

Colorful Personalities: Investigating the Relationship between Chroma, Person  
Perception, and Personality Traits

by

Adam D. Pazda

Submitted in Partial Fulfillment of the  
Requirements for the Degree  
Doctor of Philosophy

Supervised by Professor Andrew Elliot

Department of Clinical and Social Sciences in Psychology  
Arts, Sciences and Engineering  
School of Arts and Sciences

University of Rochester  
Rochester, NY

2015

### Biographical Sketch

Adam D. Pazda was born in Binghamton, NY on December 17, 1982. He attended the University of Houston from 2006 to 2008, where he received a Bachelor of Arts degree in Psychology, summa cum laude. During his time at the University of Houston, he received several academic awards, including the Richard and Thomas Franklin Scholarship, the Laurie Callicut Research Scholarship, the University of Houston Social Sciences Scholarship, and an induction into the Psi Chi National Psychology Honors Society. He began his graduate studies in 2009 under the supervision of Andrew J. Elliot at the University of Rochester, and he received his Master of Arts degree in 2012. He was awarded the Helen and Vincent Nowlis Award for Excellence in Teaching in 2013, and he received the Alfred Baldwin Award for Excellence in Research in 2014. He will begin his appointment as an Assistant Professor of Psychology at the University of South Carolina Aiken in the fall of 2015.

The following publications were a result of work conducted during doctoral study:

Thorstenson, C., Pazda, A.D., & Elliot, A.J. (in press). Sadness impairs color perception. *Psychological Science*.

Pazda, A.D. & Greitemeyer, T. (in press). Color in romantic contexts in humans. In A.J. Elliot, M. Fairchild, & A. Franklin (Eds.), *Handbook of Color Psychology*. Cambridge, England: Cambridge University Press.

Pazda, A.D., Prokop, P., & Elliot, A.J. (2014). Red and romantic rivalry: Viewing another woman in red increases perceptions of sexual receptivity, derogation, and intentions to mate-guard. *Personality and Social Psychology Bulletin*, 40, 1260-1269.

- Pazda, A.D., Elliot, A.J., & Greitemeyer, T. (2014). Perceived sexual receptivity and fashionableness: Separate paths linking red and black to perceived attractiveness. *Color Research and Application*, 39, 208-212.
- Elliot, A.J., Greitemeyer, T., & Pazda, A.D. (2013). Women's use of red clothing as a sexual signal in intersexual interaction. *Journal of Experimental Social Psychology*, 49, 599-602.
- Elliot, A.J., Tracy, J.L., Pazda, A.D., & Beall, A.T. (2013). Red enhances women's attractiveness to men: First evidence suggesting universality. *Journal of Experimental Social Psychology*, 49, 165-168.
- Elliot, A.J., & Pazda, A.D. (2012). Dressed for sex: Red as a female sexual signal in humans. *PLoS ONE*, 7 (4), e34607.
- Pazda, A.D., Elliot, A.J., & Greitemeyer, T. (2012). Sexy red: Perceived sexual receptivity mediates the red-attraction relation in men viewing women. *Journal of Experimental Social Psychology*, 48 (3), 787-790.
- Pazda, A.D., & Elliot, A.J. (2012). The color of attraction: How red influences physical appeal. In M. Paludi (Ed.), *The Psychology of Love*. Santa Barbara, CA: Praeger.
- Pazda, A.D., Elliot, A.J., & Greitemeyer, T. (2012). The color of sexuality: Female red displays are used and perceived as a sexual signal. In A. Columbus (Ed.), *Advances in Psychology Research, Volume 89*. Hauppauge, NY: Nova.

## Acknowledgments

This work would not be possible without a number of people who have guided me throughout my graduate training. First and foremost, I am eternally grateful to Andy Elliot for the countless hours he has invested in my development as a researcher, writer, and teacher. His enthusiasm for social psychology is wonderfully contagious, and he has been an outstanding role model and friend.

I am also thankful to the people who have shaped me into a curious and successful researcher. Harry Reis, Ed Deci, Miron Zuckerman, and Jeremy Jamieson have helped me think about psychology on a deeper level. Wilbert Law, Roger Feltman, Rachel Korn, Chris Thorstenson, Emily Greenwood, Adam Augustine, David de Jong, and Steffi Lichtenfeld have all provided extensive feedback on my research ideas. Tobias Greitemeyer, Pavol Prokop, and Steve Young have been invaluable collaborators across dozens of studies. I am indebted to the numerous undergraduate research assistants, too many to name here, that worked extremely hard collecting data over the years. I thank Kathi Heffner for serving on my dissertation committee and providing insightful comments during my research proposal. Kristen Yax and Chip Knee were instrumental in helping me find my passion for psychology, and I am extremely grateful for their mentorship.

I thank my family for encouraging my pursuit of a higher education and making frequent trips from Texas to Rochester. Finally, I am especially grateful to my wife, Jeanette, for the unconditional love, support, and adventures over the years.

## Abstract

Research on how color affects psychological functioning has burgeoned in recent years. The majority of studies in the domain of color psychology have focused on hue or lightness, while paying little attention to chroma. The present research sought to address this oversight in the literature by investigating the degree to which chroma influences person perception, specifically with regard to the Big Five personality traits. Drawing from Conceptual Metaphor Theory, I predicted that perceiving literal colorfulness (i.e., chroma) would influence perceptions of figurative colorfulness (i.e., extraversion, openness). In Experiment 1, participants perceived foreign words printed in high-chroma text to have a meaning associated with extraversion and openness, relative to agreeableness, conscientiousness, and neuroticism. In Experiment 2, participants rated individuals surrounded by high-chroma colors as more extraverted and open than individuals surrounded by low-chroma colors. Experiment 3 replicated these effects while manipulating chroma on targets' clothing. Study 4 examined the relationship between the Big Five traits and preferences for high and low-chroma colors. Extraverts reported liking high-chroma colors more than introverts, and higher openness was associated with stronger liking of low-chroma colors. Study 5 investigated whether the amount of chroma in participants' clothing was related to their levels of extraversion and openness; no relationship was observed. Implications for integrating chroma as a focal variable in color research are discussed.

### Contributors and Funding Sources

This work was supervised by a dissertation committee consisting of Professors Andrew Elliot (advisor) and Harry Reis from the Department of Clinical and Social Sciences in Psychology and Professor Kathi Heffner from the Department of Psychiatry. All work for the dissertation was completed independently by the student without outside funding support.

## Table of Contents

List of Tables	viii
List of Figures	ix
Chapter 1      Introduction	1
Chapter 2      Experiment 1	20
Chapter 3      Experiment 2	25
Experiment 2a	25
Experiment 2b	29
Experiment 2c	30
Chapter 4      Experiment 3	34
Chapter 5      Study 4	43
Chapter 6      Study 5	52
Chapter 7      General Discussion	58
References	68
Appendices	94

## List of Tables

<u>Table</u>	<u>Title</u>	<u>Page</u>
Table 1	Multilevel analysis in Study 5	83



## List of Figures

<u>Figure</u>	<u>Title</u>	<u>Page</u>
Figure 1	The effect of word type on high-chroma selections in Experiment 1	84
Figure 2	The effect of chroma on perceptions of the Big Five personality traits in Experiment 2a	85
Figure 3	The effect of chroma on perceptions of the Big Five personality traits in Experiment 2b	86
Figure 4	The effect of chroma on perceptions of the Big Five personality traits in Experiment 2c	87
Figure 5	The effect of chroma on perceived extraversion for each hue condition in Experiment 3	88
Figure 6	The effect of chroma on perceived openness for each hue condition in Experiment 3	89
Figure 7	The effect of chroma on perceived agreeableness for each hue condition in Experiment 3	90
Figure 8	The interaction between extraversion and chroma on color likeability ratings in Study 4	91
Figure 9	The interaction between openness and chroma on color likeability ratings in Study 4	92
Figure 10	The interaction between sex and chroma on color likeability ratings in Study 4	93

## **Chapter 1: Introduction**

First impressions are ubiquitous in daily life. Every time we encounter an unfamiliar person, from the barista at the coffee stand to the new coworker across the hall, we make immediate snap judgments based on very minimal information (Ambady & Rosenthal, 1992). Over the past few decades, researchers have been investigating specific components that contribute to forming impressions of other individuals (DeCoster & Claypool, 2004). Recently, scientists have demonstrated that color, whether displayed on clothing or observed in close proximity to a person, can influence the judgment making process (Elliot & Maier, 2014). The overwhelming majority of inquiries into color's influence on person perception have solely focused on hue effects. The present research investigates how another dimension of color, specifically chroma, may play a role in impression formation. I begin with a review of the literature on impression formation, highlighting the effects of color on person perception. Drawing from Conceptual Metaphor Theory (Lakoff & Johnson, 1980; 1999), I subsequently lay out a conceptual framework discussing why the chroma dimension of color should influence personality judgments of others, and I derive several hypotheses that are tested across 5 studies.

### **Person perception and impression formation**

A multitude of studies have investigated the degree to which people form impressions of others based on minimal information, how much consensus there is among perceivers, and how accurate these impressions are. In this context, minimal information refers to the absence of social interaction or verbal communication, otherwise known as zero acquaintance situations (Albright, Kenny, & Malloy, 1988).

There is considerable consensus among perceivers when rating a variety of personality dimensions of a target at zero acquaintance, especially for extraversion and conscientiousness (Albright et al., 1988; cf., Shevlin, Walker, Davies, Banyard, & Lewis, 2003). When unable to infer personality traits from direct interaction, perceivers use whatever cues are available to judge others' personality, such as physical appearance, which can be rife with relevant information (Naumann, Vazire, Rentfrow, & Gosling, 2009). For example, gaze direction can be a subtle cue as to how much interest people take in various aspects of their environment. Stillman and Maner (2008) found that the frequency with which a woman directed her gaze toward a man could accurately depict the woman's socio-sexuality orientation, and third party perceivers indeed used gaze frequency to infer such information. Furthermore, photographs of individuals with a frontal gaze direction are perceived as more attractive and likeable than those with a sideways gaze, presumably because it signals interest and attention toward the perceiver (Mason, Tatkov, & Macrae, 2005).

Facial expressions may also provide valuable information when making judgments of others. Borkenau, Brecke, Möttig, and Paelecke (2009) found that extraversion can be accurately perceived after a 50 millisecond exposure to a face. They found that cheerfulness of the target's facial expression accounted for the accuracy in extraversion judgments. Verplaetse, Vannest, and Braeckman (2007) found that participants could identify when someone was defecting (versus cooperating) in a prisoner's dilemma game by looking at their facial expression at the time of defection.

Interestingly, these judgments were only accurate during actual game play, but not when perceiving facial expressions prior to the game or during a practice round.

Other research has documented that facial structure alone can be sufficient to convey personality information to perceivers. Specifically, people have been shown to make accurate judgments of power, interpersonal warmth, competence, and leadership from viewing faces with a neutral expression (Rule & Ambady, 2008; 2009; 2011). Penton-Voak, Pound, Little, and Perrett (2006) found a relationship between targets' self-reports of extraversion and perceivers' judgments of targets' extraversion from viewing photographs with a neutral facial expression (emotional stability and openness were also perceived accurately for male, but not female faces). In a subsequent experiment, faces of 30 individuals who had reported being high or low on each of the Big Five personality traits were morphed to form composite images, essentially eliminating the features that make faces look unique while maintaining the defining features of the group (Rowland & Perrett, 1995). Participants could accurately discriminate between faces of individuals high on extraversion, agreeableness, and, for males, emotional stability (Penton-Voak et al., 2006). Boothroyd, Cross, Gray, Coombes, and Gregson-Curtis (2011) found that socio-sexuality can be judged accurately simply by looking at one's face. Sexual orientation can also be judged accurately from facial photographs, even when the faces are cropped such that the eyes are the only discernible feature (Rule, Ambady, & Hallett, 2009).

Snap judgments of others' personality do not require deliberate, calculated assessments; they can be fairly accurate when using gut level intuitions in extremely

short periods of time (Rule et al., 2009). For example, participants only needed 100 milliseconds to form an impression of a stranger's personality, including trustworthiness, likeability, competence, aggressiveness, and attractiveness (Willis & Todorov, 2006). Bar, Neta, and Linz (2006) found that participants only needed 39 ms to accurately perceive faces as threatening or not.

It is clear from the multitude of studies on person perception that individuals readily and easily make snap judgments of others. The majority of the extant research on person perception has investigated how various features of an individual (e.g., facial expression, facial structure, etc.) influence perceptions of that individual's personality. However, actually seeing another individual is not a necessary condition for people to make accurate personality judgments about that individual. Getting a glimpse of a person's living quarters or work space is sufficient to make an accurate impression of the individual residing in those spaces, especially for extraversion (Gosling, Ko, Mannarelli, & Morris, 2002). Similarly, viewing someone's personal website or Facebook page can provide an adequate window into their personality (Vazire & Gosling, 2004). When forming impressions of others, peripheral cues seem to be helpful in the judgment making process. The present research investigates how another peripheral cue, specifically color, influences judgments of others' personality.

### **Color and person perception**

Research investigating how color influences person perception has grown rapidly in recent years (Elliot, 2015). Elliot and Maier (2012) have developed a Color-In-Context theoretical framework to explain and predict how color influences psychological

functioning. One underlying premise of Color-In-Context theory is that color is more than an aesthetic pleasure; it can be rife with meaning that can convey symbolic information to perceivers. In other words, color can have functional value in addition to aesthetic value. The meaning that any color carries likely originates from being paired with concepts in society. In some instances we may even be biologically predisposed to ascribe meaning to color. Moreover, information conveyed by color is contingent upon the context in which it is perceived, as a single color can symbolize different concepts in different situations. Red may activate the concept of romance when perceived in affiliation contexts due to red's symbolism of love, passion, and sexuality in these contexts. For example, areas of prostitution are demarcated by red lights (e.g., Amsterdam's famous De Wallen), red is the typical color of women's lingerie, and reddened skin accompanies sexual excitation. Female sexuality has been linked with red in literature, film, theatre, and music, such as in *The Scarlet Letter*, *A Streetcar Named Desire*, *Jezebel*, *The Matrix*, *The Lady in Red*, *Little Red Corvette*, and many others (Greenfield, 2005). In contrast, red can activate the concept of danger or failure when perceived in achievement contexts because red is often associated with danger or failure in these contexts (Pravossoudovitch, Cury, Young, & Elliot, 2014). For instance, teachers use red ink to indicate errors on student assignments, red lights flash on fire trucks that race toward a burning house, and red numbers signify a drop in stock prices.

Another premise of Color-In-Context theory is that the meanings that colors convey can influence human perceptions and behavior. Numerous empirical investigations provide support for this premise. Red, for instance, has been shown to have

notable effects on person perception and subsequent behavior in the affiliation domain. For example, wearing or being in close proximity to red increases one's attractiveness to opposite sex perceivers (Elliot & Niesta, 2008; Elliot et al., 2010; Lin, 2014; Pazda, Elliot, & Greitemeyer, 2012; 2014; Roberts, Owen, & Havlicek, 2010). Furthermore, various approach-oriented behaviors follow from this increased attractiveness. Women wearing red clothing (relative to women wearing blue, green, black, white, or yellow) are tipped more generously by men (Guéguen & Jacob, 2014). Female hitchhikers wearing red are more likely to be offered a ride by male drivers than women wearing other colors (Guéguen, 2010). Women who wear red in online personal ads are contacted more frequently by male suitors compared with women wearing other colors (Guéguen & Jacob, 2012). Men physically sit closer to women in red, relative to green (Niesta-Kayser, Elliot, & Feltman, 2010), and university students have been shown to more quickly approach a red-clad person of the opposite sex when expecting to discuss college dating (but not college achievement; Meier, D'Agostino, Elliot, Maier, & Wilkowski, 2012). Red makeup on women has elicited similar approach-oriented behavior from men, including more frequent courtship attempts in bars (Guéguen, 2008; Guéguen, 2012a), and giving more liberal tips to waitresses (Guéguen & Jacob, 2011). These perceptual and behavioral outcomes of perceiving red in affiliation contexts are consistent with red's symbolic meaning in those contexts.

The research reviewed thus far supports the notion that red is perceived as a symbol of sex or romance in affiliation contexts. In other words, red sends a signal of romance, and receivers of the signal interpret it as such. However, is it the case that red is

actually used as a romantic signal, or are perceivers simply decoding the meaning of red inappropriately? Recent research has focused attention on the sending, rather than receiving, component of red as a romantic signal. Elliot and Pazda (2012) found that women who were explicitly interested in casual sexual encounters were more likely to wear red clothing in their profile picture on Internet dating sites than women interested in cultivating friendships. In a similar line of research, Beall and Tracy (2013) examined whether women would be more likely to wear red or pink clothing when conception risk is high, a time when sexual interest tends to escalate (Bullivant et al., 2004; Dennerstein et al., 1994, Haselton & Gangestad 2006; Wallen & Rupp, 2010); they indeed found that women's propensity to wear red increased during the fertile phase of their cycle. In a subsequent study, Tracy and Beall (2014) found that weather moderated this effect, such that women who had a high conception risk were only more inclined to wear red/pink when the weather was cold, not when the weather was warm. This may be due to the variety of sexual signals available for women when the weather is warm, such as wearing minimal or revealing clothing, that are not available due to discomfort or social constraints when the weather is cold. Thus, women may be particularly likely to utilize red clothing as a sexual signal when other options are limited. In another, related line of research, Guéguen (2012b) found that women are more likely to wear makeup (including red makeup) when conception risk is heightened.

Some evidence suggests that sexual interest or heightened conception risk are not necessary conditions to increase women's likelihood of wearing red; situational factors that are relevant to mating may also increase women's propensity to utilize red as a



romantic signal. For example, Elliot, Greitemeyer, and Pazda (2013) found that women chose to wear red clothing when expecting to meet an attractive man, relative to an unattractive man or an attractive woman. Prokop and Hromada (2013) found that women preferred to wear red clothing when the probability of encountering a mate was high, such as going on a date, relative to low, such as visiting one's grandparents. These results suggest that women may subconsciously (or perhaps strategically) use red in order to attract amorous attention from men. Red's signal function in affiliation contexts may facilitate human reproduction, as female red displays elicit approach-oriented behavior from men precisely at the time that women experience a peak in sexual interest and have the highest likelihood of conception.

It is clear from the research reviewed thus far that color, particularly red, can have notable effects on person perception. Specifically, perceivers (i.e., those *receiving* the signal) tend to associate red with concepts that are consistent with red's symbolism in the affiliation domain. Furthermore, those *sending* the signal tend to have romantic or sexual motivation that is also consistent with red's symbolism in the affiliation domain.

