7.1% as Asian, 2.9% as Black/African American and other (1.0%). All participants were jury eligible according to the United States juror qualifications guidelines and free from color-blindness.

Design

Two factors, Message Frame and Graph Presentation were crossed yielding four experimental conditions. The resulting design was a 2 Message Frame (Positive vs. Negative) X 2 Graph Presentation (Present vs. Absent) fixed analysis of variance.

Materials

The materials in this study consisted of a legal complaint, an experimental graph, two measures of decision-making, an inventory of company characteristics, a recall question, a company opinion question, a color-blindness measure, and a demographic
data sheet.

**Framed Legal Complaint**

The legal complaint was a 2 sentence, 36-word passage describing an allegation against a fictitious tire company, regarding the warranty of the company’s tires. The first sentence identified the parties involved in the allegation, and the second sentence stated the allegation against the company.

Two framed versions of the legal complaint were created by adding one of two 14-word sentences describing the allegation in more detail. The positively framed version included the sentence, “According to the complaint, 60% of the tires succeeded in meeting their warranty”, while the negatively framed version stated that, “According to the complaint, 40% of the tires failed to meet their warranty”. Thus, two framed legal complaints were created by adding one framed sentence to the two introductory sentences, resulting in a 3 sentence 50 word complaint.

**Experimental Graph**

The experimental graph was a part-to-whole stacked-bar graph measuring 514 x 1202 pixels, showing one bar depicting the ratio between the relative success (60%) and failure (40%) of the company’s tires in meeting their intended warranty. The graph was titled, “Warranty Outcome”, with the y-axis labeled, “Tires Sold”, and demarcated in 10% increments with numeric labels every 20%, from 0 to 100%. The graph was shown with both success and failure colored gray and was calibrated for luminance (L) and chroma (C) LCh (57.85, 219.15).

**Measures of decision-making**

Two measures of decision-making were taken using 9-point Likert scales: one
regarding guilt of the company (1-Not Guilty, 9-Guilty) and another measuring likelihood of purchasing from the company in the future (1-Very Unlikely, 9-Very Likely).

**Inventory of Company Characteristics**

The inventory of company characteristics was comprised of seven positive and six negative characteristics sampled from the brand identity, consumer marketing and color research literature. The seven positive characteristics were: admirable, competent, reliable, responsible, sincere, sympathetic, and trustworthy. The six negative characteristics were: dishonest, hostile, selfish, unapproachable, uncaring and unsuccessful. All thirteen characteristics were measured on 9-point Likert scales anchored with 1 (Strongly Disagree) and 9 (Strongly Agree).

**Recall question**

Recall was assessed by participants restating the legal complaint to the best of their ability.

**Company opinion question**

Opinion of the company was assessed by a single open-ended question, asking participants to describe their opinion of the company.

**Colorblindness measure**

Colorblindness was assessed using the Isihara Colorblindness Test (ICT) (Isihara, 1917 as cited in Thiadens et al., 2013), a compendium of 24 plated used to identify individuals with red-green colorblindness. The plates contain randomly placed and sized dots that together depict a numeric value. There are five plate types: text, vanishing, transformation, diagnostic, and hidden figure, in which normal vision and colorblind individuals identify different numeric values. We included one test plate, one vanishing
and six transformation plates to determine colorblindness with inclusion criteria set at less than 3 errors.

The ICT has been validated against the detection of Aviation Signal Lights (ASL) at both day and night, Kappa = .74 (Mertens & Milburn, 1993). Thaidens et al. (2013) assessed the discriminative validity of the ICT and found that it was capable of discriminating between cone disorder and control patients, yielding a c-statistic of .888. Additionally, Birch (1997) and (2010) concluded that the ICT was sensitive to detecting differences with a reliability between 98.4 and 99.0% for three errors.

Procedure

Participants accessed the experimental website via Amazon’s Mechanical Turk platform. First, participants were presented the Informed Consent, and after agreeing to participate, were shown the instructions before being randomly assigned to one of the four experimental conditions. The framed legal complaint was presented on the left portion of the screen and was accompanied by either the presence or absence of the experimental graph on the right. Participants were allotted 1 minute to read the legal complaint, or the legal complaint and the experimental graph.

After 1 minute, participants were given unlimited time to complete the dependent measures. Participants first completed, in a counterbalanced order, the inventory of company characteristics, and the measure of decision-making for guilt. Participants next completed the measure of decision-making for purchase intention, the recall question, and the company opinion question. Participants were then asked to fill out the demographic data sheet and the measure of colorblindness. Finally, participants were
thanked for their participation, debriefed and provided a code for payment via Amazon’s Mechanical Turk.

Data Source

Inventory of company characteristics

In order to determine if the inventory of company characteristics could be reduced to a simplified model of participant’s characterizations of the company, two principal components analyses (PCA) were conducted for the seven positive and six negative characteristics, respectively. The PCA, rotated using a varimax rotation, yielded one independent component for the positive characteristics, and two factors for the negative characteristics, with Eigen values greater than 1.0, and factor loadings exceeding .617.

For the positive characteristics, a single component composed of all six characteristics was extracted accounting for 72% of the total variance, shown in Table 1. The component was termed “ethical” according to the commonality shared by all characteristics contributing to the factor.

For the negative characteristics, two components were extracted accounting for 68% of the total variance, shown in Table 2. The first component, composed of the negative characteristics dishonest (r=.886), uncaring (r=.885) and selfish (r=.719) accounted for 49% of the variance. The component was termed “egocentric” according to the commonality shared by the characteristics included in the component. The second factor extracted was composed of the three characteristics unapproachable (r=.835), hostile (r=.772) and unsuccessful (r=.634) and accounted for 19% of the variance. This component was termed “outcast”.


The ethical, egocentric and outcast components were estimated for each participant using the Thurstone regression method (M=0; SD=1), and entered into statistical analyses to test the experimental conditions.

Measure of recall

Recall was assessed by summing the total number of information units mentioned by participants in their free recall. An information unit was defined as a unit of information mentioned either explicitly in the legal complaint, or that was logically equivalent to the information stated in the complaint. For example, the text stated the word “violated” but responses including “failed to meet and failed to live up to” were scored as correct. Minimum and maximum scores were 0 and 10 respectively, with observed scores ranging from 0 to 8. Two independent raters blind to participants' placement in experimental conditions scored the recall measure yielding an Intraclass correlation (ICC) of $r (69)=0.949$, $p <.001$.

Company opinion measure

Three scoring rubrics were created to analyze participants’ opinions of the company. The first rubric summed the total number of negative descriptions used in participants’ opinions of the company. The second measure evaluated the argumentative strength of opinions regarding the company, ranging from -2 to +2. A -2 was defined as an explicitly stated negative opinion, accompanied by one or more reasons. A -1 was defined as either an explicitly stated negative opinion and no reason, or a reason that inferred a negative opinion. For example, the statement, “they are dishonest”, while lacking the explicit statement “I do not like them” can be seen to represent a negative opinion. A 0 was defined as the absence of either an explicitly stated negative opinion or
a reason. The positive dimension of the scale used the same scoring procedure as the negative side, the only difference being a positive compared to negative opinion and the elaboration of the opinion with a reason. Two raters scored the company opinion measure yielding an Intraclass correlation (ICC) of $r(69)=0.863$, $p < .0001$.

The second scoring rubric was derived to examine the opinions participants formed about the company regarding the implications of the company’s product warranty. The scale ranged from 0 to -5, with -5 being the most negative opinion and 0 being the inability to form an opinion based on the information provided. A -5 was scored if a participant’s opinion stated the company was committing a crime either by endangering customers or by committing fraud or some illegal act. A -4 was scored if the opinion highlighted a bad business practice regarding customer satisfaction/care, or the company’s warranty. A -3 was scored if the opinion included “name calling” with the elaboration of a reason not contained in the legal complaint. A -2 was scored when “name calling” only was present, or name-calling with the addition of information contained in the complaint. A -1 was scored if a participant’s opinion stated that an error occurred regarding the company’s product but that the company was not intentionally selling faulty products. Finally, a 0 was scored in participants stated they could not form an opinion about the company, or presented dual explanations such as, “they are either very smart or very unethical”. Two raters scored participant opinions on the implications measure yielding an Intraclass correlation (ICC) of $r(69)=0.801$, $p < .001$. 
CHAPTER IV

FINDINGS AND RESULTS OF EXPERIMENT 1

In order to determine how the graph influenced the construction of a learner’s cognitive representation and decisions regarding the company, we entered our dependent variables into a series of 2-MESSAGE FRAME (Positive vs. Negative) X 2-GRAPH PRESENTATION (Absent vs. Present) Analyses of Variance (ANOVA). All analyses were evaluated at the .05 level with simple effects tests adjusted for alpha inflation using a Bonferroni correction.

The first prediction is that Message Framing will influence learners’ cognitive representations of the company—based on a number of perceptual indices.

Results indicated that the Message Frame did not influence the amount of information learners’ remembered during the recall question (p = .743). However, recall scores for the positive (M = 4.78; SD = 1.57) and negative message frame (M = 4.67; SD = 1.45) indicated that learners were able to recall approximately half of the information contained in the framed message. Despite being able to recall the information, results indicated that the framed messages failed to influence perceptions of the company’s ethicality (p = .812) or egocentricity (p = .671) (see Table 1). However, results indicated a marginally reliable influence of the Message Frame on the number of negative descriptions present in learners’ opinions of the company (F (1, 66) = 3.53, MS_error = 1.75; p = .064; partial $\eta^2 = .051$). More negative descriptions of the company were
included when the message was positive (M = 2.00; SD = 1.50) compared to negative (M = 1.37; SD = 1.13) (see Figure 1.).

Similarly, learner’s perceived more negative implications of the company’s actions when the framed message was positive (M= -2.87; SD = 1.82) compared to negative (M =-2.11; SD = 1.69), although results failed to reach a reliable level of statistical significance. While the amount of negative statements and the negative implications of the company’s actions were trending toward significance, we failed to detect differences in the argumentative strength of learners’ opinions as a function of the Message Frame (p = .114).
Table 1.

Means and Standard Deviations by Message Frame and Graph Presentation on Perceptions

<table>
<thead>
<tr>
<th>Perception</th>
<th>Message Frame</th>
<th>Graph Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Graph Present</td>
</tr>
<tr>
<td>Egocentricity</td>
<td>Positive Frame</td>
<td>.22 (.98)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.14 (1.05)</td>
</tr>
<tr>
<td>Ethicality</td>
<td>Positive Frame</td>
<td>-.26 (.83)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.12 (1.07)</td>
</tr>
<tr>
<td>Number of Negative Descriptors</td>
<td>Positive Frame</td>
<td>2.11 (1.49)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>1.15 (1.18)</td>
</tr>
<tr>
<td>Argumentative Strength</td>
<td>Positive Frame</td>
<td>-1.29 (.98)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.60 (.99)</td>
</tr>
<tr>
<td>Negative Implications Scale</td>
<td>Positive Frame</td>
<td>-3.12 (1.92)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-2.05 (1.73)</td>
</tr>
</tbody>
</table>

Whereas we documented marginal effects of the Message Frame on perceptions of the company, we failed to observe influences on indices of decision-making including purchase intention (p = .901) and judgment of guilt (p = .242) (see Table 2).
Table 2.