In the present research, I further investigate the effects of receiving and sending color signals, but I will shift the focus from hue (the focus of nearly all existing color research) to chroma. Specifically, I investigate how the chroma dimension of color can affect personality judgments (e.g., *perceiver* effects) in the context of zero-acquaintance situations. I also investigate the degree to which personality variables influence the outward display of chroma (e.g., *sender* effects). In the next section I provide an overview of color properties, specifically delineating what chroma is. I subsequently lay

out a framework derived from Conceptual Metaphor Theory (Lakoff & Johnson, 1980) for why chroma should be related to personality judgments, and why personality may influence the propensity to wear more high-chroma colored clothing.

### **Three properties of color: Hue, lightness, and chroma**

Color is the characteristic of a visual perception that can be described by attributes of hue, lightness, and chroma. The overwhelming majority of research on color effects in the domain of psychology has focused solely on hue. However, as the previous definition indicates, colors are comprised of more than just hue; lightness and chroma are other properties that are combined with hue to constitute the colors we perceive in everyday life. Some research has examined how lightness affects psychological functioning (reviewed below), though lightness has received relatively little empirical attention. Chroma has been studied primarily within the context of color preferences (Camgöz, Yener, & Güvenc, 2002; Fortmann-Roe, 2013; McManus, Jones, & Cottrell, 1981; Palmer & Schloss, 2010), though some research has investigated how chroma influences perceived heaviness (Alexander & Shansky, 1976), emotional content (Suk & Irtel, 2009; Valdez & Mehrabian, 1994), and brand identity (Labrecque & Milne, 2012). The present research extends this literature by examining the degree to which chroma, independent of hue and lightness, influences person perception. I elaborate on color terminology below to clarify the differences between color properties.

*Hue* is the "attribute of a visual perception according to which an area appears to be similar to one of the colors: red, yellow, green, and blue, or to a combination of adjacent pairs of these colors considered in a closed ring" (Commission Internationale de

l'Eclairage [CIE], 2011). When we say the word “color” in casual conversation, we typically mean “hue.” There is considerable variability in how any given hue is perceived depending on its levels of lightness and chroma. For example, we call the sky blue, and we also call the Atlantic Ocean blue. However, when sailing across the ocean, it would be clear that the color of the sky and the color of the ocean are perceptually very different. Even though they both have a similar hue, the sky appears much lighter, while the ocean appears more chromatic. Thus, we may qualify our description of the sky as *light blue* (referring to the lightness dimension), and the ocean as *deep blue* (referring to the chroma dimension).

*Lightness* is defined as "the brightness of an area judged relative to the brightness of a similarly illuminated area that appears to be white or highly transmitting" (CIE, 2011).<sup>1</sup> In simpler terms, lightness can be construed as the perceived quantity of light emanating from a stimulus. A stop sign viewed in the sunlight will appear lighter than a stop sign viewed in the shade because the sunlit sign will reflect more light. Every hue (with any degree of chroma) can be relatively light or dark.

*Chroma* can be conceptualized as the perceived quantity of hue content in a stimulus. In other words, chroma refers to the degree of a hue's colorfulness.<sup>2</sup> One could imagine a red hue that is on a continuum between completely gray and intense red (e.g.,

---

<sup>1</sup> Other color terms, such as brightness, colorfulness, and saturation are also used to describe color perception, each of which has a unique meaning. The discussion of color properties herein is simplified, as a detailed account of color models and terminology is beyond the scope of this paper. For a comprehensive overview of color models and systems, see Fairchild (2013; 2014).

<sup>2</sup> Chroma is technically defined as "the colorfulness of an area judged as a proportion of the brightness of a similarly illuminated area that appears white or highly transmitting" (CIE, 2011).

stop sign) with varying degrees of faded red (e.g., Nantucket red) falling in between. Every hue (with any degree of lightness) can vary along this continuum from relatively gray to relatively chromatic.

### **Color and conceptual metaphors**

A metaphor is a linguistic device in which a term or phrase can be applied to some unrelated concept as a way to suggest a resemblance. For example, the sentence, “work tomorrow should be smooth sailing” uses the concept of a gentle sea to describe a workday free of hardships. Although sailing across the ocean may be entirely unrelated to one’s professional activities, both share the possibility of being more or less easy, depending on the circumstances.

Cognitive theorists have suggested that metaphors are not only used as communication devices, but that they also assist in understanding abstract concepts. In other words, it is not just the case that we speak metaphorically, but we also think metaphorically (Lakoff & Johnson, 1980; 1999; Landau, Meier, & Keefer, 2010). Abstract concepts can be difficult to grasp without employing comparisons to perceptual or embodied experiences. A common example of this is comparing the idea of time (a relatively abstract concept) with movement (a relatively concrete concept). Thinking about time in terms of movement helps us understand the concept of time better. For example, if we think about a person who has *come a long way*, we can easily imagine someone who has matured or developed over time. Similarly, contemplating life circumstances *down the road* is synonymous with thinking about the future. When speaking and thinking metaphorically, the abstract concepts we are trying to understand

are known as *target* concepts, whereas the perceptual, concrete concepts we use as descriptors are known as *source* concepts (Lakoff & Johnson, 1980). Interestingly, each of the color properties previously discussed (i.e., hue, lightness, chroma) are used metaphorically as source concepts to describe a variety of target concepts. Furthermore, hue and lightness metaphors have been shown to affect human psychological functioning in various ways; the degree to which chroma metaphors influence psychological functioning is a central focus of the present research.

### **Color metaphors – hue**

The perceptual experience of seeing red is often used to describe the abstract emotion of anger (Lakoff, 1987). A number of studies have shown that metaphors comparing red with anger are more than linguistic conveniences, but actually facilitate how people process the concept of anger. For example, Fetterman, Robinson, and Meier (2012) found that participants were quicker at categorizing anger related words when displayed in red (relative to gray) text, though text color did not facilitate categorization of neutral or fear related words. In a series of experiments, Fetterman, Robinson, Gordon, and Elliot (2011) showed that inducing anger in participants led them to perceive ambiguously colored stimuli as red; priming the concept of anger without inducing the actual emotion led to similar results. Extending the red-anger metaphor to person perception, Young, Elliot, Feltman, and Ambady (2013) found that participants were quicker to correctly categorize a face displaying anger when the face was surrounded by red, relative to gray or green. Red did not, however, facilitate categorizations of happy faces. In a quasi-experimental field study, Guéguen, Jacob, Lourel, and Pascual (2012)

found that French drivers were more likely to honk at a stalled red vehicle (relative to green, blue, white, and black), indicating that seeing red may actually induce anger. Finally, in a study on color preference, Fetterman, Liu, and Robinson (2015) found that individuals who were dispositionally hostile preferred the color red more than individuals who were less hostile.

### **Color metaphors -- lightness**

A number of metaphors exist that compare lightness to morality or positivity. For example, *the light at the end of the tunnel* is an expression that signifies an expected positive ending to a currently undesirable circumstance. Having a *dark past* may reflect a history of making bad decisions. *Lighten up* is an expression to encourage someone to focus on positivity, and many people would describe a car salesperson with unethical business tactics as *shady*. Plato's Allegory of the Cave used lightness as a metaphor for knowledge (and darkness for ignorance) dating back to 520 B.C.E. Popular media frequently uses lightness and darkness to depict protagonists and antagonists, respectively. It is hard to imagine Darth Vader wearing any color other than black, and fairy tale princes always ride a white horse.

It is not the case that humans simply use light and dark to talk about good and bad. Research has shown that we actually think about good and bad in terms of lightness and darkness, and the light/dark dimension can influence our perceptions and behavior. Meier, Robinson, and Clore (2004) found that people infer words in light (versus dark) font to mean something positively valenced. A reciprocal relationship also exists, such that evaluating the valence of positive words (e.g., love), relative to negative words (e.g.,

rude), led participants to perceive gray squares as brighter, even though the squares were objectively equal in brightness (Meier, Robinson, Crawford, & Ahlvers, 2007). Hyunjin, Vonasch, Meier, and Bargh (2012) found that smiling faces were perceived as brighter in color than the same faces exhibiting a frown. Again, the faces were objectively equal in brightness. Frank and Gilovich (1988) found that football and hockey teams donning black uniforms were perceived as more aggressive, and were thus given more penalties from referees. In a subsequent experiment, participants randomly assigned to wear black uniforms sought out more aggressive activities, relative to those wearing white uniforms (Frank & Gilovich, 1988). When investigating the influence of environmental lighting on moral behavior, participants in a dimly lit room were more likely to cheat than participants in a well-lit room, which is consistent with the metaphor linking lightness/darkness with good/bad (Zhong, Bohns, & Gino, 2010). Finally, when evaluating pictures of neutral stimuli, participants rated the exact same stimuli as more positive when the lightness of the picture was increased (Lakens, Fockenberg, Lemmens, Ham, & Midden, 2013).

### **Color metaphors -- chroma**

Chroma is used metaphorically to talk about (and perhaps think about) abstract concepts related to personality, specifically with regard to the traits of extraversion and openness to experience.

*Chroma as a metaphor for extraversion.* We use a variety of words related to the visual perception of colorfulness to describe people who are energetic and outgoing. For example, we can describe a color as looking faded, which is a result of a reduction in

chroma from any given hue. Similarly, a reduction in human energy (becoming tired or worn down) is commonly described as fading. As colors are reduced in chroma, their appearance changes from vibrant to dull. A similar continuum exists for human personalities, as they can also range from vibrant (outgoing) to dull (reserved). Finally, we may refer to extraverted individuals as bold or loud, and we refer to highly chromatic colors with the exact same words. In each of these expressions, chroma is compared to adjectives that reflect the personality trait of extraversion.

*Chroma as a metaphor for openness.* There are a variety of words and expressions that compare chroma with openness to experience. For example, deep and shallow are semantic differentials that can refer to colors (high-chroma and low-chroma, respectively) as well as people (contemplative and closed-minded, respectively). Announcers who cover live sporting events usually consist of a play-by-play commentator and a color commentator, the latter of which adds diverse tidbits of information to enhance the broadcast. A person who is off color may lack intelligence or sophistication. Finally, the future is looking bright, not dull, when new and exciting events are on the horizon.<sup>3</sup> In these examples, words that literally refer to the chroma dimension of color are used to describe concepts that reflect the personality trait of openness.

---

<sup>3</sup> This expression could be construed as using the lightness dimension of color as the source concept. However, depending on what term anchors the bi-polar continuum, this expression may be associated with the chroma dimension of color. For example, if comparing bright with dark, brightness would seem more in line with the lightness dimension of color. Conversely, if comparing bright with dull, brightness better represents the chroma dimension.



From the examples indicated above, it is clear that we use words literally related to chroma to describe abstract personality traits, specifically extraversion and openness. It remains to be seen whether chroma-related words merely assist in talking about concepts related to extraversion and openness, or if we actually think about extraversion and openness in terms of chroma or colorfulness.

### **Research Overview**

The extent to which chroma-related metaphors affect human psychological functioning has yet to be investigated. The aim of the present research is to address this gap in the literature in several ways. The first step of the present research is to explore whether people actually associate chroma with concepts related to extraversion and openness. In other words, does the concrete concept of chroma overlap with the abstract concepts of extraversion and openness in our minds, or are chroma-related metaphors simply semantic conveniences?

The second step in the present research is to investigate the degree to which the chroma dimension of color can influence person perception when making zero-acquaintance judgments. Specifically, when highly chromatic colors are displayed on or in close proximity to other individuals, will people infer that those individuals are relatively high on the personality traits of extraversion and openness? Exploring this possibility will bridge the domains of impression formation, color psychology, and conceptual metaphor theory in relation to chroma.

The third step in the present research is to investigate the underlying reasons why chroma may influence person perception. If high-chroma colors make people appear

more extraverted and open, there may be two avenues by which this effect occurs. First, color may convey extraversion and openness through a truly metaphorical route. We use "colorful" words to describe extraverted and open individuals, so color conveys extraversion from the metaphoric transfer between literal colorfulness (the source concept) and figurative colorfulness (the target concept). Alternatively, people who are extraverted or open may prefer bolder, more intense (i.e., high-chroma) colors. They may also be more likely to wear clothing that is high in chroma, and they may be more likely to paint the walls of their living/working spaces in these colors. The repeated exposure of extraversion/openness paired with high-chroma colors may condition people to associate extraversion/openness with chroma. This would suggest that the metaphors between chroma and personality have experiential origins.

There is reason to believe that relatively extraverted individuals may prefer more intense (i.e., high-chroma) colors. Eysenck (1967), for example, has posited that a characteristic of extraverted individuals is a relatively low baseline level of cortical arousal (whereas introverts have a relatively high baseline of cortical arousal). As a consequence of this biological difference, extraverts seek out external stimuli (and introverts avoid stimuli) to attain an optimal level of arousal. Electroencephalography (EEG) studies have supported this notion (Savage, 1964), as have more indirect tests. For instance, extraverts responded with less salivation than introverts when taste buds were exposed to pure lemon juice, indicating that introverts are more sensitive to gustatory stimulation (Eysenck & Eysenck, 1967). Comparable effects have been shown in the auditory domain. Ludvig and Happ (1974) found that introverts were more

uncomfortable than extraverts following a loud sound. Campbell and Hawley (1982) demonstrated that extraverted college students were more likely to seek out noisy environments for reading, relative to their introverted counterparts. Additional evidence suggests that extraverts seek out visual stimulation, as they inspect aspects of their visual field at a higher rate (Brebner & Cooper, 1978), and they have a higher tolerance for light stimuli (Ludvig & Happ, 1974). As chroma is essentially the intensity of hue content in any given color, it seems reasonable to posit that extraverted individuals will show a stronger preference for highly chromatic colors, relative to introverts.

A multitude of studies investigating factors that influence individuals' color preferences have been conducted. Variables such as age (Adams, 1987; Zentner, 2001), gender (Alexander, 2003; Jadv, Hines, & Golombok, 2010), and culture (Burkitt, Tala, & Low, 2007; Hurlbert & Ling, 2007; Palmer & Schloss, 2010) have been studied, though the influence of personality on color preference has been largely ignored. Furthermore, studies on color preference have almost exclusively focused on hue, with few exceptions. When investigating general color preferences, Eysenck (1941a) discovered that people typically fall into one of two groups -- those who prefer highly chromatic colors, and those who prefer lowly chromatic colors. Eysenck (1941a) did not, however, investigate potential moderating variables that might explain why individuals may gravitate toward one preference or the other. In a subsequent study, extraverted participants reported a preference for modern paintings with lively colors, while introverts preferred more subdued colors in paintings, though chroma was not manipulated systematically (Eysenck, 1941b). Barrett and Eaton (1947) explored whether

personality variables were related to a general preference for colors or tints (which can roughly be conceptualized as high-chroma vs. low-chroma colors). Their general findings indicated that those who preferred colors were more sensitive to objects in the external environment, whereas those who preferred tints were more involved with their own internal thoughts. Barrett and Eaton's (1947) findings seem to provide initial support that a preference for chroma is associated with extraversion, but it is important to note that the spectral properties of their stimuli were not controlled in any way, and their measure of extraversion was relatively indirect. Robinson (1975) found that extraverts preferred warmer (e.g., red, yellow) colors, while introverts preferred cooler (e.g., blue, green) colors, but chroma was not considered in the investigation.

The studies described above point to the possibility of a relationship between personality and color preference, though no study has thoroughly investigated how extraversion and openness relate to a preference for chromatic colors. The present research will address this by systematically varying the spectral property of chroma (keeping hue and lightness constant), measuring preferences for these colors, and predicting color preferences from individuals' level of extraversion and openness.

The final step in the proposed research is to explore whether relatively extraverted and/or open individuals may be more likely to wear highly chromatic clothing in real life situations. Just as women sometimes utilize the color red to convey romantic interest to others (Elliot & Pazda, 2012; Prokop & Hromada, 2013), people in general may utilize the chroma dimension of color to convey personality information to others nonverbally. This last step will shift the focus from *perceiver* effects to *sender* effects of color signals.

## Chapter 2: Experiment 1

Experiment 1 examined whether there is a general association between high-chroma and concepts related to extraversion and openness, relative to concepts that share no metaphorical connections with chroma (e.g., agreeableness, conscientiousness, and neuroticism). I hypothesized that seeing foreign words printed in highly chromatic text would influence how people perceive the meaning of those words. Specifically, I predicted that foreign words displayed in high-chroma would be perceived to have a meaning associated with extraversion and openness, but not agreeableness, conscientiousness, or neuroticism.

### Method

*Participants.* One hundred and seven individuals residing in the United States (38 males) were recruited from Amazon's Mechanical Turk and paid \$.10 for participating. The age range of participants was 18 to 86, with a mean of 36. Sample size was determined by calculating the minimum number of participants ( $n = 90$ ) required to detect a small effect size ( $d = .30$ ) with .80 power, then meeting or exceeding the required  $n$ . In each experiment, all data were collected before any analyses were conducted, and all data exclusions, manipulations (i.e., experimental conditions), and variables analyzed are reported. Participation in this and all subsequent studies was restricted ex ante to individuals without a color-vision deficiency. Individuals who were familiar with the Turkish language were excluded from participating in Study 1 (the only study in which this is applicable).

*Procedure.* Participants followed a web link to gain access to a study entitled “words and meanings,” which was described as a task that would entail guessing the meaning of words in a foreign language. Participants completed 15 trials of a word matching task. For each trial, an English word was presented on the screen with a pair of foreign words, side by side, presented directly below. Participants were instructed to click on the foreign word that most likely has the same meaning as the English word displayed. The English word (displayed in black text) varied across trials and represented one of the Big Five personality traits (three trials for each trait). A different set of foreign words was used for each trial, and one foreign word was randomly selected to be displayed in high-chroma blue text, with the other in achromatic text of the same lightness. This was done to ensure that each foreign word had an equal probability of being displayed in either color, thus eliminating the possibility of a word effect. A GretagMacBeth spectrophotometer was used to determine the color parameters from the spectral data (high-chroma LCh = 59.1, 110.7, 290.0; no-chroma LCh = 59.9, --, --) The order of trials was randomized.

*Stimuli.* The English words were derived from items contained in the Big Five Inventory (John & Srivastava, 1999). For example, two of the English words referring to extraversion in the present experiment, outgoing and sociable, were derived from the item that states, “I see myself as someone who is outgoing, sociable.”

The foreign words were constructed by slightly modifying Turkish words, such that each pair contained the same number of letters, syllables, and vowels (see Appendix A). Furthermore, each pair of words was created to be similar sounding in pronunciation

to avoid a possible Bouba-Kiki effect (i.e., the nonarbitrary mapping of sounds with concepts; Köhler, 1929; Milan et al., 2013).