Means and Standard Deviations by Message Frame and Graph Presentation on Decisions

<table>
<thead>
<tr>
<th>Decision</th>
<th>Message Frame</th>
<th>Graph Presentation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Graph Present</td>
<td>Graph Absent</td>
</tr>
<tr>
<td>Purchase Intention</td>
<td>Positive Frame</td>
<td>1.70 (1.15)</td>
<td>2.62 (1.92)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>2.35 (1.95)</td>
<td>1.88 (1.36)</td>
</tr>
<tr>
<td>Judgment of Guilt</td>
<td>Positive Frame</td>
<td>6.74 (1.66)</td>
<td>5.97 (1.69)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>6.34 (2.02)</td>
<td>7.34 (1.27)</td>
</tr>
</tbody>
</table>

The next question was open, asking whether the Graph Presentation would influence the construction of learners’ cognitive representations of the company— independent of the Message Frame.

Similar to Message Frame, Graph Presentation did not influence the amount of information learners’ recalled (p = .992). Further results indicated that perceptions of the company including; egocentricity (p = .766), the number of negative descriptors in learners’ opinions (p = .690), the argumentative strength of learners’ opinions (p = .920), or perceived negative implications (p = .549) were not influenced by the Graph Presentation. However, for perceptions of the company’s ethicality, data were trending toward significance $F(1, 66) = 3.02, MS_{error} = .992; p = .087; \text{ partial } \eta^2 = .044)$. The data suggest that the company may have been perceived as more ethical when the graph was absent ($M = .21; SD = 1.01$) compared to present ($M = -.19, SD = .96$) (Figure 2.).
Finally, for decision-making, results failed to reveal influences of Graph Presentation on the likelihood of future purchase intention (p = .570) or judgment of guilt (p = .774).

The final question related to the effect of the Graph Presentation on the Message Frame. We proposed two competing hypotheses, one stating that the presence of the graph would enhance the effect of the message frame, and another stating that the presence of the graph would nullify the effect of the message frame.

Again, results indicated that the amount of information recalled was not influenced by the interaction of the Message Frame and Graph Presentation (p = .654) (see table 2). Despite the similarity of information recalled, perceptions of the company’s egocentricity were reliably influenced $F (1,66) = 3.84, MS_{error} = .98; p = .054; \text{ partial } \eta^2 = .055$. Simple
effects tests revealed that when the graph was absent, perceptions of the company’s egocentricity trended higher when the message frame was negative (M = .25; SD = .92) compared to positive (M = -.31; SD = .99), $F (1,66) = 2.70$, $MS_{error} = .98$; $p = .105$; partial $\eta^2 = .039$ (Figure 3.). This result may provide tentative support for Hypothesis 1b; however, statistical power was not great enough to determine whether it is sufficiently reliable. While perceived egocentricity was influenced we failed to reveal influences on perceptions of the company’s ethicality ($p = .421$), the number of negative descriptions of the company ($p = .249$), the argumentative strength of learners’ opinions ($p = .181$), or perceived negative implications ($p = .301$).

![Figure 3. Perceived Egocentricity by Message Frame and Graph Presentation](image-url)
In addition to influences on perceptions of the company, results indicated a reliable interaction of the Message Frame and Graph Presentation on judgments of guilt, $F(1,66) = 4.74$, $MS_{\text{error}} = 2.89; p = .033$; partial $\eta^2 = .067$ (Figure 4.).

Simple effects tested revealed that when the graph was absent, participants had less doubt that the company was guilty when the message was negative ($M = 7.34; SD = 1.27$) compared to positive ($M = 5.97; SD = 1.69$), $F(1,66) = 5.35$, $MS_{\text{error}} = 2.89; p = .024$; partial $\eta^2 = .075$. Additional simple effects tests revealed a marginally significant difference for the presence versus absence of the graph when the message was negative $F(1,66) = 3.21$, $MS_{\text{error}} = 2.89; p = .077$; partial $\eta^2 = .046$. When the message was negative and the graph was present ($M = 6.34; SD = 2.02$) participants had marginally more doubt that the company was guilty, compared to when the graph was absent ($M = 7.34; SD = 1.27$). Results also indicated a marginally significant interaction on purchase intention $F$. 
$(1,66) = 3.07, MS_{\text{error}} = 2.72; p = .084; \text{partial } \eta^2 = .044,$ however, simple effects tests failed to reach a reliable level of statistical significance ($p > .114$).
CHAPTER V

INTRODUCTION TO EXPERIMENT 2

Based on the results of experiment 1—specifically the finding that the achromatic graph influenced construction of learners’ concepts about the company, we were interested in the visual features of the graph—specifically, color. In experiment 2, we varied three levels of graph color—green, red or all gray—in order to investigate if the colors used to make the success portion of the graph salient would result in differences in the cognitive concept learners’ form about the company. If, as Moller, Elliot and Maier (2009) and Kuhbander and Pekrun (2013) concluded that green is positively related to success and red negatively related to success, then we expect that viewing a graph with success colored green will result in the construction of a more positive concept of the company compared to when the graph is all gray or success is colored red. We also predicted that the concept learners’ form about the company will be more negative when success is colored red compared to when the graph is all gray.