## Results

Across all 15 trials, data were coded “1” if the word displayed in high-chroma blue was selected and “0” if the word displayed in achromatic gray was selected. I then averaged responses for words that reflected the same underlying personality trait, resulting in five variables that each represented one of the Big Five traits. For example, the trials consisting of the words outgoing, sociable, and energetic were combined into one variable representing extraversion. The mean proportion of high-chroma selections for each trait are as follows:  $M_{extraversion} = .54$ ,  $M_{openness} = .51$ ,  $M_{agreeableness} = .48$ ,  $M_{conscientiousness} = .46$ ,  $M_{neuroticism} = .47$ .

I conducted a series of orthogonal planned contrasts within a repeated-measures ANOVA to determine whether word color influenced participants' selections for words related to extraversion and openness, relative to agreeableness, conscientiousness, and neuroticism<sup>4</sup>. The mean proportion of high-chroma selections for extraversion and openness was .524, and the mean proportion of high-chroma selections for agreeableness, conscientiousness, and neuroticism was .476, for a difference of .048. The contrast on this difference was significant,  $F(1, 416) = 4.32$ ,  $p = .030$ ,  $d = .23$ , indicating that participants were more likely to guess that words displayed in high-chroma had a meaning associated

---

<sup>4</sup> A total of 4 orthogonal contrasts were conducted simultaneously, which increases the reliability of the error term relative to conducting a single contrast (Rosenthal & Rosnow, 1984). The contrast codes for extraversion, openness, agreeableness, conscientiousness, and neuroticism, respectively, were as follows: 3 3 -2 -2 -2; 0 0 2 -1 -1; 0 0 0 1 -1; 1 -1 0 0 0. The contrast comparing extraversion and openness with agreeableness, conscientiousness, and neuroticism is the only one relevant to the study hypothesis.

with extraversion and openness, relative to agreeableness, conscientiousness, and neuroticism (see Figure 1).

In ancillary analyses I conducted post-hoc pairwise comparisons for all personality traits individually. Extraversion was significantly different from conscientiousness,  $t(104) = 2.02$ ,  $p = .046$ ,  $d = .20$ . None of the other pairwise comparisons reached significance ( $ts < 1.63$ ,  $ps > .10$ ). I also tested whether participant sex had any main or interactive effects on word judgments; it did not.

## **Discussion**

The results of Experiment 1 supported my hypothesis. When judging the meaning of foreign words, high-chroma increased the perception that the words had a meaning associated with extraversion and openness, relative to other personality traits. This is consistent with the use of chroma metaphors in language to describe human personalities, which suggests that people think of figurative colorfulness in terms of literal colorfulness. In sum, the color of words people are not familiar with affects their impressions of the meaning of those words in metaphor consistent ways.

It should be noted that the results of the planned contrast comparing extraversion and openness to agreeableness, conscientiousness, and neuroticism yielded different results from the pairwise comparisons. Only one pairwise comparison (extraversion vs. conscientiousness) was significant, and openness did not significantly differ from any of the other personality traits. This may be a result of the post-hoc tests having less power than the planned contrast. However, it may also indicate that chroma is more strongly associated with extraversion than with openness. This stronger association with



extraversion may be responsible for the significant contrast difference. In the next two experiments, I examine extraversion and openness separately to investigate how chroma relates to these traits individually, rather than jointly.

Using Mturk to conduct experimental research on the effects of color stimuli is not without limitations. Participants in the study viewed the color stimuli on their own computer monitor, and color presentation across monitors inevitably varies to some degree. This means that even though the lightness values of both colors were equated during the creation of the stimuli, there is no guarantee that the lightness values were exactly equal during the presentation of the stimuli. While this may increase the external validity of the results, it simultaneously decreases the internal validity while adding unsystematic variance to the data. This limitation is circumvented in each subsequent experiment by using a standardized computer monitor in a laboratory setting for all color stimuli presentation.

Another limitation of Experiment 1 is that it is uncommon for individuals to encounter foreign words in real-life, and it is also uncommon to read words in various colored text. Thus, the extent to which these results would generalize to any meaningful judgments is unknown. Experiment 2 seeks to address this limitation by investigating how color may influence personality judgments of people in zero-acquaintance situations.

### Chapter 3: Experiment 2

Experiment 2 examined whether highly chromatic colors in close proximity to an individual influence how people perceive that individual's personality. If literal colorfulness (i.e., chroma) is associated with figurative colorfulness (i.e., extraversion, openness), then people should perceive individuals in close proximity to high-chroma colors as relatively more extraverted and open than the same individuals near low-chroma colors. Utilizing a color manipulation near an individual, rather than on an individual's clothing, has the benefit of removing the assumption that the individual had a conscious choice regarding the color displayed. This allows for a more conservative test of the effect of chroma on person perception. Experiment 2 examined three different hues (green, blue, and red) separately, and was thus broken into three sub-experiments under the same general umbrella. Furthermore, the control colors in Experiment 2 were not entirely achromatic, but contained some amount of chroma. This allowed hue to be held constant in addition to lightness.

#### Experiment 2a

##### Method

Fifty seven participants (14 males) took part in the experiment<sup>5</sup>. Upon arrival to the laboratory, participants were informed that the experiment was about making snap judgments of personality from viewing others' photographs. Participants were then seated at a computer where the duration of the experiment took place.

---

<sup>5</sup> Sample sizes for Experiments 2a-2c were determined a priori by calculating the number of participants necessary to detect a medium ( $d = .40$ ) effect at .80 power ( $n = 41$ ), then meeting or exceeding the required  $n$ .

*Materials.* Ten photographs were selected from the Radboud faces database (Langner et al., 2010). All photographs were of Caucasian males with a neutral facial expression and a frontal gaze direction. Each photograph was placed on separate high-chroma and low-chroma green backgrounds using Adobe Photoshop CS5. The resulting stimulus set consisted of twenty photographs: Ten faces on a high-chroma background and the same ten faces on a low-chroma background. The hue and lightness values of both colors were equated, thus, chroma was the only spectral property that varied between the colors. A GretagMacBeth spectrophotometer was used to determine the color parameters from the spectral data (high-chroma LCh = 79.3, 96.9, 145.7; low-chroma LCh = 78.6, 51.5, 146.0).

*Procedure.* Participants viewed all twenty photographs on the computer monitor, one at a time, for five seconds each. After the five seconds elapsed, the photograph disappeared from the monitor and was replaced by the Five-Item Personality Inventory (FIPI; Gosling, Rentfrow, & Swann, 2003). Participants were instructed to rate the extent to which each trait applied to the person in the photograph that they had just viewed (e.g., extraverted, enthusiastic). Responses were made by moving a slider anchored from “not at all” to “very much.” Slider values ranged from 0 to 100 in increments of 1, though participants were blind to the exact numerical value of the slider. After completing the FIPI, the computer advanced to the next photograph, followed by another FIPI. This process continued until all twenty pictures had been rated; the order in which the photographs were presented was randomized.

## Results and discussion

Ratings for each of the Big Five personality traits were averaged across all ten faces within each color condition and submitted to a 2 (chroma: high, low)  $\times$  2 (sex: male, female) mixed-design ANOVA<sup>6</sup>.

*Extraversion.* The main effect of chroma was significant,  $F(1, 55) = 12.41, p = .001$ . Targets with a high-chroma background were perceived as more extraverted ( $M = 40.93, SD = 14.02$ ) than targets with a low-chroma background ( $M = 37.05, SD = 13.73$ ),  $d = .47$  (see Figure 2). The main effect of sex was also significant,  $F(1, 55) = 6.14, p = .016$ . Men perceived the targets as more extraverted ( $M = 43.88, SD = 12.77$ ) than women did ( $M = 34.10, SD = 13.52$ ),  $d = .73$ . The interaction between chroma and sex was not significant.

*Openness.* The main effect of chroma was significant,  $F(1, 55) = 8.91, p = .004$ . Targets with a high-chroma background were perceived as more open to experience ( $M = 43.07, SD = 14.71$ ) than the same targets with a low-chroma background ( $M = 40.37, SD = 14.57$ ),  $d = .39$ . The main effect of sex was also significant,  $F(1, 55) = 5.31, p = .025$ . Men perceived the targets as more open ( $M = 46.62, SD = 16.10$ ) than women did ( $M = 36.82, SD = 13.59$ ),  $d = .69$ . The interaction between chroma and sex was not significant.

*Agreeableness.* No main or interactive effects were observed.

---

<sup>6</sup> Analyses for Experiments 2-3 were modeled after previous work examining personality judgments across a wide array of targets (Mason et al., 2005; Young, 2015). I also analyzed the data using multi-level modeling, which allows targets to be modeled as a random effect. This produced highly similar results (i.e., all significant effects and interactions remained significant).

*Conscientiousness.* The main effect of sex was significant,  $F(1, 55) = 5.44, p = .023$ . Men perceived the targets as more conscientious ( $M = 48.39, SD = 7.66$ ) than women did ( $M = 39.27, SD = 14.32$ ),  $d = .70$ . No other effects were observed.

*Neuroticism.* The main effect of sex was significant,  $F(1, 55) = 5.82, p = .019$ . Men perceived the targets as less neurotic ( $M = 51.17, SD = 8.45$ ) than women did ( $M = 60.95, SD = 14.77$ ),  $d = .72$ . No other effects were observed.

The results of Experiment 2a support my hypotheses. Targets surrounded by high-chroma borders were perceived as more extraverted and open than the same targets surrounded by low-chroma borders. Chroma did not influence the perception of other personality traits, indicating that chroma's effect on perceived personality is specific to traits that reflect figurative colorfulness.

A number of sex effects were also observed, such that men had a tendency to rate the targets more positively on most of the Big Five personality traits than women. This may suggest a sex difference in how individuals perceive others at zero-acquaintance, or it may indicate that same-sex judgments differ from opposite-sex judgments. At present, I am hesitant to draw conclusions about possible sex differences in personality judgments because the stimulus pictures were comprised entirely of males. This issue is revisited in Experiment 3.

In the next experiment, I examine whether the effects documented in Experiment 2a will be present for a different hue, specifically, blue.

## Experiment 2b

### Method

Sixty two participants (13 males) took part in the experiment. The procedure was identical to that of Experiment 2a with one exception. The photographs in Experiment 2b were surrounded by a high-chroma blue background (LCh = 33.2, 117.5, 296.7) and a low-chroma blue background (LCh = 33.9, 30.8, 296.3).

### Results and discussion

Ratings for each of the Big Five personality traits were averaged across all ten faces within each color condition and submitted to a 2 (chroma: high, low)  $\times$  2 (sex: male, female) mixed-design ANOVA.

*Extraversion.* The main effect of chroma was significant,  $F(1, 58) = 5.05, p = .028$ . Targets with a high-chroma background were perceived as more extraverted ( $M = 34.82, SD = 13.16$ ) than targets with a low-chroma background ( $M = 33.26, SD = 13.67$ ),  $d = .29$  (see Figure 3). The main effect of sex was not significant, nor was the chroma by sex interaction.

*Openness.* The main effect of chroma was significant,  $F(1, 60) = 5.68, p = .021$ . Targets surrounded by high-chroma were perceived as more open ( $M = 40.11, SD = 13.49$ ) than targets surrounded by low-chroma ( $M = 38.50, SD = 13.61$ ),  $d = .31$ . The main effect of sex was not significant, nor was the chroma by sex interaction.

*Agreeableness.* No main or interactive effects emerged.

*Conscientiousness.* No main or interactive effects emerged.

*Neuroticism.* No main or interactive effects emerged.

Experiment 2b replicated the chroma effects observed in the previous study. Specifically, chroma increased perceived extraversion and openness, but did not influence the perception of other personality traits. In the next experiment, I test whether the effects observed in Experiments 2a and 2b will replicate across another hue, specifically, red.

### **Experiment 2c**

#### **Method**

Forty five participants (8 males) took part in the experiment. The procedure was identical to that of Experiment 2a with one exception. The photographs in the present experiment were surrounded by a high-chroma red background (LCh = 62.7, 89.8, 28.0) and a low-chroma red background (LCh = 62.1, 25.0, 27.4).

#### **Results and discussion**

Ratings for each of the Big Five personality traits were averaged across all ten faces within each color condition and submitted to a 2 (chroma: high, low)  $\times$  2 (sex: male, female) mixed-design ANOVA.

*Extraversion.* The main effect of chroma was significant,  $F(1, 43) = 5.05, p = .030$ . Targets with a high-chroma background were perceived as more extraverted ( $M = 34.77, SD = 16.75$ ) than targets with a low-chroma background ( $M = 32.77, SD = 15.52$ ),  $d = .33$  (see Figure 4). The main effect of sex was not significant, nor was the chroma by sex interaction.

*Openness.* No main or interactive effects were observed.

*Agreeableness.* No main or interactive effects were observed.

*Conscientiousness.* No main or interactive effects were observed.

*Emotional stability.* The main effect of chroma was significant,  $F(1, 43) = 7.29, p = .010$ . Targets with a high-chroma background were perceived as less emotionally stable ( $M = 38.55, SD = 14.43$ ) than targets with a low-chroma background ( $M = 41.50, SD = 15.80$ ),  $d = .40$ . The main effect of sex was not significant, nor was the chroma by sex interaction.

Experiment 2c replicated the effect of extraversion from the previous two experiments. Individuals surrounded by high-chroma red were perceived as more extraverted than the same individuals surrounded by low-chroma red. The effect of chroma on openness, however, did not replicate with a red hue. An unexpected effect of chroma emerged for emotional stability, such that high-chroma led to decreased perceived stability of the targets. This may indicate that hue moderates the effect of chroma on personality judgments. For example, a very intense red hue may be associated lower emotional stability due to the reddening of skin during various emotional experiences (e.g., anger, embarrassment). Some research indirectly supports this possibility, as hospital patients have been shown to perceive red walls as emotionally upsetting (Goldstein, 1939; 1942). It seems that chroma influences perceptions in a manner consistent with chroma metaphors, but it may also intensify perceptions of hue meanings for other traits. In this case, red may carry the meaning of emotional instability, and high-chroma red may be more strongly associated with emotional instability than low-chroma red.



## Experiment 2 discussion

Experiment 2 provides further evidence that literal colorfulness is associated with figurative colorfulness. Faces that were surrounded by high-chroma hues were perceived as more extraverted (2a-2c) and open (2a, 2b) than the same faces surrounded by low-chroma hues. This result was generally not found for the other Big Five personality traits, indicating that chroma affects perceptions in a metaphor-consistent manner.

There were two unpredicted findings in Experiment 2. Chroma had no effect on judgments of openness in Experiment 2c, and chroma decreased perceived emotional stability in Experiment 2c. These unexpected results may indicate that hue moderates the effects of chroma on personality judgments. The colors in Experiments 2a-2c were equated on hue and lightness within each sub-experiment, but hue and lightness were not equated across experiments. For example, the high-chroma blue matched the low-chroma blue on hue and lightness, but did not match the high-chroma green or red on hue and lightness. Due to these circumstances, it is not possible to directly compare effects across hues. This issue is addressed in Experiment 3.

A limitation of Experiment 2 is that the stimulus photographs were all of men, and the samples were primarily comprised of female participants. This means that the majority of the ratings across all three sub-experiments were for opposite-sex judgments. Previous work in the domain of person perception has shown that color affects opposite-sex judgments, but not same-sex judgments (Elliot & Niesta, 2008, Elliot et al., 2010; cf. Roberts et al., 2010). These null effects on same-sex judgments were in the domain of interpersonal attraction, so it makes sense that color would influence perceptions of

opposite sex, but not same sex individuals. There is no theoretical basis for predicting that perceiver-target sex congruency would moderate the results of the present experiment. Nonetheless, including female targets and a sufficient sample of participants of both sexes is necessary before ruling out this possibility. This limitation is addressed in Experiment 3.

The chroma manipulation in Experiment 2 was administered within-subjects, which has inherent advantages and disadvantages. Within-subjects study designs are more powerful than between-subjects designs because each subject serves as his/her own comparison. The downside of within-subjects designs is that each participant receives both treatment conditions. This may increase the likelihood of guessing the study hypothesis, which may impact how participants respond. I attend to this limitation of within-subjects designs by adding a funnel debriefing in Experiment 3.

### Chapter 4: Experiment 3

Experiment 3 extends the previous two experiments by examining how people infer personality traits from others' clothing color. In addition, several methodological advances were utilized to address the limitations of the previous experiment. First, clothing color was manipulated to provide a more externally valid test of the influence of chroma on personality judgments. Second, chroma and lightness were equated across each hue, and hue and lightness were equated across levels of chroma. This allowed a direct test of hue as a moderator of chroma effects on personality judgments. Third, participants judged both male and female targets to test whether men and women judge same and opposite sex targets in a similar manner. Fourth, a funnel debriefing was administered at the end of the experiment to test for awareness of the study hypotheses.

#### Method

Two hundred and three participants (60 males) were recruited from the undergraduate research subject pool at the University of Rochester<sup>7</sup>. Upon arrival at the laboratory, participants were informed that the experiment was about making snap judgments of personality from viewing others' photographs. Participants were seated at a computer, where the duration of the experiment took place.

*Materials.* Eighteen photographs (9 female) were selected from the Radboud faces database (Langner et al., 2010). All photographs were of Caucasian individuals with a neutral facial expression and a frontal gaze direction. Photographs were taken from

---

<sup>7</sup> Sample size was determined a priori by calculating the number of participants necessary to detect a within-between interaction at .80 power ( $n = 195$ ), then exceeding the required  $n$ .

the waist-up, so the torso of each individual was visible, and all targets were wearing a standardized black t-shirt. The shirt color of each target was manipulated using Adobe Photoshop CS5. Six versions were created for each target, such that they were wearing a green, blue, or red shirt, each of which was high-chroma or low-chroma (See Appendix B for LCh values). Lightness was held constant across all six versions. Hue was treated as between subjects variable with three levels, and chroma was treated as a within subjects variable with two levels.

*Procedure.* Participants were randomly assigned to a hue condition (green, blue, or red), and they viewed all 18 targets twice (once in high chroma and once in low chroma) on the computer monitor, one at a time, for five seconds each. After the five seconds had elapsed, the photograph disappeared from the monitor and was replaced with the FIPI (Gosling et al., 2003). Participants were instructed to answer the questions based on their impression of the person in the photograph they had just viewed. Responses were made by moving a slider anchored from “not at all” to “very much.” Slider values ranged from 0 to 100 in increments of 1, though participants were blind to the exact numerical value. After completing the FIPI, the computer advanced to the next photograph, followed by another FIPI. This process continued until all 36 pictures had been rated; the photographs were presented in random order. At the conclusion of the experiment, a funnel debriefing was conducted to probe for suspicion (e.g., “Did anything seem strange or unusual to you about the experiment?”) and awareness (e.g., “Can you guess the hypothesis of the study?”).

## Results

Ratings for each personality trait were averaged and submitted to a 3 (hue: red, blue, green)  $\times$  2 (chroma: high, low)  $\times$  2 (participant sex: male, female)  $\times$  2 (target sex: male, female) mixed-design ANOVA.

*Extraversion.* The predicted main effect of chroma emerged,  $F(1,191) = 35.38, p < .001$ . Targets wearing high-chroma colors were perceived as more extraverted ( $M = 36.50, SD = 14.74$ ) than targets wearing low-chroma colors ( $M = 33.95, SD = 15.23$ ). This effect was qualified by a significant chroma by hue interaction,  $F(2, 191) = 4.42, p = .013$ . To examine this interaction, I tested the influence of chroma on perceived extraversion separately for each hue condition. For green, high-chroma increased perceived extraversion ( $M = 36.80, SD = 14.13$ ), relative to low-chroma ( $M = 34.45, SD = 13.64$ ),  $t(75) = 2.60, p = .011, d = .30$  (see Figure 5). The effect of chroma was also significant (and much stronger) for blue. High-chroma increased perceived extraversion ( $M = 41.03, SD = 14.66$ ), relative to low-chroma ( $M = 34.64, SD = 14.13$ ),  $t(61) = 5.23, p < .001, d = .79$ . Finally, for red, high-chroma also increased perceived extraversion ( $M = 34.73, SD = 17.23$ ), relative to low-chroma ( $M = 32.54, SD = 16.59$ ),  $t(58) = 2.07, p = .043, d = .24$ .

A main effect of target sex also emerged, such that male targets were perceived as more extraverted ( $M = 36.63, SD = 15.35$ ) than female targets ( $M = 33.87, SD = 14.38$ ),  $F(1, 191) = 21.69, p < .001, d = .33$ . No other main or interactive effects were observed.

*Openness.* The predicted main effect of chroma emerged,  $F(1,191) = 12.24, p < .001$ , such that targets wearing high-chroma colors were perceived as more open ( $M =$

39.0,  $SD = 15.29$ ) than targets wearing low-chroma colors ( $M = 37.0$ ,  $SD = 15.28$ ). This effect was qualified by a significant chroma by hue interaction,  $F(2, 191) = 4.12$ ,  $p = .018$ . To examine this interaction, I tested the influence of chroma on perceived openness ratings separately for each hue condition. For green, high-chroma increased perceived openness ( $M = 38.88$ ,  $SD = 15.81$ ), relative to low-chroma ( $M = 35.63$ ,  $SD = 15.00$ ),  $t(76) = 4.22$ ,  $p < .001$ ,  $d = .50$  (see Figure 6). For blue, high chroma also increased perceived openness ( $M = 39.85$ ,  $SD = 15.19$ ), relative to low-chroma ( $M = 37.30$ ,  $SD = 15.87$ ),  $t(62) = 2.52$ ,  $p = .014$ ,  $d = .32$ . Chroma had no effect on perceived openness for red (high-chroma  $M = 36.66$ ,  $SD = 14.81$ ; low-chroma  $M = 36.33$ ,  $SD = 15.22$ ),  $t(60) = .53$ ,  $p = .67$ .

A main effect of target sex also emerged, such that male targets were perceived as more open ( $M = 39.28$ ,  $SD = 15.68$ ) than female targets ( $M = 36.71$ ,  $SD = 15.06$ ),  $F(1, 191) = 17.14$ ,  $p < .001$ ,  $d = .29$ .

*Agreeableness.* An unexpected main effect of chroma emerged, such that targets wearing high-chroma colors were perceived as more agreeable ( $M = 42.96$ ,  $SD = 15.64$ ) than targets wearing low-chroma colors ( $M = 40.04$ ,  $SD = 14.85$ ),  $F(1, 197) = 5.79$ ,  $p = .017$ . This effect was qualified by a significant chroma by hue interaction,  $F(2, 197) = 4.38$ ,  $p = .013$ . To examine this interaction, I tested the influence of chroma on perceived agreeableness ratings separately for each hue condition. For green, high-chroma increased perceived agreeableness ( $M = 42.34$ ,  $SD = 14.50$ ), relative to low-chroma ( $M = 39.79$ ,  $SD = 14.52$ ),  $t(76) = 3.84$ ,  $p < .001$ ,  $d = .47$  (see Figure 7). There was no effect of chroma on perceived agreeableness for blue (high-chroma  $M = 44.73$ ,  $SD = 16.45$ ; low-chroma  $M = 43.32$ ,  $SD = 14.33$ ),  $t(60) = 1.31$ ,  $p = .20$ . The effect was also nonsignificant

for red (high-chroma  $M = 39.11$ ,  $SD = 16.08$ ; low-chroma  $M = 39.71$ ,  $SD = 15.87$ ),  $t(60) = .88$ ,  $p = .38$ .

A main effect of target sex also emerged, such that male targets were perceived as more agreeable ( $M = 42.19$ ,  $SD = 15.32$ ) than female targets ( $M = 40.81$ ,  $SD = 15.37$ ),  $F(1, 197) = 5.47$ ,  $p = .02$ ,  $d = .16$ .

*Conscientiousness.* A main effect of target sex emerged, such that male targets were perceived as less conscientious ( $M = 43.29$ ,  $SD = 14.95$ ) than female targets ( $M = 46.11$ ,  $SD = 15.78$ ),  $F(1, 195) = 16.17$ ,  $p < .001$ ,  $d = .28$ . No other main or interactive effects were observed.

*Neuroticism.* No main or interactive effects were observed.

In the funnel debriefing, sixteen participants (7.9%) correctly guessed the hypothesis of the study. A guess was counted as correct if the participant mentioned that shirt color influenced either extraversion or openness (or any synonym related to those traits, e.g., enthusiastic, outgoing). After reanalyzing the data with these participants omitted, all significant effects reported above remained significant with one exception. The main effect of target sex on perceived agreeableness dropped below significance,  $F = 2.81$ ,  $p = .096$ .

## Discussion

The results of Experiment 3 are highly consistent with the results of the previous experiments. Varying the amount of chroma on targets' clothing changed how people perceived the targets' personality. Consistent with my hypotheses, higher chroma led to greater perceived extraversion and openness.

Some additional results were found in Experiment 3 that were not hypothesized. First, chroma failed to influence openness judgments for targets wearing red, which is consistent with the results from Experiment 2c. This could potentially be due to the association between high-chroma red and political conservatism (which is negatively correlated with openness; Carney, Jost, Gosling, & Potter, 2008). However, this would lead to the prediction that blue (a color associated with liberalism) would differ from red in openness judgments, which was not the case. Replicating these results across a wider array of hues would elucidate whether the absence of a chroma effect on openness judgments is unique to red, or if this extends to “warmer” colors in general (Mehrabian & Russell, 1974). Second, chroma increased perceived agreeableness for targets wearing green, but not red or blue. This may be due to the tendency for green to have generally positive associations (Clark & Costall, 2008; Moller, Elliot, & Maier, 2009), but I am hesitant to draw firm conclusions here due to the absence of this effect in Experiment 2a.

In general, target sex seemed to play a role in personality judgments, with males being rated as higher on extraversion, openness, and agreeableness than females. While this may reflect a difference in how the sexes are generally perceived, I am cautious about interpreting these results. Only nine faces of each target sex were rated, and there may be important differences (aside from sex) between the stimulus pictures. For example, it is possible that the male targets were generally more attractive than the female targets, which may have produced a halo effect (Dion, Berscheid, & Walster, 1972). There was also considerable variability in target facial structure, which has been shown to influence personality judgments (Penton-Voak et al., 2006; Rule & Ambady,



2011). The target-sex differences observed in Experiment 3 would need to be replicated across a much bigger stimulus set to draw any firm conclusions.

The stimulus pictures in Experiment 3 were all of Caucasian individuals facing forward with a neutral facial expression. This relatively narrow stimulus set has the advantage of safeguarding against possible confounds (e.g., ethnicity, facial expression, gaze direction). However, this comes at the expense of generalizing the results across different people and situations. It is quite possible that facial expression may moderate the effects of chroma documented herein, such that chroma may more strongly influence perceived extraversion and openness for someone who is smiling, but not frowning. Similarly, high-chroma red may increase perceived neuroticism when the target exhibits an angry face, relative to a neutral face. It may also be the case that chroma influences personality judgments more strongly for some ethnicities over others. The only way to know with any degree of certainty is to manipulate these variables and see how they interact with chroma when making judgments. Exploring these possibilities is feasible, as the Radboud Faces Database (Langer et al., 2010) includes stimulus pictures of various ethnicities with multiple facial expressions and gaze directions. This is beyond the scope of the present research, but it would be interesting to carry out in the future, nonetheless.

Experiment 3 extends the results of the previous experiments in several ways. First, it shows that chroma influences personality judgments in a more externally valid way. Clothing usually accompanies people in their daily lives, so the effects observed here more closely resemble impression formation as it occurs in the real world. Second, the extent to which hue moderates chroma's effect on personality judgments was

explicitly tested. The effect of chroma on extraversion judgments did not depend on hue, which indicates that literal colorfulness may be associated with figurative colorfulness across a wide spectrum of hues. The interaction between chroma and hue on perceived agreeableness indicates that there may be something particular about a high-chroma green that elicits perceptions of agreeableness. This poses interesting questions regarding how and why green carries a positive meaning in the domain of person perception. Third, Experiment 3 directly tested whether chroma affected same-sex and opposite-sex judgments in a similar fashion. In general, perceiver-target sex congruency did not moderate chroma effects on personality judgments. Fourth, the funnel debriefing in Experiment 3 showed that participants were generally not aware of the study hypotheses. While this is reassuring, replicating the results using a between-subjects chroma manipulation would provide further support.

The question remains whether chroma's influence on personality judgments is solely due to metaphoric transfer or if another factor such as societal conditioning may play a role. For example, it may be the case that we use high chroma words to think about concepts related to extraversion and openness, and as a result, perceiving high chroma on or near an individual activates the concepts of extraversion and openness. This activation may influence our judgment of others' personalities when little or no other information is available. Alternatively, it may be the case that extraverted and open individuals have a preference for high-chroma colors, which may increase the likelihood of these individuals wearing highly chromatic clothing, driving a colorful car, or decorating the walls of their homes with high-chroma colors. From repeated exposure to extraverted and open

individuals with high-chroma colors, people may learn to associate extraversion and openness with chroma, independent from the metaphorical use of chroma to describe these traits. I will shift my focus to this possibility in Studies 4 and 5 by investigating the degree to which personality traits are related to a preference for high and low-chroma colors, as well as a propensity to wear high or low-chroma colors in real life.

## Chapter 5: Study 4

The results obtained in the previous experiments suggest that people associate literal colorfulness (i.e., chroma) with figurative colorfulness (i.e., extraversion and openness). This association was present when making judgments about foreign words (Experiment 1) and people (Experiments 2 and 3). The effect of chroma on perceived extraversion and openness may be due to metaphoric transfer or it may have experiential origins. Specifically, it is possible that people high on extraversion and openness prefer high-chroma colors. It may follow that they are more likely to wear high-chroma clothing or decorate with high-chroma colors. If this is indeed the case, repeated observations of individuals who are extraverted and open with high-chroma colors may be responsible for the effects observed in Experiments 1-3. The goal of Study 4 is to test whether an association exists between individual personality traits and self-reported liking of high-chroma and low-chroma colors. Due to previous research indicating that extraverts tend to gravitate toward high-intensity stimuli (Eysenck & Eysenck, 1967; Ludvig & Happ, 1974), I hypothesized that higher scores on extraversion would be associated with increased liking toward high-chroma colors and decreased liking toward low-chroma colors. Based on the notion that openness is associated with aesthetic sensitivity and a desire for variety (Costa & McCrae, 1992a), I predicted that higher scores on openness would be associated with increased liking toward both high and low-chroma colors. Finally, I predicted that the other Big Five personality traits would be unrelated to color preferences.

## Method

*Participants and procedure.* Two hundred and sixty two participants (83 males) from the undergraduate research subject pool at the University of Rochester participated in the study for extra course credit.<sup>8</sup> Participants arrived at the laboratory to complete a study on color preferences, and they were seated at a computer where the duration of the study took place. Participants were shown several pairs of square color patches across a wide spectrum of hues, side-by-side, on a 19 inch CRT monitor. Each pair of color patches was equated on hue and lightness, such that the only dimension that varied within pairs was chroma (hue and lightness varied between pairs; see Appendix C for LCh values). Displayed directly underneath each color patch was the question, "How much do you like this color?" to which participants responded on a 1 (not at all) to 9 (very much) Likert-type scale. The order of the color patch presentation was randomized across participants. After rating each color, participants were redirected to an online survey that assessed their personality. Sensory-processing sensitivity and state affect were also measured to serve as covariates in the analysis.

*Measures.* The NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992b) was used to assess participants' personality. The NEO-FFI contains 60 items that are comprised of 5 subscales (12 items for each of the Big Five personality traits). Participants were instructed to indicate their level of agreement with each item (e.g., I like to have a lot of people around me) on a scale from 1 (strongly disagree) to 5

---

<sup>8</sup> Sample size was determined a priori by estimating the number of participants necessary to detect a cross-level interaction at .80 power.

(strongly agree). Internal reliability for each subscale was lower than what is typically found with this measure (Cronbach's  $\alpha = .65, .51, .71, .66, .71$  for extraversion, openness, agreeableness, conscientiousness, and neuroticism, respectively).

The Highly Sensitive Person scale (HSP; Aron & Aron, 1997) was used to assess participants' sensory-processing sensitivity (Cronbach's  $\alpha = .91$ ). Participants responded to 27 items (e.g., "Are you bothered by intense stimuli, like loud noises or chaotic scenes?") on a scale from 1 "not at all" to 7 "extremely." This measure was included because sensory-processing sensitivity is typically negatively correlated with extraversion (Aron & Aron, 1997). It is also reasonable to expect that highly sensitive individuals will have a preference for low-chroma colors, as low-chroma is less visually intense. Partialing out the effect of sensory-processing sensitivity will provide a clearer picture of how personality traits relate to color preferences.

The Positive Affect Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) assessed participants' state affect. Participants were instructed to indicate the degree to which they felt 20 emotions (e.g., interested, afraid) at the present moment on a scale from 0 "very slightly or not at all" to 5 "extremely." Cronbach's  $\alpha$  for positive and negative affect were .90 and .86, respectively. It may be the case that state affect influences color preferences (e.g., happier people show increased liking toward high-chroma colors), so controlling for this possibility enhances the rigor of this investigation.

## **Results**

I used multilevel modeling (HLM 6.0; Raudenbush, Byrk, & Congdon, 2004) to test the extent to which personality traits (controlling for sensory-processing sensitivity,

state affect, and sex) interact with chroma in the self-reported liking of colors. I created a three-level model in which repeated assessments of color likeability across levels of chroma (dummy coded; 1 = high-chroma, 0 = low-chroma) were modeled at level 1 (group-mean centered). Individual hues were modeled at level 2. Participants (with sex dummy coded; 1 = male, 0 = female), sensory-processing sensitivity, positive/negative affect, and each of the Big Five traits were modeled at level 3 (grand-mean centered). The intercepts at each level were treated as random effects (see equations below).

Level 1 model

$$Y = \pi_0 + \pi_1(\text{chroma}) + E$$

Level 2 model

$$\pi_0 = \beta_{00} + r_0$$

$$\pi_1 = \beta_{10}$$

Level 3 model

$$\begin{aligned} \beta_{00} = & \gamma_{000} + \gamma_{001}(\text{sex}) + \gamma_{002}(\text{hsp}) + \gamma_{003}(\text{positive affect}) + \gamma_{004}(\text{negative affect}) + \\ & \gamma_{005}(\text{neuroticism}) + \gamma_{006}(\text{extraversion}) + \gamma_{007}(\text{openness}) + \gamma_{008}(\text{agreeableness}) + \\ & \gamma_{009}(\text{conscientiousness}) + \mu_{00} \\ \beta_{10} = & \gamma_{100} + \gamma_{101}(\text{sex}) + \gamma_{102}(\text{hsp}) + \gamma_{103}(\text{positive affect}) + \gamma_{104}(\text{negative affect}) + \\ & \gamma_{105}(\text{neuroticism}) + \gamma_{106}(\text{extraversion}) + \gamma_{107}(\text{openness}) + \gamma_{108}(\text{agreeableness}) + \\ & \gamma_{109}(\text{conscientiousness}) \end{aligned}$$

The mean rating of color likeability across all participants, hues, and levels of chroma ( $\gamma_{000}$ ) was 5.15. There was a main effect of chroma,  $\gamma_{100} = .95$ ,  $t(4474) = 15.58$ ,  $p$

$< .001$ , such that high-chroma colors were generally liked more than low-chroma colors. There was also a main effect of openness,  $\gamma_{007} = .38$ ,  $t(252) = 2.71$ ,  $p = .008$ , indicating that higher scores on openness were associated with increased liking toward the color stimuli in general. No other main effects emerged, though several interactive effects were present, indicating that the effect of chroma on likeability ratings varied as a function of personality traits.

As hypothesized, the interaction between extraversion and chroma was significant,  $\gamma_{106} = .37$ ,  $t(4474) = 2.16$ ,  $p = .030$ . I conducted simple slopes analyses following the procedure recommended by Preacher, Curran, and Bauer (2006). Higher scores on extraversion predicted stronger liking of high-chroma colors ( $b = .56$ ,  $p = .014$ ), but extraversion did not predict liking of low-chroma colors ( $b = .19$ ,  $p = .23$ ; see Figure 8).

There was also an interaction between openness and chroma,  $\gamma_{107} = -.31$ ,  $t(4474) = -2.09$ ,  $p = .037$ . Simple slopes analyses revealed that higher scores on openness were associated with stronger liking of low-chroma colors ( $b = .39$ ,  $p = .008$ ), but not high-chroma colors ( $b = .07$ ,  $p = .72$ ; see Figure 9).

An unexpected interaction between conscientiousness and chroma emerged,  $\gamma_{109} = .49$ ,  $t(4474) = 3.34$ ,  $p = .001$ . Higher conscientiousness was associated with stronger liking of high chroma colors ( $b = .49$ ,  $p = .012$ ), but not low chroma colors ( $b = .02$ ,  $p = .88$ ).

Although not of central interest to my hypotheses, each of the control variables in the model moderated the effect of chroma on color likeability ratings. The slope for



sensory-processing sensitivity was different across levels of chroma,  $\gamma_{102} = -.19$ ,  $t(4474) = -2.65$ ,  $p = .008$ . Individuals who were high on sensitivity liked high-chroma colors less than individuals who were low on sensitivity ( $b = -.12$ ), and the opposite pattern was observed for low-chroma colors ( $b = .09$ ). However, neither of the simple slopes significantly differed from zero ( $ps > .14$ ).

The slope for negative affect also differed across levels of chroma,  $\gamma_{104} = -.03$ ,  $t(4474) = -2.49$ ,  $p = .013$ . Descriptively, negative affect was negatively related to liking high-chroma colors ( $b = -.026$ ), but not low-chroma colors ( $b = .002$ ), though neither of the simple slopes were significantly different from zero ( $ps > .19$ ).