We also varied two levels of message frame—positive and negative—in order to replicate the results of experiment 1. Again, we expected that a positively framed message would result in the construction of a more positive concept about the company compared to a negatively framed message.

Finally, we were interested in the interaction between the three colored graphs and the message frames. We hypothesized that congruent message and graph combinations—specifically, the positively framed message and graph with green making success
salient—would result in the most positive concept of the company compared to all combinations due to the positive information provided by the positively framed message, and the color green making success salient in the graph.
CHAPTER VI

METHODOLOGY FOR EXPERIMENT 2

Participants

One hundred eight participants (51% male, mean age = 38; SD = 13.7 years) were recruited from the United States using the Amazon Mechanical Turk platform, and were randomly assigned to one of six between-subjects experimental conditions. Demographic data revealed the participants lived in 35 states with the greatest frequencies residing in California (N = 12), Texas (N = 8) and, Illinois (N = 7).

Ethnically, eighty-two percent of participants identified as white/Caucasian, 7.4% as Latino, 6.5% as black/African American, 2.8% as Asian, and other (1.3%). All participants were jury eligible according to the United States juror qualifications guidelines and free from color-blindness.

Design

Two factors, Message Frame and Graph Color were crossed yielding six experimental conditions. The resulting design was a 2 Message Frame (Positive vs. Negative) X 3 Graph Color (All Gray vs. Green Success vs. Red Success) fixed analysis of variance.

Materials

Materials in this study again consisted of the legal complaint, the experimental graph, the two measures of decision-making, the inventory of company characteristics,
the recall question, the company opinion question, the color-blindness measure, and the demographic data sheet.

**Framed Legal Complaint**

The legal complaint used in Experiment 2 was identical to Experiment 1 except for the selective use of color. In Experiment 2 we colored the success portion of the graph red or green, or colored no portion of the graph (all gray). The colors red and green were calibrated for luminance (L), chroma (C) and hue (h). Red LCh (56.22, 83.53, 51.74) and green LCh (57.65, 81.77, 133.91) were equated for luminance and chroma. Gray LCh (57.85, 219.15), since it is an achromatic color, was equated with red and green for luminance only.

All other experimental materials and procedures were identical to those used in Experiment
CHAPTER VII

RESULTS OF EXPERIMENT 2

In order to determine if differently colored graphs influenced the construction of a learner’s cognitive representation and decisions regarding the company, we entered our dependent variables into a series of 2-Message Frame (Positive vs. Negative) X 3-Graph Color (Gray vs. Green vs. Red) Analyses of Variance (ANOVA). All analyses were evaluated at the .05 level with simple effects tests adjusted for alpha inflation using a Bonferroni correction.

The first prediction is that the Message Frame will influence learners’ cognitive representations of the company—based on a number of perceptual indices.

Overall, results indicated that the Message Frame did not influence the amount of information learners’ recalled (p = .190), however, learners’ who read either the positive (M = 4.40; SD = 1.69) or negative (M = 4.84; SD = 1.72) message recalled approximately half of the information contained in the message. Despite recalling half of the information, results indicated that the message frames failed to reliably influence perceptions of the company’s ethicality (p = .889) or callousness (p = .928). Additionally, Message Frame failed to influence perceptions of the company including; the number of negative descriptions mentioned in opinions of the company (p = .458), the argumentative strength of learners’ opinions (p = .769), or the perceived negative
implications of the company’s actions (p = .263). Regarding decisions about the company Message Frame also failed to reliably influence either future purchase intention (p = .895) or judgments of guilt (p = .572).

The next question related to the influence of using green, red or gray to make the success portion of the graph salient on construction of learners’ cognitive representations of the company— independent of the Message Frame.

Results indicated that Graph Color alone failed to influence the amount of information learners’ recalled from the messages (p = .732), with information in all graph conditions being equally remembered, gray (M = 4.72; SD = 1.52), green (M = 4.73; SD = 1.76), and red (M = 4.45; SD = 1.88). Similar to the pattern of results for Message Frame, Graph Color did not influence perceptions of the company’s ethicality (p = .476) or callousness (p = .815). Additionally, Graph Color failed to influence perceptions of the company as measured by learners’ opinions of the company including the number of negative descriptors mentioned (p = .554), the argumentative strength of the opinion (p = .377), or the negative implications of the company’s actions (p = .974). Regarding decisions, the Graph Color also failed to influence future purchase intention (p = .399) or judgments of guilt (p = .185).

The final question related to the effect of Graph Color on Message Frame. We hypothesized that the portion of the graph made salient by color (success) could be either congruent (green) or incongruent (red), and that a congruent text and graph pairing would enhance the strength of the message.
Again, results indicated that the information in the framed messages was equally recalled in all conditions \((p = .690)\) (see table 3). Regarding perceptions of the company, results revealed that perceptions of the company’s ethicality \((p = .488)\) and callousness \((p = .109)\) were not influenced by the interaction of the Message Frame and Graph Color.

Table 3.