Finally, participant sex interacted with chroma,  $\gamma_{101} = .85$ ,  $t(4474) = 6.33$ ,  $p < .001$ . Men liked high-chroma colors more than women ( $b = .64$ ,  $p = .001$ ), and men liked low-chroma colors less than women ( $b = -.21$ ,  $p = .09$ ; see Figure 10)<sup>9</sup>.

## Discussion

Study 4 provides evidence that extraversion and openness are related to color preferences, though several unexpected effects were also found. My hypothesis that higher scores on extraversion would be associated with a stronger preference for high-chroma colors was supported by the data. This association was present when controlling for the effects of the other Big Five personality traits, sensory-processing sensitivity, positive/negative affect, and sex. However, higher scores on extraversion did not predict decreased liking of low-chroma colors, contrary to my expectations. This pattern of

---

<sup>9</sup> In ancillary analyses, I tested whether any of the two-way interactions in the model were moderated by sex. None of the three-way interactions were significant ( $ps > .64$ ).

results suggests that introverts and extraverts differ in their preference for high-intensity visual stimuli, but not for low-intensity visual stimuli.

My hypothesis that higher scores on openness would predict a greater liking toward the color stimuli in general was supported, which is consistent with the trait of openness being associated with aesthetic sensitivity and a desire for diversity (Costa & McCrae, 1992). Interestingly, this effect was mostly driven by an increase in low-chroma likeability ratings. It seems that people generally prefer high-chroma colors over low-chroma colors, but this difference is less pronounced for people high in openness.

An unexpected effect of conscientiousness emerged, such that higher conscientiousness was associated with more likeability of colors that were high, but not low, in chroma. It is difficult to speculate as to why this pattern emerged, as there is no obvious explanation for the relationship between conscientiousness and colorfulness.

An unexpected sex difference was observed, such that men liked high-chroma colors more (and low-chroma colors less) than women. This was the case when controlling for personality variables and positive/negative affect. While this result is of no theoretical relevance to the hypotheses of the study, it remains interesting nonetheless. Gender norms in American culture emphasize boldness/assertiveness for men, but not for women (Eagly, 1987). Men may prefer high-chroma colors (and dislike low-chroma colors) because high-chroma is metaphorically congruent with male gender roles. Future research investigating the degree to which high-chroma colors are associated with masculinity (and low-chroma with femininity) would shed some light on the observed sex differences in color preferences.

The results obtained in Study 4 are consistent with previous findings that suggest extraverts and introverts react differently to high-intensity stimuli. Extraverts have been shown to prefer loud environments (Ludvigh & Happ, 1974) and have a weaker reaction to gustatory stimulation (Eysenck & Eysenck, 1967) and bright lights (Ludvigh & Happ, 1974). The present research shows that extraverts also like high-intensity colors, relative to introverts; this effect cannot be explained by differences in sensory-processing sensitivity. While the difference in color preferences between extraverts and introverts is potentially a result of varying baseline levels of cortical arousal (Eysenck, 1967), more research is necessary before drawing conclusions about why these differences in color preferences exist. High-chroma colors are verbally described as intense, yet it remains unknown whether this visual intensity has any impact on human physiology.

The color stimuli in Study 4 consisted of a wide array of hues with various degrees of lightness. This suggests that the effects documented herein are not specific to any particular color, but may be generalized across colors. Moderation analyses testing whether these effects are stronger for certain hues would not be informative because hue and lightness varied across color pairs. Conducting a study that holds lightness constant across all pairs of color patches would be necessary to test for moderation by hue. However, this would be an extremely difficult task, as some colors are inherently much lighter than others (e.g., yellow). Holding lightness constant would likely produce color stimuli that are not ideal representations of certain hues. For example, the yellow hue used in Study 4 resembled the color of a lemon, which is a very prototypical yellow. Adjusting the lightness to match that of the other color stimuli would produce a yellow

that looks more like Dijon mustard, which is more of a brownish-yellow. Using color stimuli that deviates from prototypical color categories may not be ideal in testing hypotheses regarding color preferences.

Although the results from Study 4 provide evidence that color preferences differ as a function of extraversion and openness, it remains unclear whether this translates into wearing high or low-chroma colors in everyday life. Study 5 aims to address this lingering question by investigating whether personality traits influence the amount of chroma in peoples' clothing.

## Chapter 6: Study 5

Study 5 investigated the degree to which personality traits, specifically extraversion and openness, predict the level of chroma on individuals' clothing in real life. Due to the association between extraversion and high-chroma, along with extraverts' greater liking of high-chroma colors, I hypothesized that extraverts would wear more chromatic colored clothing than their introverted counterparts. Due to the association between openness and increased liking toward colors in general (particularly low-chroma colors), I predicted that there would be more variability in chroma for people high on openness, relative to people low on openness. Finally, I predicted that agreeableness, conscientiousness, and neuroticism would be unrelated to the chroma content of individuals' clothing.

### Method

*Participants and procedure.* Two hundred and sixty eight participants were recruited from the University of Rochester undergraduate research pool.<sup>10</sup> The study was described as investigating the degree to which the change of seasons influences human facial expressions in order to conceal the hypotheses. Participants came to the lab across an 11-week span during the spring semester to have their picture taken. Each photograph was taken from the waist up under standardized lighting conditions against a plain black background. Participants were instructed to stand straight and smile naturally while their picture was taken. Following the picture session, participants' personality was assessed via a computerized survey. Participants were invited back to complete a second picture

---

<sup>10</sup> The target sample size was equivalent to that of Study 4.

session 15 days or later after their first session. Of the 268 participants who completed the first session, 171 attended the second session.

*Measures.* The NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992b) was used to assess participants' personality. Internal reliability for each subscale was good (Cronbach's  $\alpha = .80, .69, .74, .84, .87$  for extraversion, openness, agreeableness, conscientiousness, and neuroticism, respectively).

*Clothing color measurements.* Two research assistants independently coded each participant's clothing color from the waist up. Due to most clothing items being multicolored, coders were instructed to select only the color that was most prominent (see Elliot & Pazda, 2012, for a similar procedure). In cases where two colors were equally prominent, coders were instructed to select the color closest to the participant's body (e.g., shirts took precedent over jackets). Inter-coder agreement was excellent ( $\kappa = .82$ ), and a third coder resolved any discrepancies.

After all participant pictures were coded for the most prominent color, two separate research assistants measured the spectral properties of each color in CIELAB space using Adobe Photoshop CS5. Colors were measured by selecting a 30 x 30 pixel sample using the eyedropper tool. Color measurements across coders were extremely similar ( $r = .98$ ). CIELAB values were then converted to CIELCH values using the formula provided by Lindbloom (2015). Chroma and lightness values for each picture were averaged across coders. Chroma values were strongly positively skewed (skewness = 1.88, standard error = .12) and were thus log-transformed to achieve a normal distribution.

## Results

I used multilevel modeling (HLM 6.0; Raudenbush, Byrk, & Congdonc, 2004) to examine the extent to which participants' personality traits predicted the level of chroma in their clothing. Due to the timing of data collection (starting in the winter and ending in the spring), I anticipated that time of season may also influence the degree of chroma on clothing. Spring colors are typically more chromatic than winter colors, so I modeled time of season (in weeks; group-mean centered) at level 1. The level 2 variables included each of the Big Five personality traits and participant sex (dummy coded; 1 = male; 0 = female). All level 2 variables were grand-mean centered, and the intercept was treated as a random effect (see equations below).

### Level 1 model

$$\text{chroma} = \pi_0 + \pi_1(\text{time}) + E$$

### Level 2 model

$$\begin{aligned} \pi_0 &= \beta_{00} + \beta_{01}(\text{sex}) + \beta_{02}(\text{extraversion}) + \beta_{03}(\text{openness}) + \beta_{04}(\text{neuroticism}) + \\ &\quad \beta_{05}(\text{agreeableness}) + \beta_{06}(\text{conscientiousness}) + r_0 \\ \pi_1 &= \beta_{10} + \beta_{11}(\text{sex}) + \beta_{12}(\text{extraversion}) + \beta_{13}(\text{openness}) + \beta_{14}(\text{neuroticism}) + \\ &\quad \beta_{15}(\text{agreeableness}) + \beta_{16}(\text{conscientiousness}) \end{aligned}$$

Contrary to my hypothesis, the predicted effect of extraversion was not significant,  $\beta_{02} = -0.04$ ,  $t(260) = -.62$ ,  $p = .54$ , indicating that higher extraversion was not associated with higher chroma on clothing. Also contrary to my prediction, time of season was not at all associated with level of chroma on clothing,  $\beta_{10} = .00$ . None of the

other predictors in the model reached significance, and no interactive effects were observed (see Table 1).<sup>11</sup>

To test whether higher openness was associated with more variability in chroma, I dichotomized the data into individuals who scored + 1 standard deviation or higher on openness and - 1 standard deviation or lower on openness. I then conducted a Levene's test for equality of variances on the untransformed chroma values (averaged across picture sessions) for these two groups. The test yielded a significant result,  $F = 7.49$ ,  $p = .007$ . Inspection of the variances for each group indicated that there was more variance in chroma for individuals low in openness ( $\sigma^2 = 460.96$ ) than individuals high in openness ( $\sigma^2 = 162.56$ ), which is inconsistent with my prediction. A Levene's test on the transformed chroma values yielded similar results ( $F = 3.58$ ,  $p = .06$ ).

## Discussion

My hypotheses in Study 5 were not supported by the data. Extraversion was not related to the degree of chroma on participants' clothing. Time of season was also unrelated to amount of chroma on participants' clothing. Finally, contrary to my hypothesis, openness was inversely related to the variability of chroma in participants' clothing.

There are a variety of factors that may be responsible for the null results in Study 5. The biggest problem is the general lack of variance in chroma on participants' clothing. Fifty-four percent of the photographs across both picture sessions contained a chroma

---

<sup>11</sup> In ancillary analyses, I examined the pictures from the first photo session and second photo session separately. The pattern of results was similar (and non-significant) for each session. I also conducted the reported analyses on the untransformed chroma values, which yielded extremely similar results.



value of 10 or less, indicating that the most prominent color in over half of the photographs was black, white, or gray. Twenty-five percent of the photographs had a chroma value between 10 and 20, which is slightly more colorful than gray, but extremely muted nonetheless. Ultimately, about 75% of the photographs in the study had virtually no chroma. The decision to code only the most prominent color on each individual's clothing was made a priori and based on previous research (Beall & Tracy, 2013; Elliot & Pazda, 2012). However, in hindsight, this approach may not have been ideal. Coding only one color leaves out other information that may tell more of the story. For example, one could imagine an individual wearing a white and green striped shirt, with the white stripes being slightly thicker than the green ones. This individual's shirt would get coded as white (with a chroma value of zero), even though the shirt may in fact have a high amount of chroma within the green stripes. Coding (and perhaps averaging) both colors in this hypothetical instance would provide more accuracy and variability in chroma measurements.

Another limitation of Study 5 is that all of the participants were college students. This limitation is typical in psychology research, but it may be particularly problematic when investigating aspects of individuals' attire. The first problem with a college student sample is that many students frequently wear school colors on campus. The primary University of Rochester color is navy blue, which happens to be extremely low in chroma. Additionally, black, which contains no chroma, is a highly popular and frequently worn color (Elliot & Pazda, 2012; Pazda et al., 2014). This may partially explain why the overall chroma values were so low across the sample. The second

problem is that college students' motivation to express their personality through clothing color may not be as strong when attending a relatively non-social activity (i.e., participating in a research study). Obtaining photographs in a more social area may be optimal when investigating how personality traits affect self-presentation.

On a similar note, situational factors may be necessary for individuals to utilize clothing color to express their personality. The sender effects of color that were reviewed in the introduction (i.e., women wearing red to indicate romantic or sexual interest) depended on various circumstances. Most notably, women were more likely to wear red clothing when the probability of encountering a potential mate was relatively high, but not low (Prokop & Hromada, 2013). In other words, the signal value of red was only relevant when there was an appropriate perceiver present. If we extend this logic to the hypotheses of Study 5, it may be the case that extraverted individuals wear highly chromatic clothing only when the motivation to nonverbally communicate one's personality is advantageous. If people are planning on interacting mostly with others with whom they are well-acquainted, there may be little to no thought into what they wear. However, if expecting to interact with people who are relatively less-known (e.g., a first date, freshman orientation, etc.), people may be motivated to present themselves more in line with their personality, which may include high (or low) chroma for extraverts (or introverts).

## Chapter 7: General Discussion

Across 5 studies, I tested several hypotheses under the general umbrella of how the chroma dimension of color relates to human perceptions, preferences, and behavior. In Experiment 1, I found that when participants judged foreign words, chroma influenced the perceived meaning of those words. When printed in high-chroma text, foreign words were assumed to have a meaning associated with extraversion and openness, relative to agreeableness, conscientiousness, and neuroticism. In Experiment 2, I found that when judging others' personality in zero-acquaintance situations, individuals who were surrounded by high-chroma borders were generally perceived as more extraverted and open than the same individuals surrounded by low-chroma borders. In Experiment 3, I found that individuals wearing highly chromatic clothing were perceived as more extraverted and open than individuals wearing less chromatic clothing. Study 4 provided evidence that extraversion is associated with increased liking toward high-chroma colors, and openness is associated with increased liking toward low-chroma colors. However, the results of Study 5 suggest that the relationship between personality traits and color preferences did not extend to individuals' selection of clothing color in real life.

The results from Experiments 1-3 add to a growing literature on how color affects human psychological functioning. It is not the case that metaphors linking literal colorfulness to figurative colorfulness are merely semantic devices that help us talk about people. Rather, literal colorfulness actually influences how we think about other people. This may have nontrivial real-world implications. For example, there are a variety of occupations in which success may depend on having certain personality traits.

Salespeople, waiters, and marketers, which extraverts seem to be best suited as, may be perceived as more competent if wearing highly chromatic clothing. The opposite may be the case for librarians, computer programmers, and statisticians, which are positions that are stereotypically held by introverts. Likewise, individuals who subscribe to web-dating services, where zero-acquaintance impressions are ubiquitous, may attract people with a similar personality by choosing attire with the appropriate amount of chroma. While these possibilities are speculative, future research investigating whether chroma influences perceived competence or general likeability (mediated by perceived personality traits) would be informative.

Research on color preferences has a long history, but, to my knowledge, Study 4 in the present research is the first to investigate how personality traits explicitly relate to a preference for high and low-chroma colors (with chroma being manipulated while holding hue and lightness constant). Extraverts' affinity for high-intensity color stimuli is consistent with their inclination to seek arousal in other domains (Eysenck & Eysenck, 1967; Ludvig & Happ, 1974). Interestingly, the relationship between extraversion and a preference for high-chroma was present when controlling for the effect of sensory-processing sensitivity, despite the tendency for these to be highly negatively correlated (Aron & Aron, 1997). There is a great deal of conceptual overlap between Eysenck's (1967) hypothesis that extraverts have lower levels of cortical arousal with the evidence that extraverts are less sensitive in the sensory domain (Aron & Aron, 1997). However, the results from Study 4 suggest that these may be distinct phenomena, and future research addressing precisely how they differ would be worthwhile.

## Limitations

The present research contributes to our understanding of how color influences impression formation, but there are several limitations that warrant attention. First, the chroma manipulations in Experiments 1-3 were all administered within subjects. Demand characteristics of within-subjects designs may raise awareness of the study hypotheses, which may subsequently influence participant responses. Indeed, nearly 8% of participants correctly guessed the hypothesis in Experiment 3. While these participants did not seem to be driving the observed effects, it is very possible that even more participants were aware of the hypothesis, but failed to mention so during the funnel debriefing. Utilizing a between-subjects study design would circumvent this issue because participants would only be exposed to one level of chroma. This would dramatically reduce making color intensity a salient feature of the study. On a similar note, it is possible that the effect sizes reported herein would be smaller when using a between-subjects design. When participants rated multiple targets with varying degrees of chroma, they had a basis for comparison. It might be the case that the effect of chroma on perceived extraversion is stronger when rating people in high *and* low-chroma during the same judgment task. If only making judgments of others in high *or* low-chroma, but not both, people may rely less on color cues to form impressions. Utilizing between-subjects study designs would provide more information regarding the size of chroma effects on personality judgments.

A second limitation of the present research is that all personality judgments were self-reported after receiving explicit instructions to form an impression about each target.

This raises the question of whether chroma's influence on perceived personality is spontaneous or deliberative. A multitude of studies have documented differences between unintentional and intentional trait inferences (Uleman & Saribay, 2012). Unintentional, or spontaneous trait inferences (STIs; Uleman, 1999) occur when someone attends to another person without the goal of forming an impression. These inferences are guided by constructs that are easily accessible in the mind. Intentional trait inferences are thoughtful, deliberative judgments with the specific goal of forming an impression (e.g., an unstructured job interview). In Experiment 3, targets wearing high chroma may have been perceived as more extraverted because participants made an assumption about the targets' motivation to wear high-chroma (e.g., they want to be noticed or approached), which would fall under the deliberate category. This cognition was likely absent in Experiment 2, as border colors are not something that targets would be presumed to have control over, making spontaneous inferences more likely. Future research that addresses implicit associations between extraversion/openness with chroma would provide information regarding the automaticity of these effects.

Another limitation of the present research is that the samples were comprised nearly entirely of individuals residing in Western countries, which limits the generalizability of these findings across cultures. It is conceivable that chroma may influence perceived personality traits differently in Eastern cultures, where social norms and desirable personality traits differ from those in Western cultures (Ward & Chang, 1997). For example, wearing high-chroma may be perceived as deviating from social norms, which may decrease perceived agreeableness or conscientiousness in East Asia

(Kim & Markus, 1999). Moreover, previous research has shown that Western cultures tend to make spontaneous trait inferences more than Eastern cultures (Na & Kitayama, 2011). Thus, cultural differences may be more pronounced if chroma's effect on perceived personality is indeed an automatic process. On a similar note, all of the targets in Experiments 2 and 3 were Caucasian individuals, which limits the generalizability of the results across ethnicities. It may be the case that chroma influences the degree of perceived extraversion for Caucasian targets in a different manner than Asian targets, as collectivism (a cultural variable typical of Asian cultures) is strongly correlated with introversion (Hofstede & McCrae, 2004).

### **Future directions**

The results of these studies indicate that chroma influences impression formation in a manner consistent with chroma metaphors, but the origins of these effects remain unknown. Is it the case that language is responsible for thinking about figurative colorfulness in terms of literal colorfulness, or might the overlap in language be a result of underlying conceptual similarities? In other words, are color metaphors in language a necessary condition for chroma to influence person perception? One possible way to answer this question is to study whether the effects documented herein are also present in societies with a language that lacks chroma metaphors. It is conceivable that there is a language with various synonyms for extraversion, but none of which overlap with literal colorfulness. If the chroma effects observed with English speaking participants fail to replicate with participants who speak this language (assuming it exists), this would provide evidence that metaphors are a prerequisite for the observed chroma effects.