*Means and Standard Deviations by Message Framing and Graph Color on Perceptions*

<table>
<thead>
<tr>
<th>Perception</th>
<th>Message Frame</th>
<th>Graph Color</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gray Graph</td>
<td>Green Success</td>
<td>Red Success</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Callousness</td>
<td>Positive Frame</td>
<td>.20 (.90)</td>
<td>-.29 (.95)</td>
<td>.07 (.89)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.25 (1.07)</td>
<td>.19 (.74)</td>
<td>.10 (1.13)</td>
<td></td>
</tr>
<tr>
<td>Ethicality</td>
<td>Positive Frame</td>
<td>-.22 (.93)</td>
<td>.29 (.91)</td>
<td>-.14 (.92)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.06 (1.21)</td>
<td>-.01 (.80)</td>
<td>.07 (1.17)</td>
<td></td>
</tr>
<tr>
<td>Number of Negative Descriptors</td>
<td>Positive Frame</td>
<td>2.11 (1.49)</td>
<td>1.47 (1.17)</td>
<td>2.00 (1.13)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>1.15 (1.18)</td>
<td>1.90 (1.30)</td>
<td>1.94 (1.76)</td>
<td></td>
</tr>
<tr>
<td>Argumentative Strength</td>
<td>Positive Frame</td>
<td>-1.29 (.98)</td>
<td>-.88 (.99)</td>
<td>-1.33 (.81)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.60 (.99)</td>
<td>-1.28 (.64)</td>
<td>-1.16 (.92)</td>
<td></td>
</tr>
<tr>
<td>Negative Implications Scale</td>
<td>Positive Frame</td>
<td>-3.12 (1.92)</td>
<td>-2.60 (1.59)</td>
<td>-2.71 (1.32)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-2.05 (1.73)</td>
<td>-2.61 (1.49)</td>
<td>-2.64 (1.72)</td>
<td></td>
</tr>
</tbody>
</table>

However, when perceptions of the company were measured from learners’ opinions of the company, the data were trending toward a significant interaction on the number of negative descriptors mentioned \(F(2, 102) =2.52, MS_{error} = .185; p = .085;\) partial \(\eta^2 = .047\) (Figure 5.).
Simple effects tests revealed that when the Graph Color was gray, significantly more negative descriptions of the company were mentioned when the Message Frame was positive (p = 2.11; SD = 1.49) compared to negative (p = 1.15; SD = 1.18), $F(1,102) = 4.63$, $MS_{error} = 1.85; p = .034$; partial $\eta^2 = .043$. Additionally, the argumentative strength of learners’ opinions was reliably influenced by the interaction of Message Frame and Graph Color $F(2, 102) = 3.47$, $MS_{error} = .80; p = .035$; partial $\eta^2 = .064$ (see Figure 6.).
Simple effects tests revealed that when Graph Color was gray, learners’ opinions had greater argumentative strength when the Message Frame was positive (M = -1.29; SD = .98) compared to negative (M = -.60; SD = .99), $F(2, 102) = 5.49, M_{\text{error}} = .80; p = .021; \text{partial } \eta^2 = .051$). Additional simple effects tests revealed that when the Message Frame was negative, the argumentative strength of learners’ opinions was stronger when the Graph Color was green (M = -1.28; SD = .64) compared to gray (M = -.60; SD = .99), $F(2, 102) = 3.34, M_{\text{error}} = .80; p = .039; \text{partial } \eta^2 = .062$). Regarding the perceived negative implications of the company’s actions, we failed to observe a reliable interaction between Message Frame and Graph Color ($p = .325$). Finally, in relation to decision-making, results revealed that the Message Frame and Graph Color did not influence either future purchase intention ($p = .542$) or judgment of guilt ($p = .199$) (see Table 4).
Table 4.

*Means and Standard Deviations by Message Framing and Graph Color on Decisions*

<table>
<thead>
<tr>
<th>Decision</th>
<th>Message Frame</th>
<th>Graph Color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gray Graph</td>
</tr>
<tr>
<td>Purchase Intention</td>
<td>Positive Frame</td>
<td>-.21 (.74)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>.00 (.94)</td>
</tr>
<tr>
<td>Judgment of Guilt</td>
<td>Positive Frame</td>
<td>6.74 (1.66)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>6.34 (2.02)</td>
</tr>
</tbody>
</table>
CHAPTER VIII
INTRODUCTION TO EXPERIMENT 3

In experiment 3, similar to experiment 2, we varied three levels of graph color—green, red or all gray in order to investigate if the colors used to make the failure portion of the graph salient would result in differences in the cognitive concept learners form about the company. Since Moller, Elliot and Maier (2009) and Kuhbander and Pekrun (2013) concluded that red is positively related to failure and negatively related to success, and green is positively related to success, we expected that viewing a graph with failure colored red would result in the construction of a more negative concept of the company compared to when the graph is all gray or failure is colored green. We also predicted that the concept learners’ form about the company would be more positive when failure is colored green compared to when the graph is all gray.

Again, we also varied the two levels of message frame—positive and negative— in order to replicate the results of experiment’s 1 and 2, again expecting that a positively framed message would result in the construction of a more positive concept about the company compared to a message that is negatively framed.

Finally, we were interested in the interaction between the three colored graphs and the message frames. This time, we hypothesized that congruent message and graph combinations—specifically, the negatively framed message and graph with red making salient failure would result in the most negative cognitive concept of the company compared to all other combinations due to the negative information provided by the negatively framed message and the color red making failure salient in the graph.
Participants

Ninety-five participants (57% female, mean age = 38; SD= 13.7 years) were recruited from the United States using the Amazon Mechanical Turk platform, and were randomly assigned to one of six between-subjects experimental conditions. Demographic data revealed the participants lived in 35 states with the greatest frequencies residing in California (N = 10), Florida (N = 7) and, Pennsylvania (N = 7).

Ethnically, eighty-five percent of participants identified as white/Caucasian, 5.3% as Latino, 4.2% as black/African American, 4.2% as Asian, and other (1.3%). All participants were jury eligible according to the United States juror qualifications guidelines and free from color-blindness.

Design

Two factors, Message Frame and Graph Color were crossed yielding six experimental conditions. The resulting design was a 2 Message Frame (Positive vs. Negative) X 3 Graph Color (All Gray vs. Green Failure vs. Red Failure) fixed analysis of variance.

Materials

Materials in this study again consisted of the legal complaint, the experimental graph, the two measures of decision-making, the inventory of company characteristics, the recall question, the company opinion question, the color-blindness measure, and the demographic data sheet.
Framed Legal Complaint

The legal complaint used in Experiment 2 was identical to Experiment 1.

Experimental Graph

In Experiment 3, the stacked-bar graph was identical to Experiment 1 except for the selective use of color. In Experiment 3 we colored the failure portion of the graph red or green, or colored no portion of the graph (all gray). The colors red and green were calibrated for luminance (L), chroma (C) and hue (h). Red LCh (56.22, 83.53, 51.74) and green LCh (57.65, 81.77, 133.91) were equated for luminance and chroma. Gray LCh (57.85, 219.15), since it is an achromatic color, was equated with red and green for luminance only.

All other experimental materials and procedures were identical to those used in Experiment 1.
CHAPTER IX

RESULTS OF EXPERIMENT 3

In order to determine if differently colored graphs influenced the construction of a learner’s cognitive representation and decisions regarding the company, we entered our dependent variables into a series of 2-Message Frame (Positive vs. Negative) X 3-Graph Color (Gray vs. Green vs. Red) Analyses of Variance (ANOVA). All analyses were evaluated at the .05 level with simple effects tests adjusted for alpha inflation using a Bonferroni correction.

The first prediction is that the Message Frame will influence learners’ cognitive representations of the company—based on a number of perceptual indices.

Overall, results indicated that the Message Frame did not influence the amount of information learners’ recalled (p = .312), however, learners’ recalled approximately half of the information contained in the messages (positive M = 4.40; SD = 1.69) (negative M = 4.84; SD = 1.72). Despite recalling half of the information, results indicated that the Message Frame failed to reliably influence perceptions of the company’s ethicality (p = .912) or callousness (p = .438). Additionally, Message Frame failed to exert an influence on perceptions of the company including: the number of negative descriptions mentioned in opinions of the company (p = .431), the argumentative strength of learners’ opinions (p = .390), or the perceived negative implications of the company’s actions (p = .534). Regarding decisions about the company Message Frame also failed to reliably influence either future purchase intention (p = .259) or judgments of guilt (p = .400).
The next question related to the influence of using green, red or gray to make the failure portion of the graph salient on construction of learners’ cognitive representations of the company— independent of the Message Frame.

Results indicated that Graph Color alone failed to influence the amount of information learners’ recalled from the messages (p = .991), with information in all graph conditions being equally remembered, gray (M = 4.72; SD = 1.52), green (M = 4.74; SD = 1.78), and red (M = 4.66; SD = 1.51). Similar to the pattern of results for Message Frame, Graph Color did not influence perceptions of the company’s ethicality (p = .536) or callousness (p = .990). Additionally, Graph Color failed to influence perceptions of the company as measured by learners’ opinions of the company including the number of negative descriptors mentioned (p = .641), the argumentative strength of the opinion (p = .486), or the negative implications of the company’s actions (p = .717). Regarding decisions, the Graph Color also failed to influence future purchase intention (p = .678) or judgments of guilt (p = .467).

The final question related to the effect of Graph Color on Message Frame. We hypothesized that the portion of the graph made salient by color (failure) could be either congruent (red) or incongruent (green) with the Message Frame, and that the congruent text and graph pairing would enhance the strength of the message.

Again, results indicated that the information in the framed messages was equally recalled in all conditions (p = .314) (see table 5). Regarding perceptions of the company results revealed that perceptions of the company’s ethicality (p = .395) and callousness (p = .568) were not influenced by the interaction of the Message Frame and Graph Color.
Regarding perceptions as measured by opinions of the company, the interaction of the Message Frame and Graph Color failed to reliably influence the number of negative descriptions of the company (p = .167), or argumentative strength of learners’ opinions (p = .112).

Table 5.

<table>
<thead>
<tr>
<th>Perception</th>
<th>Message Frame</th>
<th>Graph Color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gray Graph</td>
<td>Green Success</td>
</tr>
<tr>
<td>Callousness</td>
<td>Positive Frame</td>
<td>.20 (.90)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.25 (1.07)</td>
</tr>
<tr>
<td>Ethicality</td>
<td>Positive Frame</td>
<td>-.22 (.93)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.06 (1.21)</td>
</tr>
<tr>
<td>Number of Negative Descriptors</td>
<td>Positive Frame</td>
<td>2.11 (1.49)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
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</tr>
<tr>
<td>Argumentative Strength</td>
<td>Positive Frame</td>
<td>-1.29 (.98)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-.60 (.99)</td>
</tr>
<tr>
<td>Negative Implications Scale</td>
<td>Positive Frame</td>
<td>-3.12 (1.92)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>-2.05 (1.73)</td>
</tr>
</tbody>
</table>

However, results revealed a significant interaction for the negative implications learner’s mentioned in their opinion of the company $F (2, 83) = 4.16, M_{error} = 2.92; p = .019; \text{partial } \eta^2 = .091$ (Figure 7.).
Figure 7.