However, if the chroma effects do indeed replicate across languages, this would suggest that the conceptual similarities between literal and figurative colorfulness are sufficient to influence the judgment making process.

Examining the degree to which chroma influences behavior seems like a logical next step of the research presented herein. Wearing a high-chroma color, for example, may influence how the person donning the color behaves, and it may also influence how others behave toward that person. With regard to the former, self-perception theory (Bem, 1967) would predict that people wearing high-chroma may think of themselves as relatively extraverted. This is because we tend to make inferences about ourselves based on observations about our own behavior. Wearing a colorful shirt may lead someone to infer that they want to be noticed, approached, and interacted with, which may elicit behavior that does just that. Examining whether people behave in a more extraverted manner when wearing more chromatic clothing would shine light on this possibility.

A number of studies have documented an effect known as behavioral confirmation (Snyder, Tanke, & Berscheid, 1977), whereby initial expectations about someone influence behavior toward that person (which subsequently elicits the expected behavior). If people perceive others wearing high-chroma clothing as extraverted, they may act in a more outgoing and friendly manner toward them. This behavior may cause reciprocal actions, such that people donning high-chroma colors actually act more extraverted than individuals donning low-chroma colors. Indeed, research has shown that when people are given explicit information about an individual's level of extraversion, they actively seek information that confirms their preexisting beliefs (Snyder & Swann,



1978). Investigating whether the amount of chroma on one's clothing elicits behavior from others that confirms the expectation of extraversion would be enlightening.

The results of Study 4 raise interesting new research questions in the domain of consumer behavior. Exploring how personality traits impact decisions to purchase goods in certain colors or shop at certain stores may be fruitful. Similarly, investigating how attitudes toward brands with colorful logos varies as a function of personality would be equally interesting. On an applied level, retailers that typically feature highly chromatic colors (e.g., Express, Old Navy) may fail to take advantage of their introverted customers' color preferences. Likewise, retailers that sell goods in a restricted range of colors (e.g., White House, Black Market) may be less appealing to customers high in openness.

### **Implications for color psychology**

The present research adds to our knowledge of how color, specifically chroma, can influence human psychological functioning. While this may provide a springboard into new areas of inquiry, it also raises some questions regarding the previously documented effects in the domain of color psychology.

*Does chroma moderate hue effects?* The chroma dimension of color essentially refers to the amount of hue content in a stimulus. The more chromatic the color, the more colorful it appears. With regard to hue meanings, it seems reasonable to expect that chromaticity may affect the strength of relationship between a given hue and its associated meaning. For example, in achievement contexts, a high-chroma red may be more strongly associated with failure than a low-chroma red. Similarly, in romantic contexts, a high-chroma red may be more strongly associated with romance than a low-

chroma red. This strength of association difference may lead to different outcomes when perceiving red in various contexts. Specifically, perceiving high-chroma red in achievement contexts may undermine performance more than perceiving low-chroma red (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007). Likewise, in affiliative contexts, individuals wearing high-chroma red may be perceived as more attractive than individuals wearing low-chroma red (Elliot & Niesta, 2008; Pazda et al., 2012). This may especially be the case for women perceiving red on men, as high-chroma red may carry an explicitly different meaning (e.g., dominance) than low-chroma red (e.g., femininity).

The overwhelming majority of research investigating hue effects has used color stimuli that are highly chromatic (Lichtenfeld, Elliot, Maier, & Pekrun, 2012; Pazda, Prokop, & Elliot, 2014). The most typical study design involves making one of the three following comparisons: (a) comparing a high-chroma hue of interest (e.g., red) to another high-chroma control color (e.g., blue, green), (b) comparing a high-chroma hue of interest to an achromatic control color equated on lightness (i.e., gray), and (c) comparing a high-chroma hue of interest to an achromatic control color not equated on lightness (i.e., black, white). The first type of comparison is the most rigorous, as it allows researchers to make claims about hue effects because lightness and chroma are held constant. The second type of comparison is less rigorous because any result may be a hue effect or a chroma effect. The last type of comparison is far less rigorous because any result could be potentially due to hue, chroma, or lightness. If researchers find similar results from methods (a) and (b), they commonly interpret this as evidence of a hue effect. However, it is conceivable that there may actually be multiple effects at work: one

for hue, another for chroma, plus their interaction. Future research investigating hue effects would do well to include a comparison condition that varies chroma while holding hue and lightness constant. This would allow any main or interactive effects of chroma to be explicitly tested.

*Does lightness moderate chroma effects?*

The lightness dimension of color has been paid little attention in empirical work. Most of the research investigating lightness effects has focused solely on black, white, and gray stimuli (Frank & Gilovich, 1988; Meier et al., 2004; 2007), meaning lightness is typically studied without the presence of chroma. It remains unclear whether lightness may influence any of the effects obtained in the present studies (or previously published research on hue effects). It is conceivable that high-chroma colors that are also high on lightness may affect perceptions differently from high-chroma colors that are low in lightness. Future research that systematically varies all three color properties to investigate how each contributes to human psychological functioning would be extremely informative. Unfortunately, this is not an easy task, as equating color stimuli on spectral properties is tremendously labor intensive. Moreover, color stimuli can only be equated if the color gamut of the monitor used to display the stimuli is sufficiently large (it may be impossible for some monitors to display colors at the higher ends of the chroma and lightness spectrums). Additionally, the number of participants necessary to run high-powered studies with multiple color manipulations would increase dramatically.

## **Concluding remarks**

In conclusion, the present research makes a novel contribution to our understanding of psychological processes in three ways. First, it adds to the body of work on conceptual metaphors by documenting the tendency for people to think about abstract personality traits in terms of literal colorfulness. Comparing personality to the perceptual experience of seeing color helps simplify an incredibly complex psychological construct. Second, it reveals a nonintuitive variable (chroma) that people utilize when forming impressions of others. Whether chroma's influence on person-perception is an automatic or controlled process, it nevertheless impacts how we perceive others' personality in zero-acquaintance situations. Finally, and most importantly, the present research draws awareness to a dimension of color to which little attention (theoretical or empirical) has been paid. Burgeoning research in the domain of color psychology has provided evidence that color is more than meets the eye; it can affect human psychological functioning in subtle, yet meaningful ways. Most of the research questions in this domain have focused on colors as categories (e.g., what is the effect of red, relative to other colors, on attractiveness?). However, a categorical conceptualization of color may be overly narrow when formulating hypotheses, as it neglects the chroma and lightness dimensions. It is my hope that this work will draw attention to new research questions that consider color as a multidimensional construct (e.g., at which levels of chroma and lightness does red produce the strongest effect?), and that each dimension may have unique effects on human psychological functioning.

## References

- Adams, R. (1987). An evaluation of color preference in early infancy. *Infant Behavior and Development, 10*, 143-150.
- Albright, L., Kenny, D. A., & Malloy, T. E. (1988). Consensus in personality judgments at zero acquaintance. *Journal of Personality and Social Psychology, 55*, 387-395.
- Alexander, G. M. (2003). An evolutionary perspective of sex-typed toy preferences: pink, blue, and the brain. *Archives of sexual behavior, 32*, 7-14.
- Alexander, K. R., & Shansky, M. S. (1976). Influence of hue, value, and chroma on the perceived heaviness of colors. *Perception and Psychophysics, 19*, 72-74.
- Ambady, A., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin, 111*, 256-274.
- Aron, E. N. & Aron, A. (1997). Sensory-processing sensitivity and its relation to introversion and emotionality. *Journal of Personality and Social Psychology, 73*, 345-368.
- Bar, M., Neta, M., & Linz, H. (2006). Very first impressions. *Emotion, 6*, 269-278.
- Barrett, D. M., & Eaton, E. B. (1947). Preference for color or tint and some related personality data. *Journal of Personality, 223-232*.
- Beall, A. T. & Tracy, J. L. (2013). Women are more likely to wear red or pink at peak fertility. *Psychological Science, 24*, 1837-1841.
- Bem, D. J. (1967). Self-perception: An alternative interpretation of cognitive dissonance phenomena. *Psychological Review, 74*, 183-200.

- Boothroyd, L. G., Cross, C. P., Gray, A. W., Coombes, C., & Gregson-Curtis, K. (2011). Perceiving the facial correlates of sociosexuality: Further evidence. *Personality and Individual Differences, 50*, 422-425.
- Borkenau, P., Brecke, S., Möttig, C., & Paelecke, M. (2009). Extraversion is accurately perceived after a 50-ms exposure to a face. *Journal of Research in Personality, 43*, 703-706.
- Brebner, J., & Cooper, C. (1978). Stimulus or response induced excitation: A comparison of the behavior of introverts and extraverts. *Journal of Research in Personality, 12*, 306-311.
- Bullivant, S. B., Sellergren, S. A., Stern, K., Spencer, N. A., Jacob, S., Mennella, J. A., & McClintock, M. K. (2004). Women's sexual experience during the menstrual cycle: Identification of the sexual phase by noninvasive measurement of luteinizing hormone. *Journal of Sexual Research, 41*, 82-93.
- Burkitt, E., Tala, K., & Low, J. (2007). Finnish and English children's color use to depict affectively characterized figures. *International Journal of Behavioral Development, 31*, 59-64.
- Camgöz, N., Yener, C., & Güvenç, D. (2002). Effects of hue, saturation, and brightness, on preference. *Color Research and Application, 27*, 199-207.
- Campbell, J. B., & Hawley, C. W. (1982). Study habits and Eysenck's theory of extraversion introversion. *Journal of Research in Personality, 16*, 139-146.
- Carney, D. R., Jost, J. T., Gosling, S. D., & Potter, J. (2008). The secret lives of liberals

- and conservatives: Personality profiles, interaction styles, and the things they leave behind. *Political Psychology*, 29, 807-840.
- CIE. (2011). *ILV: International Lighting Vocabulary*, CIE Standard S 017.
- Clarke, T., & Costall, A. (2008). The emotional connotations of color: a qualitative investigation. *Color Research and Application*, 33, 406-410.
- Costa, P. T., Jr & McCrae, R. R. (1992a). Four ways five factors are basic. *Personality and Individual Differences*, 13, 653-665.
- Costa, P. T., Jr & McCrae, R. R. (1992b). *Revised NEO Personality Inventory (NEO-PI R) and NEO Five-Factor Inventory (NEO-FFI) professional manual*. Odessa, FL: Psychological Assessment Resources.
- DeCoster, J., & Claypool, H. M. (2004). A meta-analysis of priming effects on impression formation supporting a general model of informational biases. *Personality and Social Psychology Review*, 8, 2-27.
- Dennerstein, L., Gotts, G., Brown, J., Morse, C., Farley, T., & Pinol, A. (1994). The relationship between the menstrual cycle and female sexual interest in women with PMS complaints and volunteers. *Psychoneuroendocrinology*, 19, 293-304.
- Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of Personality and Social Psychology*, 24, 285-290.
- Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation*. Hillsdale, NJ: Erlbaum.
- Elliot, A. J. (2015). Color and psychological functioning: a review of theoretical and empirical work. *Frontiers in Psychology*, 6:368. doi: 10.3389/fpsyg.2015.00368.

- Elliot, A. J., Greitemeyer, T., & Pazda, A. D. (2013). Women's use of red clothing as a sexual signal in intersexual interaction. *Journal of Experimental Social Psychology, 49*, 599– 602.
- Elliot, A. J., & Maier, M. A. (2012). Color-in-context theory. *Advances in Experimental Social Psychology, 45*, 61–126.
- Elliot, A. J., & Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology, 65*, 95-120.
- Elliot, A. J., Maier, M. A., Moller, A. C., Friedman, R., & Meinhardt, J. (2007). Color and psychological functioning: The effect of red on performance attainment. *Journal of Experimental Psychology: General, 136*, 154-168.
- Elliot, A. J., & Niesta, D. (2008). Romantic red: Red enhances men's attraction to women. *Journal of Personality and Social Psychology, 95*, 1150-1164.
- Elliot, A. J., Niesta Kayser, D., Greitemeyer, T., Lichtenfeld, S., Gramzow, R. H., Maier, M.A., & Liu, H. (2010). Red, rank, and romance in women viewing men. *Journal of Experimental Psychology: General, 139*, 399-417.
- Elliot, A. J., & Pazda, A. D. (2012). Dressed for sex: Red as a female sexual signal in humans. *PLoS ONE, 7*, e34607.
- Eysenck, H. J. (1941a). Personality factors and preference judgments. *Nature, 148*, 346.
- Eysenck, H. J. (1941b). *'Type'-factors in aesthetic judgments*. London: Cambridge University Press.
- Eysenck, H. J. (1967). *The biological basis of personality*. Boston, MA: Thomas.



- Eysenck, B. G., & Eysenck, H. J. (1967). Salivary response to lemon juice as a measure of introversion. *Perceptual and Motor Skills*, 24, 1047-1053.
- Fairchild, M.D. (2013). *Color Appearance Models, 3rd Edition*. Chichester, UK: Wiley-IS&T Series in Imaging Science and Technology.
- Fairchild, M. D. (2014). Color models and systems. In A. Elliot & M. Fairchild (Eds.), *Handbook of Color Psychology*. Cambridge University Press.
- Fetterman, A. K., Liu, T., & Robinson, M. D. (2015). Extending color psychology to the personality realm: Interpersonal hostility varies by red preferences and perceptual biases. *Journal of Personality*, 83, 106-116.
- Fetterman, A. K., Robinson, M. D., & Meier, B. P. (2012). Anger as seeing red: Evidence for a perceptual association. *Cognition & Emotion*, 26, 1445-1458.
- Fetterman, A. K., Robinson, M. D., Gordon, R. D., & Elliot, A. J. (2011). Anger as seeing red: Perceptual sources of evidence. *Social Psychological and Personality Science*, 2, 311-316.
- Fortmann-Roe, S. (2013). Effects of hue, saturation, and brightness on color preference in social networks: Gender-based color preference on the social networking site Twitter. *Color Research and Application*, 38, 196-202.
- Frank, M. G., & Gilovich, T. (1988). The dark side of self- and social perception: Black uniforms and aggression in professional sports. *Journal of Personality and Social Psychology*, 54, 74-85.
- Goldstein, K. (1939). *The organism*. New York: American Book Company.

- Goldstein, K. (1942). Some experimental observations concerning the influence of colors on the function of the organism. *Occupational Therapy*, 21, 147-151.
- Gosling, S. D., Ko, S. J., Mannarelli, T., & Morris, M. E. (2002). A room with a cue: Personality judgments based on offices and bedrooms. *Journal of Personality and Social Psychology*, 82, 379-398.
- Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the big-five personality domains. *Journal of Research in Personality*, 37, 504-528.
- Greenfield, A. B. (2005). *A perfect red: Empire, espionage, and the quest for the color of desire*. New York: Harper Collins.
- Guéguen, N. (2008). The effects of women's cosmetics on men's approach: an evaluation in a bar. *North American Journal of Psychology*, 10, 221-228.
- Guéguen, N. (2010). Color and women hitchhikers' attractiveness: Gentlemen drivers prefer red. *Color Research and Application*, 37, 76-78.
- Guéguen, N. (2012a). Does red lipstick really attract men? An evaluation in a bar. *International Journal of Psychology Studies*, 4, 206-209.
- Guéguen, N. (2012b). Makeup and menstrual cycle: Near ovulation, women use more cosmetics. *Psychological Record*, 62, 1-8.
- Guéguen, N. & Jacob, C. (2011). Enhanced female attractiveness with use of cosmetics and male tipping behavior in restaurants. *Journal of Cosmetic Science*, 62, 283-290.

- Guéguen, N. & Jacob, C. (2012), Color and cyber-attractiveness: Red enhances men's attraction to women's internet personal ads. *Color Research and Application*, 38, 309-312.
- Guéguen, N. & Jacob, C. (2014). Clothing color and tipping: Gentlemen patrons give more tips to waitresses with red clothes. *Journal of Hospitality & Tourism Research*, 38, 275-280.
- Guéguen, N., Jacob, C., Lourel, M., & Pascual, A. (2012). When drivers see red: Car color frustrators and drivers' aggressiveness. *Aggressive Behavior*, 38, 166-169.
- Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior*, 49, 509–518.
- Hofstede, G., & McCrae, R. R. (2004). Personality and culture revisited: Linking traits and dimensions of culture. *Cross-Cultural Research*, 38, 52-88.
- Hurlbert, A. C., & Ling, Y. (2007). Biological components of sex differences in color preference. *Current Biology*, 17, R623-R625.
- Hyunjin, S., Vonasch, A., Meier, B. P., & Bargh, J. A. (2012). Brighten up: Smiles facilitate perceptual judgments of facial lightness. *Journal of Experimental Social Psychology*, 48, 450-452.
- Jadva, V., Hines, M., & Golombok, S. (2010). Infants' preferences for toys, colors, and shapes: Sex differences and similarities. *Archives of sexual behavior*, 39, 1261-1273.

- John, O. P., & Srivastava, S. (1999). The Big-Five trait taxonomy: History, measurement, and theoretical perspectives. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (Vol. 2, pp. 102–138). New York: Guilford Press.
- Kim, H., & Markus, H. R. (1999). Deviance or uniqueness, harmony or conformity? A cultural analysis. *Journal of Personality and Social Psychology*, 77, 785-800.
- Köhler, W. (1929). *Gestalt Psychology*. New York: Liveright
- Labrecque, L. I., & Milne, G. R. (2012). Exciting red and competent blue: the importance of color in marketing. *Journal of the Academy of Marketing Science*, 40, 711-727.
- Lakens, D., Fockenberg, D. A., Lemmens, K. P., Ham, J., & Midden, C. J. (2013). Brightness differences influence the evaluation of affective pictures. *Cognition and Emotion*, 27, 1225-1246.
- Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago, IL: University of Chicago Press.
- Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago, IL: The University of Chicago Press.
- Lakoff, G. & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenges to western thought*. New York: Basic Books.
- Landau, M. J., Meier, B. P., & Keefer, L. A. (2010). A metaphor-enriched social cognition. *Psychological Bulletin*, 136, 1045-1067.
- Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D.H.J., Hawk, S.T., & van Knippenberg, A. (2010). Presentation and validation of the Radboud Faces

- Database. *Cognition & Emotion*, 24(8), 1377—1388. DOI: 10.1080/02699930903485076.
- Lichtenfeld, S., Elliot, A. J., Maier, M. A., & Pekrun, R. (2012). Fertile green: Green facilitates creative performance. *Personality and Social Psychology Bulletin*, 38, 784-797.
- Lin, H. (2014). Red-colored products enhance the attractiveness of women. *Displays*, 35, 202-205.
- Lindbloom, B. (2015). Lab to LCH(ab) [Conversion equation]. Retrieved from <http://www.brucelindbloom.com/index.html?ColorCalculator.html>
- Ludvigh, E. J., III, & Happ, D. (1974). Extraversion and preferred level of sensory stimulation. *British Journal of Psychology*, 65, 359-365.
- Mason, M. F., Tatkow, E. P., & Macrae, C. N. (2005). The look of love. Gaze shifts and person perception. *Psychological Science*, 16, 236-239.
- McManus, I. C., Jones, A. L., & Cottrell, J. (1981). The aesthetics of colour. *Perception*, 10, 651-666.
- Mehrabian, A., & Russell, J. A. (1974). *An Approach to Environmental Psychology*. Cambridge, MA: MIT Press.
- Meier, B. P., D'Agostino, P. R., Elliot, A. J., Maier, M. A., & Wilkowski, B. M. (2012). Color in context: Psychological context moderates the influence of red on approach- and avoidance-motivated behavior. *PLoS ONE*, 7, e40333.