Simple effects tests revealed that when Graph Color was gray, learners’
mentioned marginally more negative implications of the company’s actions when the
Message Frame was positive (M = -3.12; SD = 1.92) compared to negative (M = -2.05;
SD = 1.73) ($F(1, 83) = 2.52$, $MS_{error} = 2.92$; $p = .073$; partial $\eta^2 = .038$). Additional simple
effects tests revealed that when the Graph Color was red, learners mentioned more
negative implications of the company’s actions when the Message Frame was negative
(M = -3.53; SD = 1.39) compared to positive (M = -2.07; SD = 1.68) ($F(1, 83) = 4.95$,
$MS_{error} = 2.92$; $p = .029$; partial $\eta^2 = .056$). Finally, simple effects tests indicated that the
data were trending toward significance when the Message Frame was negative. When
the message was negatively framed and paired with a graph where failure was made
salient with red (M = -3.53; SD = 1.39), learners’ mentioned marginally ($p = .059$) more
negative implications of the company’s actions compared to when the graph was gray (M
= -2.05; SD = 1.73) ($F(2, 83) = 2.85$, $MS_{error} = 2.92$; $p = .063$; partial $\eta^2 = .064$). When
considering decisions, results indicated that Message Frame and Graph Color did not reliably influence either future purchase intention (p = .925) or judgments of guilt (p = .934) (see Table 6).

Table 6.

*Means and Standard Deviations by Message Framing and Graph Color on Decisions*

<table>
<thead>
<tr>
<th>Decision</th>
<th>Message Frame</th>
<th>Graph Color</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td></td>
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</tr>
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<td>Judgment of Guilt</td>
<td>Positive Frame</td>
<td>6.74 (1.66)</td>
</tr>
<tr>
<td></td>
<td>Negative Frame</td>
<td>6.34 (2.02)</td>
</tr>
</tbody>
</table>
CHAPTER IX

GENERAL DISCUSSION

Across three experiments, we aimed to determine whether a single statistical graph would influence the cognitive concept learners form about a company named in a legal complaint. In general, the results revealed that statistical graphs do exert a reliable affect on the opinions learners derive of a company following a legal complaint about the company, as well as the decisions the learners make about the company. The presence of a statistical graph does not appear to influence learners’ memory of the complaint.

In Experiment 1, we aimed to delineate the findings of Park and Feigenson (2013) who concluded that the presentation of a PowerPoint containing statistical graphs provided informational cues that strengthened the effect of a framed message as measured by enhanced recall, more positive evaluations of the lawyer delivering the message, and decisions of the company’s responsibility. However, Park and Feigenson (2013) failed to adequately control the graphs used in the investigation. Therefore, in Experiment 1, we manipulated the presence versus absence of a single statistical graph to understand the effect of the graph and framed message on concept formation in the legal setting.

The results of Experiment 1 revealed that not all dimensions of learners’ concepts of the company were influenced by the framed message and graph. While we documented a reliable interaction between the framed message and graph for decisions of guilt and perceived egocentricity, we failed to observe an influence on learners’ recall of information contained in the complaint, and differences in the learners’ opinions of the
company. Thus, the conclusions of Park and Feigenson (2013) were not supported. However, results of Experiment 1 partially supported the findings of Garcia-Retamero and Galesic (2010). Specifically, our results revealed that neither perceptions of the company’s egocentricity or judgments of guilt were enhanced by the presence of the statistical graph, but instead were reliably observed only when the graph was absent. This pattern of results indicates that the statistical graph may have allowed learners’ to “see through” the framed message—an interpretation supported by the finding that learners’ had marginally more doubt that the company was guilty when the negatively framed message was paired with the graph, compared to when it was not. This finding suggests that similar to Morewedge and Kahneman’s (2010) discussion of framing effects arising automatically via Type 1 processing, when learners “see through” the frame it brings about controlled Type 2 processing which allows learners to monitor, modify or reject their previously held conceptions.

Experiment 2 aimed to further delineate the findings of Experiment 1, while addressing an additional limitation of Park and Feigenson (2013). In their study, Park and Feigenson (2013) stated that the visual features of their graphics were not controlled—specifically, that color might have been operating to account for the influence of their graphs on mock juror behavior. Therefore, in Experiment 2, we manipulated one dimension of color—hue—to make salient the success portion of the statistical graph used in Experiment 1. While research on salience has failed to consider the use of different colors, we hypothesized that, green’s relationship with success would provide influential information on text-graph processing, since the color green makes success salient (Kuhbander and Pekrun, 2013; Moller, Elliot and Maier, 2009).
Results of Experiment 2 revealed that the color green did influence the construction of the learners’ concept about the company—but not for all dimensions. Green failed to interact with the message frame to affect recall, evaluations of the company’s characteristics, and decisions about guilt and purchase intention. However, when learners’ stated their opinion about the company, the opinions had greater argumentative strength when the message was negative and success was colored in green, compared to when the graph was achromatic. While the finding failed to support our hypothesis that the congruent message frame and graph combination would result in the construction of a positive concept of the company, it did provide support to our contention that color used in graphs provides additional information that is encoded into the concept a learner derives from the information about a company named in a complaint. Specifically, when the message was negative, presenting a graph making the successes of the company salient using the color green, resulted in learners stating marginally more negative things about the company and having a stronger argument about their opinion. We believe that the pairing of the graph with the framed message allowed learners’ to “see through” the message frame—much in the same way as explained by Garcia-Retamero and Galesic (2010). That is, when the graph showing success in green was paired with an incongruent message where the statement put the company in a negative light and focused on failure, participants had stronger arguments against the company, compared to when the graph was all gray. Thus, the color green did operate to influence learners’ evaluations of the company. However, when paired with a negative statement, green’s association with success (cf. Kuhbander & Pekrun, 2013; Moller, Elliot & Maier, 2009) evoked a reaction that elucidated the discrepancy between
the complaint and the graph—a discrepancy that influenced learners to react more negatively to the company.

Based on the results of Experiments 1 and 2, Experiment 3 focused on the differential use of red and green to make failure instead of success, salient. Based upon Moller, Elliot, and Maier’s (2009) and Kuhbander and Pekrun’s (2013) findings that red, compared to green, is positively associated with failure, we hypothesized that the combination of the negative message and the graph with red making failure salient would result in a more negative concept of the company compared to all other combinations. The results revealed that when red was used to make failure salient, learners described more negative implications of the company’s actions. Recall of the complaint, evaluations of company characteristics, and decisions were unaffected. Relative to the Negative Implications Scale, receiving a negative message and a graph making failure salient in red resulted in learners’ opinions focusing on bad business practices and poor treatment of customers, compared to learners’ stating that the company’s product was faulty but that it was not their fault. This pattern of results support Moller, Elliot and Maier, (2009) and Kuhbander and Pekrun (2013) by showing that the color red influences the processing of information, and that this differential processing results in the encoding and construction of a different concept.

Practical Implications

While Park and Feigenson’s (2013) findings provided the starting point for applied research into the legal setting, its limitations proved to be important areas of investigation. Whereas, Park and Feigenson (2013) concluded that including a
PowerPoint influenced the construction of learner’s cognitive concept, our results show that their findings are qualified in several ways. One, the effect documented by Park and Feigenson (2013) may have arisen from a cumulative effect of the graphs. Similar to Isberner et al (2013) the presence of multiple graphs may have provided incremental informational cues that resulted in the observed pattern of results. Two, investigation of the graphs used in Park and Feigenson’s (2013) study revealed that the plaintiff’s PowerPoint slides contained a predominately red color palette compared to the blue palette used by the defense. This difference typifies the manipulation of color in visual displays. While research has indicated that red is associated with failure and negativity (Moller, Elliot & Maier, 2009; Kuhbander & Pekrun, 2013) blue has been found to confer cues of competence (Labrecque & Milne, 2010), pleasantness (Valdez & Mehrabian, 1994) and trust (Alberts & van der Geest, 2011). While the associations of colors to concepts has a rich history, it is only through the methodical investigation of colors in individual contexts that we can come to understand how color and specifically hue influence human cognition and behavior.

Limitations

One of the largest limitations of the present investigation is the brief time learners’ had to interact with our experimental materials. We manipulated a 50-word text and a stacked-bar graph, both of which represent simple text and graphic manipulations. While investigation of brief text and graphic materials is an important area, the materials used in our investigation present a simplified take on the legal context. In addition, learners’ were presented only one perspective regarding the case and were not asked to participate in any deliberation with additional jurors, both of which must be investigated to
understand the long-term effects of visual materials on concept formation and decision-making in the legal setting.

Secondly, our investigation took place in an online environment causing two difficulties, one ecological and one methodological. Regarding ecological validity, our online investigation is a departure from actual legal decision-making. Methodologically, conducting our investigation online reduced the specificity of our color manipulations. Most computer screens and monitors represent colors somewhat differently; most of us have experienced building a PowerPoint Presentation and choosing a color palette, only to be confused by the monitor looking different than your computer screen. It is for this reason that most research on color occurs in highly controlled laboratory environments where colors can be calibrated using spectrophotometers. However, despite this limitation, several studies have investigated color manipulations in online settings (Bakhshi & Gilbert, 2015; Bazley, Cronqvist, & Mormann, 2016 and Lichtenfeld, 2012) yielding theoretically consistent results.

Conclusion

In the aggregate, despite a body of research on text and graphics, including a graphic may not always be beneficial to enhancing communication. In Experiment 1, we found that the presence of an achromatic graph actually increased the amount of doubt learners’ had about the company’s guilt when the graph was paired with the negatively framed message. This shows that in communication, the presentation of visual information appears to influence the message of a communicating text. In the present
investigation, the message of the text was negatively valenced, and the presence of the graph led to a behavioral outcome inconsistent with this message.

Secondly, our investigation reinforces the growing body of research demonstrating that color is not only aesthetic but that it is also capable of communicating information learners’ appear to incorporate into their concepts about a situation or topic. While in this investigation, we viewed color as an informational cue capable of influencing the encoding and organization of knowledge, color has also been found to influence affect (Plass, Heidig, Hayward, Homer & Um, 2013) and motivation (Elliot, 2015). Therefore, we argue that theories of text and graphic comprehension and theories of multimedia learning must acknowledge the influences that color has on human affect, motivation, cognition and behavior similar to the Cognitive Affective Theory of Multimedia Learning (Mayer, 2014) (CATML) and Emotional Design (Plass, Heidig, Hayward, Homer & Um, 2013).
REFERENCES
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