- Meier, B. P., Robinson, M. D., & Clore, G. L. (2004). Why good guys wear white: Automatic inferences about stimulus valence based on color. *Psychological Science, 15*, 82-87.
- Meier, B. P., Robinson, M. D., Crawford, L. E., & Ahlvers, W. J. (2007). When 'light' and 'dark' thoughts become light and dark responses: Affect biases brightness judgments. *Emotion, 7*, 366-376.
- Milan, E., Iborra, O., de Cordoba, M. J., Juarez-Ramos, V., Artacho, M. A. R., & Rubio, J. L. (2013). The Kiki-Bouba effect: A case of personification and ideasthesia. *Journal of Consciousness Studies, 20*, 84-102.
- Moller, A. C., Elliot, A. J., & Maier, M. A. (2009). Basic hue-meaning associations. *Emotion, 9*, 898-902.
- Na, J., & Kitayama, S. (2011). Spontaneous trait inference is culture-specific. *Psychological Science, 22*, 1025-1032.
- Naumann, L. P., Vazire, S., Rentfrow, P. J., & Gosling, S. D. (2009). Personality judgments based on physical appearance. *Personality and Social Psychology Bulletin, 35*, 1661-1671.
- Niesta-Kayser, D., Elliot, A. J., & Feltman, R. (2010). Red and romantic behavior in men viewing women. *European Journal of Social Psychology, 40*, 901-908.
- Palmer, S. E., & Schloss, K. B. (2010). An ecological valence theory of human color preference. *Proceedings of the National Academy of Sciences, 107*, 8877-8882.

- Pazda, A. D., Elliot, A. J., & Greitemeyer, T. (2012). Sexy red: Perceived sexual receptivity mediates the red-attraction relation in men viewing women, *Journal of Experimental Social Psychology*, 48, 787-790.
- Pazda, A. D., Elliot, A. J., & Greitemeyer, T. (2014). Perceived sexual receptivity and fashionableness: Separate paths linking red and black to perceived attractiveness. *Color Research and Application*, 39, 208-212.
- Pazda, A. D., Prokop, P., & Elliot, A. J. (2014). Red and romantic rivalry: Viewing another woman in red increases perceptions of sexual receptivity, derogation, and intentions to mate-guard. *Personality and Social Psychology Bulletin*, 40, 1260-1269.
- Penton-Voak, I. S., Pound, N., Little, A. C., & Perrett, D. I. (2006). Personality judgments from natural and composite facial images: More evidence for a “kernel of truth” in social perception. *Social Cognition*, 24, 607-640.
- Pravossoudovitch, K., Cury, F., Young, S. G., & Elliot, A. J. (2014). Is red the color of danger? Testing an implicit red-danger association. *Ergonomics*, 57, 503-510.
- Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics*, 31, 437-448.
- Prokop, P., & Hromada, M. (2013). Women use red in order to attract mates. *Ethology*, 119, 605-613.
- Raudenbush, S. W., Byrk, A. S., & Congdon, R. (2004). HLM6 for Windows. [Computer software]. Lincolnwood, IL: SSI.

- Roberts, S. C., Owen, R. C., & Havlicek, J. (2010). Distinguishing between perceiver and wearer effects in clothing color-associated attributions. *Evolutionary Psychology*, 8, 350-364.
- Robinson, C. (1975). Color preference as a function of introversion and extraversion. *Perceptual and Motor Skills*, 40, 702.
- Rosenthal, R., & Rosnow, R. L. (1984). *Essentials of Behavioral Research: Methods and Data Analysis*. New York, NY: McGraw-Hill.
- Rowland, D. A., & Perrett, D. I. (1995). Manipulating facial appearance through shape and color. *IEEE Computer Graphics and Applications*, 15, 70-76.
- Rule, N. O., & Ambady, N. (2008). The face of success: Inferences from chief executive officers' appearance predict company profits. *Psychological Science*, 19, 109-111.
- Rule, N. O., & Ambady, N. (2009). She's got the look: Inferences from female chief executive officers' faces predict their success. *Sex Roles*, 61, 644-652.
- Rule, N. O., & Ambady, N. (2011). Judgments of power from college yearbook photos and later career success. *Social Psychological and Personality Science*, 2, 154-158.
- Rule, N. O., Ambady, N., & Hallett, K. C. (2009). Female sexual orientation is perceived accurately, rapidly, and automatically from the face and its features. *Journal of Experimental Social Psychology*, 45, 1245-1251.
- Savage, R. D. (1964). Electro-cerebral activity, extraversion and neuroticism. *British Journal of Psychiatry*, 110, 98-100.



- Shevlin, M., Walker, S., Davies, M., Banyard, P., & Lewis, C. A. (2003). Can you judge a book by its cover? Evidence of self-stranger agreement on personality at zero acquaintance. *Personality and Individual Differences*, 35, 1373-1383.
- Snyder, M., Tanke, E. D., & Berscheid, E. (1977). Social perception and interpersonal behavior: On the self-fulfilling nature of social stereotypes. *Journal of Personality and Social Psychology*, 35, 656-666.
- Snyder, M., & Swann, W. B. (1988). Hypothesis-testing processes in social interaction. *Journal of Personality and Social Psychology*, 36, 1202-1212.
- Stillman, T. F., & Maner, J. K. (2009). A sharp eye for her SOI: perception and misperception of female sociosexuality at zero acquaintance. *Evolution and Human Behavior*, 30, 124-130.
- Suk, H. J., & Irtel, H. (2010). Emotional response to color across media. *Color Research and Application*, 35, 64-77.
- Tracy, J. L. & Beall, A. T. (2014). The impact of weather on women's tendency to wear red or pink when at high risk for conception. *PLoS ONE*, 9, e88852.
- Uleman, J. S. (1999). Spontaneous versus intentional inferences in impression formation. In S. Chaiken & Y. Trope (Eds.) *Dual-Process Theories in Social Psychology* (pp. 141-160). New York, NY: Guilford.
- Uleman, J. S., & Saribay, S. A. (2012). Initial impressions of others. In K. Deaux & M. Snyder (Eds.), *Oxford handbook of personality and social psychology* (pp. 337-366). New York, NY: Oxford University Press.

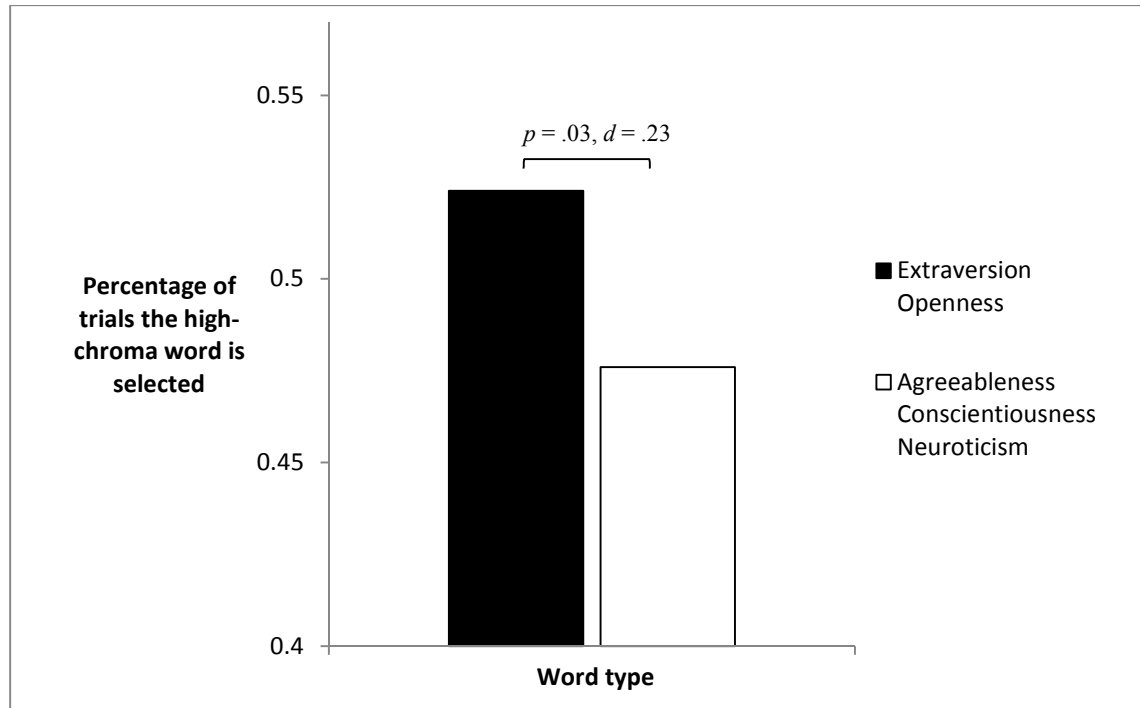
- Valdez, P., & Mehrabian, A. (1994). Effects of color on emotions. *Journal of Experimental Psychology: General*, 123, 394-409.
- Vazire, S., & Gosling, S. D. (2004). E-perceptions: Personality impressions based on personal websites. *Journal of Personality and Social Psychology*, 87, 123-132.
- Verplaetse, J., Vanneste, S., & Braeckman, J. (2007). You can judge a book by its cover: the sequel.: A kernel of truth in predictive cheating detection. *Evolution and Human Behavior*, 28, 260-271.
- Wallen, K., & Rupp H. A. (2010). Women's interest in visual sexual stimuli varies with menstrual cycle phase at first exposure and predicts later interest. *Hormones and Behavior*, 57, 263–268.
- Ward, C., & Chang, C. C. (1997). Cultural fit: A new perspective on personality and sojourner adjustment. *International Journal of Intercultural Relations*, 21, 525-533.
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54, 1063-1070.
- Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological Science*, 17, 592-598.
- Young, S. G., Elliot, A. J., Feltman, R., & Ambady, N. (2013). Red enhances the processing of facial expressions of anger. *Emotion*, 13, 380-384.
- Zentner, M. R. (2001). Preferences for colours and colour-emotion combinations in early childhood. *Developmental Science*, 4, 389-398.

Zhong, C., Bohns, V. K., & Gino, F. (2010). Good lamps are the best police: Darkness increases dishonesty and self-interested behavior. *Psychological Science*, 21, 311-314.

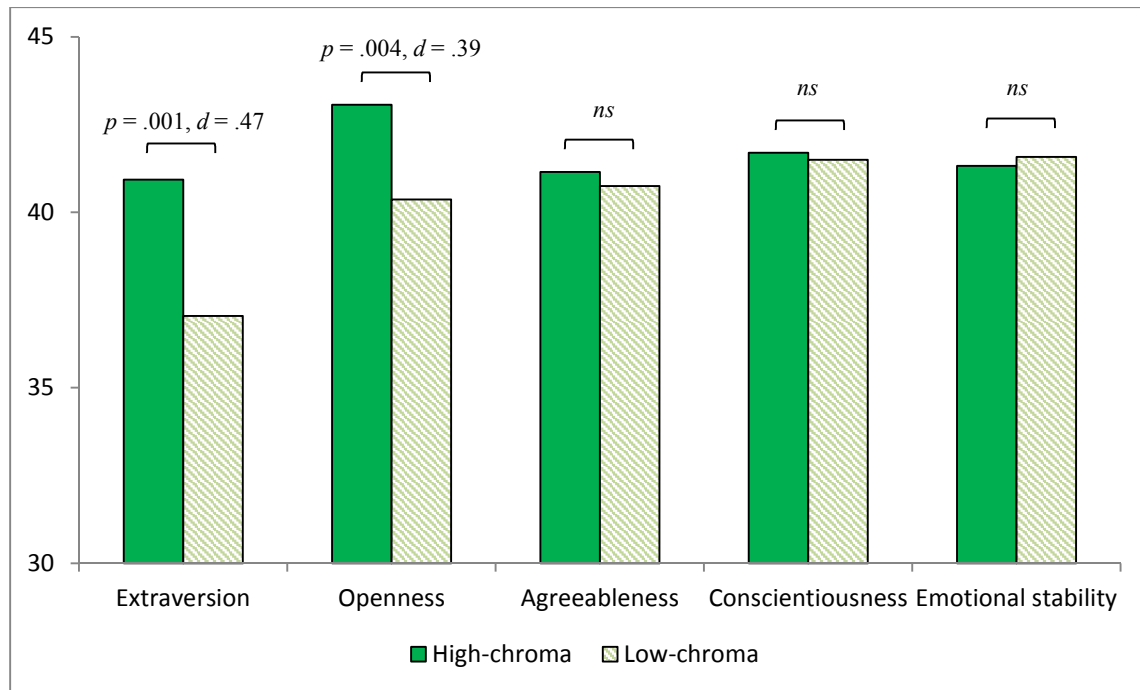
**Table 1.** Multilevel analysis in Study 5. The dependent variable is log-transformed chroma. Coefficients in the table are unstandardized estimates.

	<i>b</i>	<i>SE</i>	<i>t</i>	<i>df</i>	<i>p</i>
Intercept	1.00	0.02	43.63	260	0.00
Sex	-0.05	0.06	-0.83	260	0.41
Extraversion	-0.04	0.04	-0.90	260	0.37
Openness	-0.02	0.05	-0.43	260	0.67
Neuroticism	-0.01	0.04	-0.36	260	0.72
Agreeableness	0.04	0.05	0.69	260	0.49
Conscientiousness	-0.06	0.04	-1.30	260	0.20
Time	-0.01	0.01	-0.54	424	0.59
Time*Sex	0.00	0.03	0.13	424	0.89
Time*Extraversion	0.02	0.02	0.89	424	0.37
Time*Openness	0.01	0.02	0.34	424	0.74
Time*Neuroticism	0.01	0.01	0.72	424	0.47
Time*Agreeableness	0.03	0.03	1.20	424	0.23
Time*Conscientiousness	0.00	0.01	0.00	424	0.99

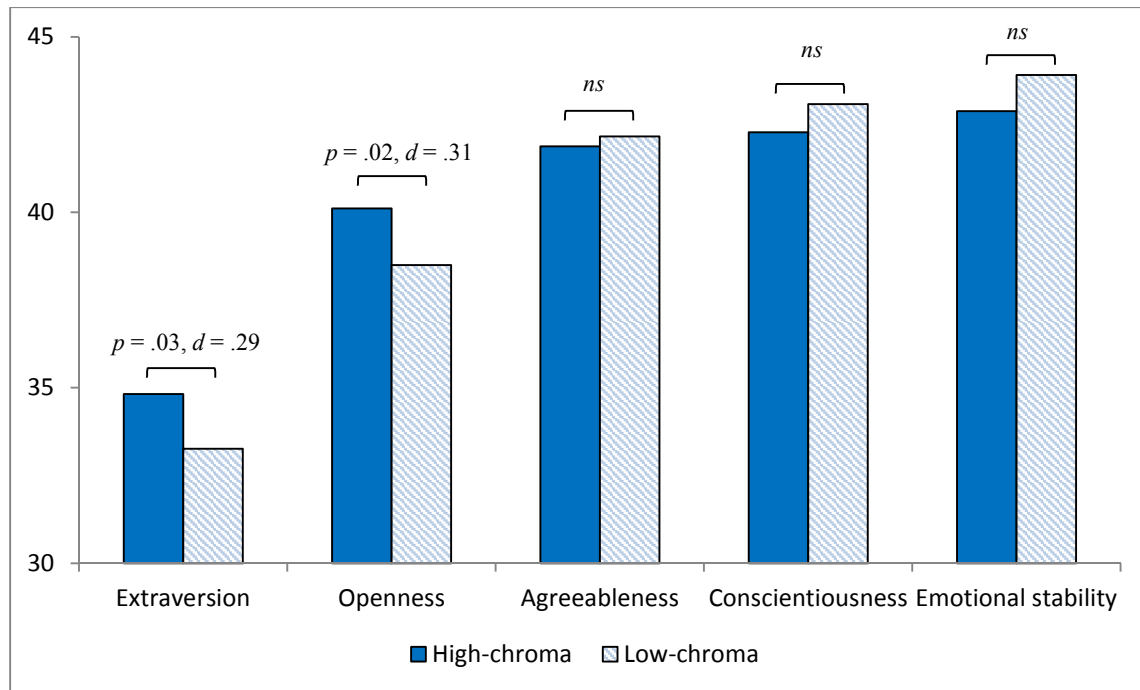
**Figure 1.** The effect of word type on high-chroma selections in Experiment 1.



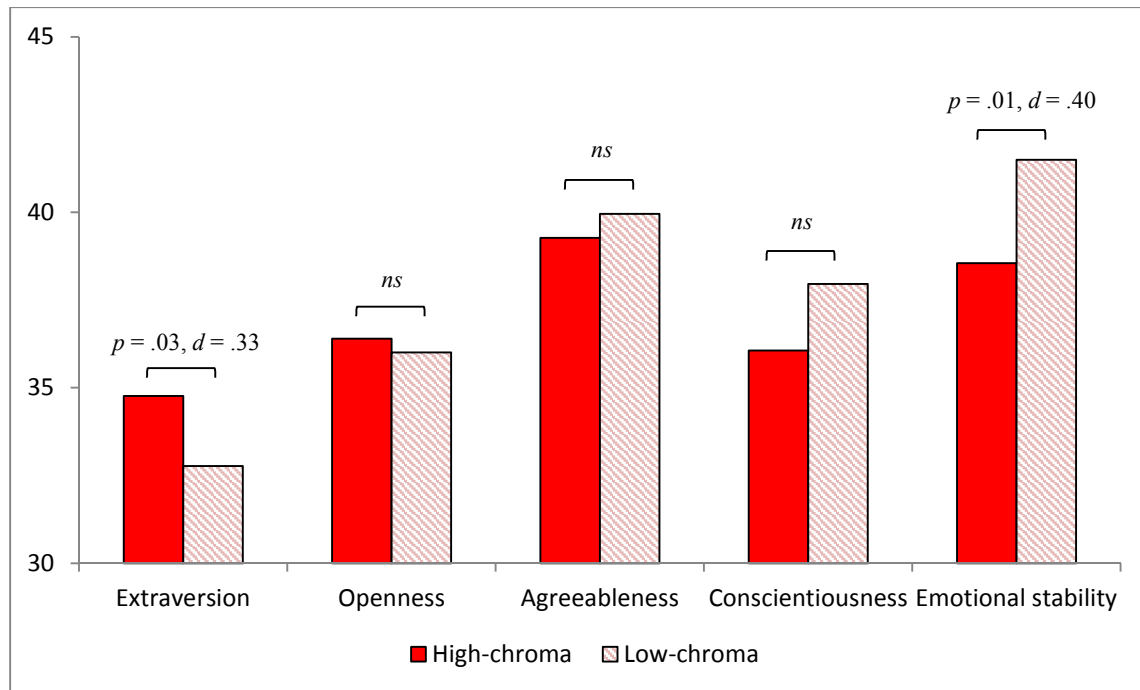
**Figure 2.** The effect of chroma on perceptions of the Big Five personality traits in Experiment 2a.



**Figure 3.** The effect of chroma on perceptions of the Big Five personality traits in Experiment 2b.

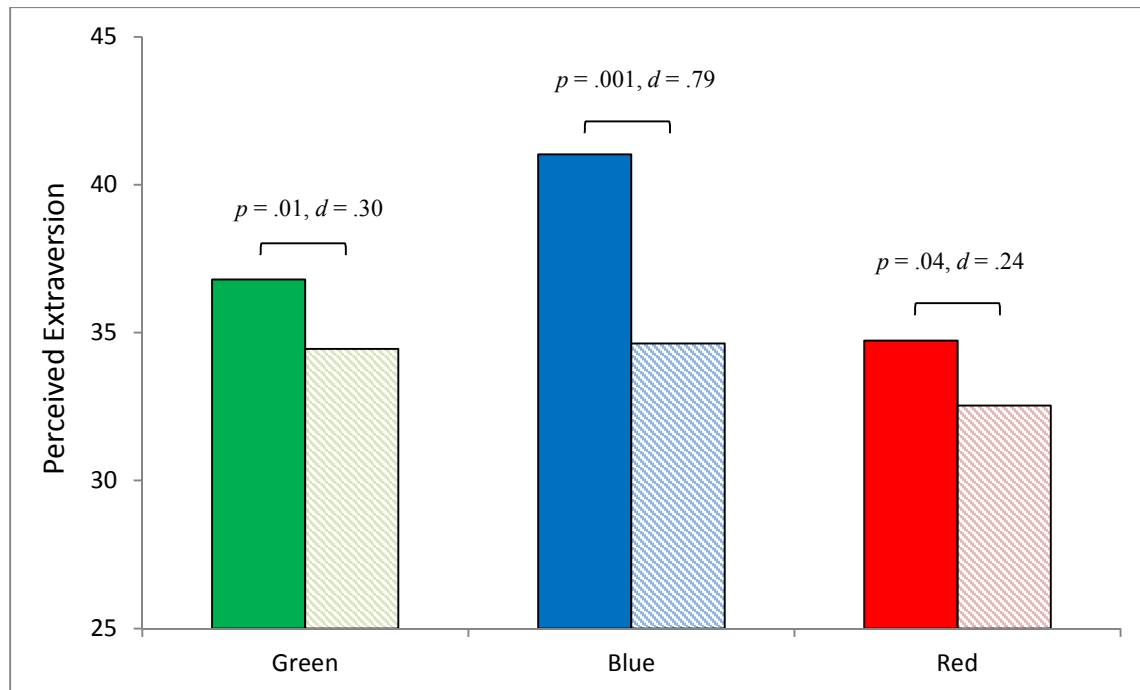


**Figure 4.** The effect of chroma on perceptions of the Big Five personality traits in Experiment 2c.

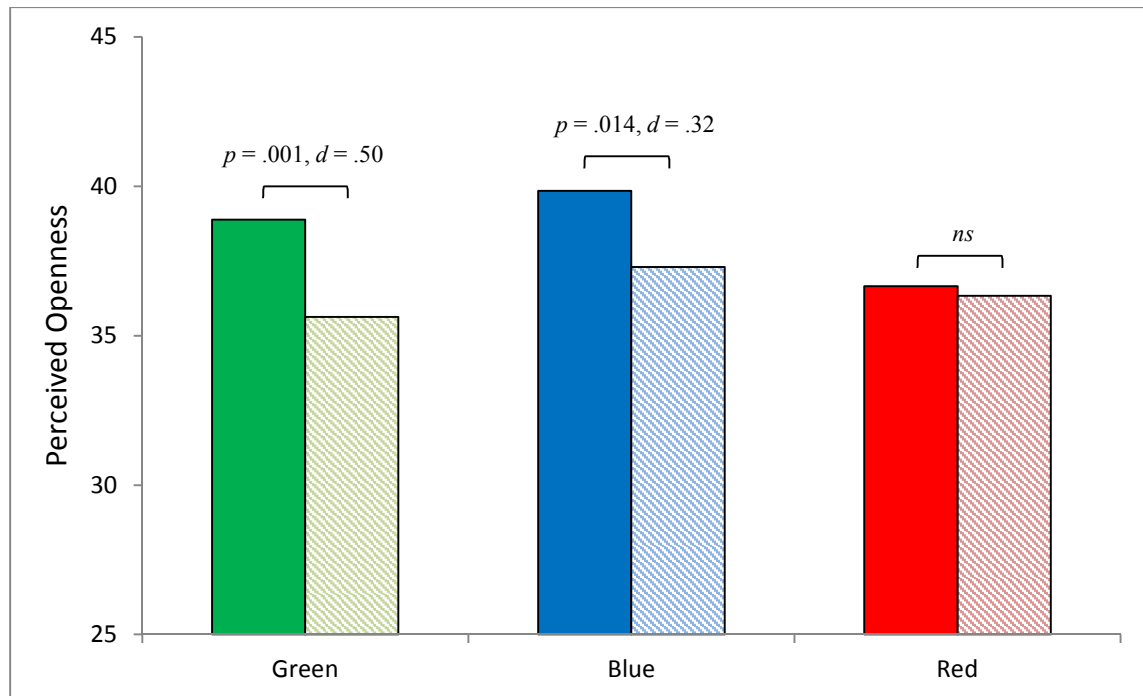




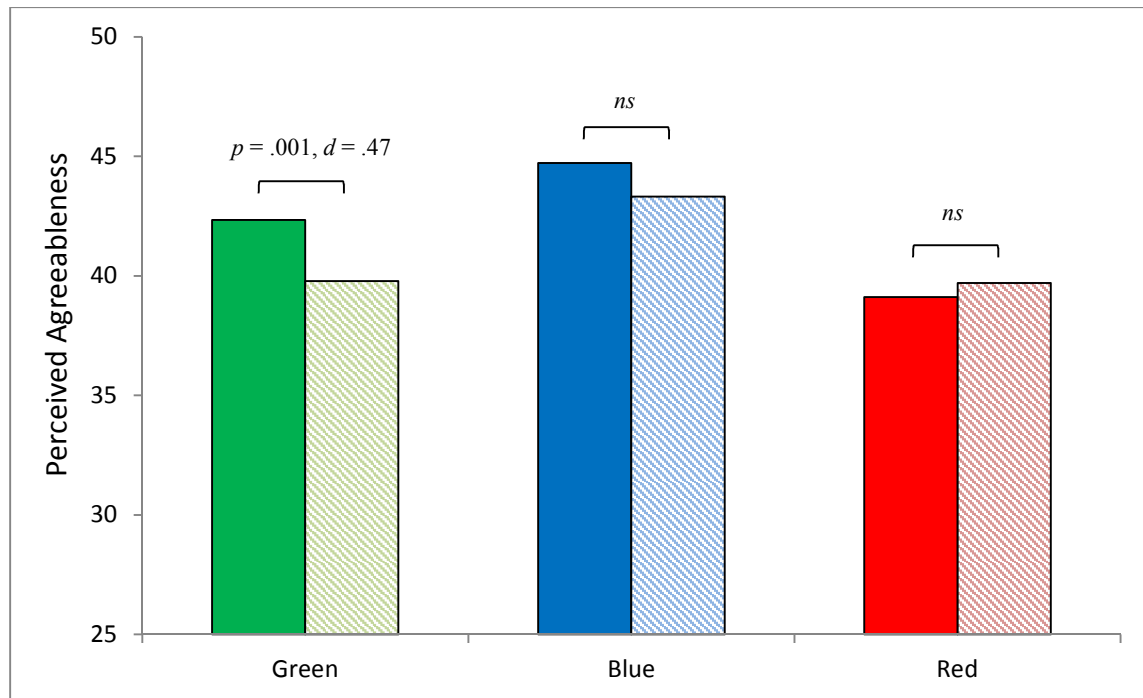
**Figure 5.** The effect of chroma on perceived extraversion for each hue condition in Experiment 3. Solid bars represent high-chroma, and striped bars represent low-chroma.



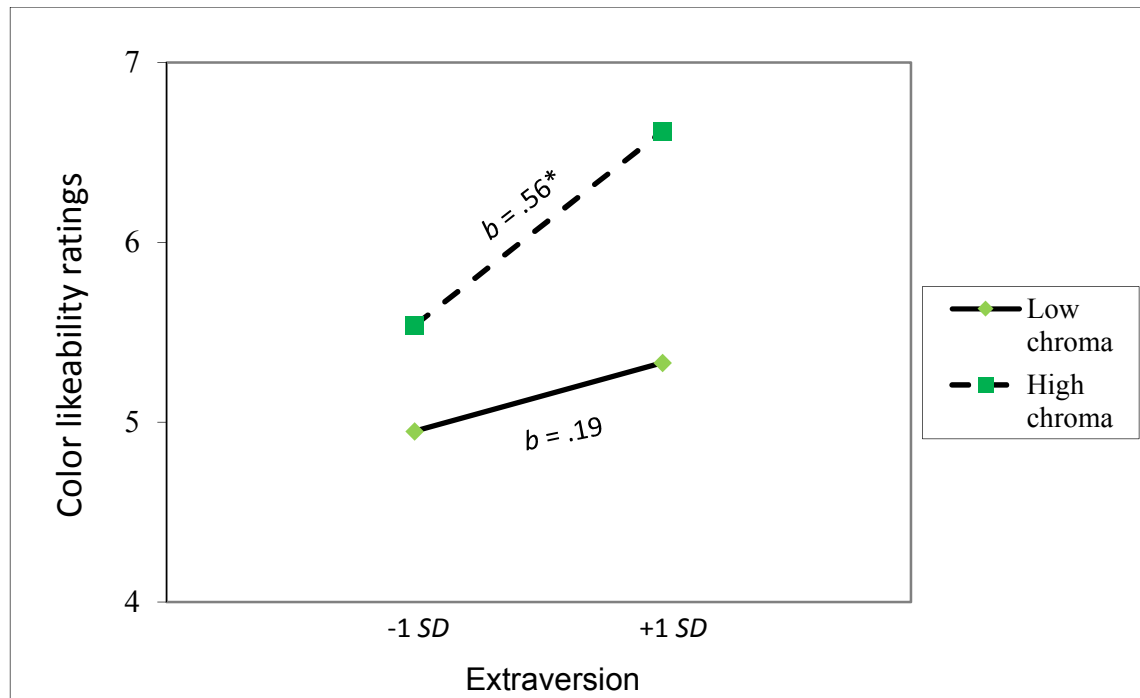
**Figure 6.** The effect of chroma on perceived openness for each hue condition in Experiment 3. Solid bars represent high-chroma, and striped bars represent low-chroma.



**Figure 7.** The effect of chroma on perceived agreeableness for each hue condition in Experiment 3. Solid bars represent high-chroma, and striped bars represent low-chroma.

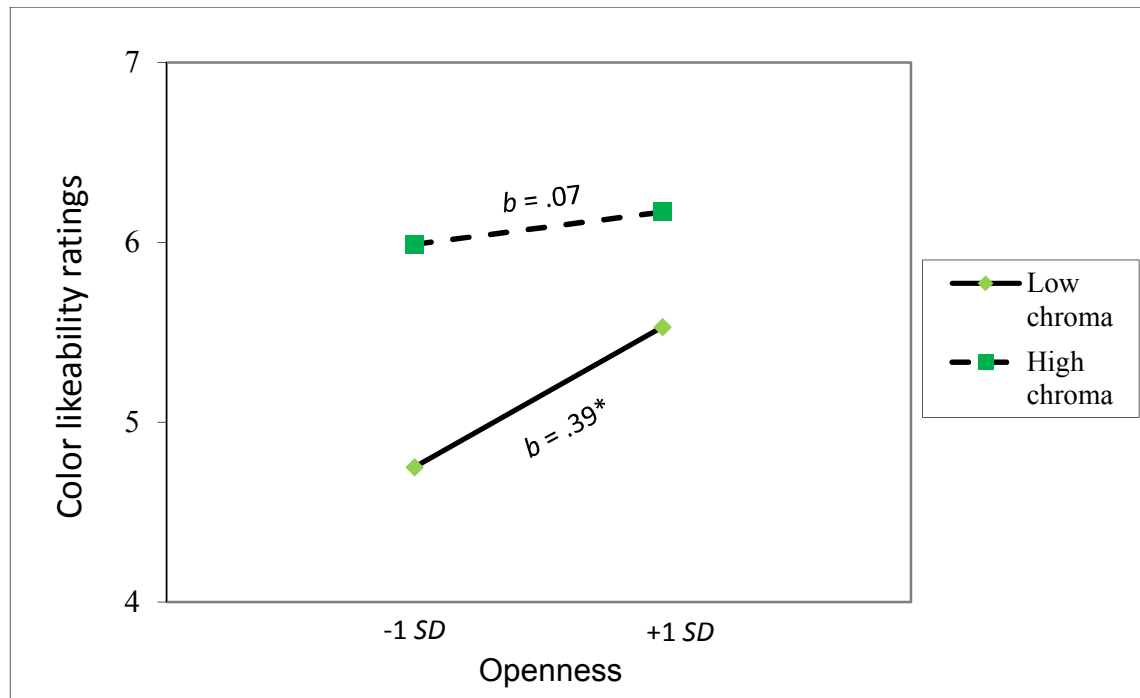


**Figure 8.** The interaction between extraversion and chroma on color likeability ratings in Study 4.



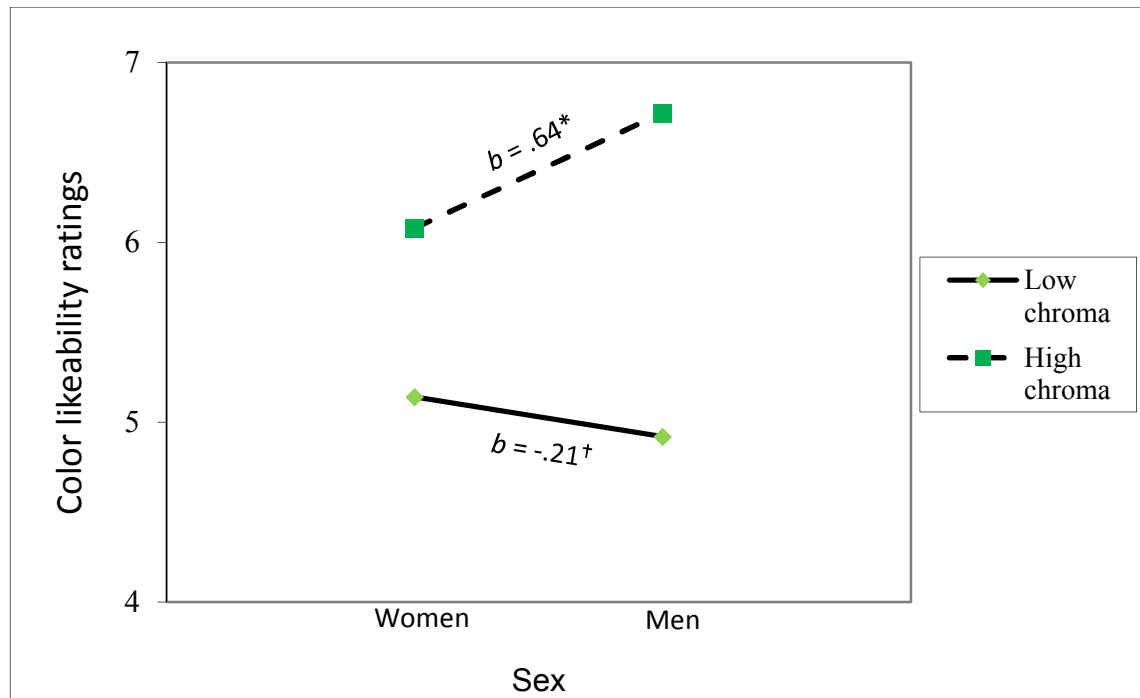
Note: \*  $p < .05$

**Figure 9.** The interaction between openness and chroma on color likeability ratings in Study 4.



Note: \*  $p < .01$

**Figure 10.** The interaction between sex and chroma on color likeability ratings in Study 4.



Note:  $^\dagger p < .10$ .  $^* p < .01$

## Appendix A

<u>Foreign word pairs</u>		<u>English words</u>
Aralik	Aramak	Outgoing
Akaba	Akelo	Imaginative
Bakan	Bakar	Careful
Basmak	Bardak	Anxious
Calzak	Cazulk	Cooperative
Dusmek	Duymak	Energetic
Etmek	Erkek	Artistic
Fakir	Fakat	Responsible
Hazat	Hazir	Upset
Kadar	Kadin	Kind
Mektep	Mekrek	Sociable
Parlak	Parmak	Creative
Takim	Tabak	Organized
Teklif	Teklar	Stressed
Varmak	Vermek	Generous

## Appendix B

Hue	High-chroma			Low-chroma		
	L	C	h	L	C	h
Green	64.4	79.8	150.0	63.9	33.7	150.7
Blue	64.1	80.0	275.2	64.1	33.6	275.9
Red	63.8	80.2	12.5	64.2	34.1	12.7



## Appendix C

Color-pair number	High-chroma			Low-chroma		
	L	C	h	L	C	h
1	59.9	81.4	16.0	59.9	40.7	15.7
2	76.0	79.5	52.5	75.1	33.8	52.0
3	100.6	84.6	113.2	100.5	14.2	114.0
4	97.4	114.2	140.1	96.6	39.0	139.7
5	81.6	102.2	142.0	82.4	30.2	141.2
6	57.9	73.5	149.1	58.7	28.1	148.4
7	103.6	75.1	227.5	102.6	54.9	222.7
8	56.8	81.8	280.1	57.0	35.4	280.3
9	56.8	153.6	306.9	56.5	50.0	307.0