PERSONALITY TRAIT CORRELATES AND INFLUENCE OF COLOR ON BIAS IN

TAE KWON DO JUDGING

by

Donald Christopher Garcia MacPhail, B.S.

A thesis submitted to the Graduate Council of
Texas State University for approval in partial fulfillment
of the requirements for the degree of
Master of Arts
with a Major in Psychological Research
May 2022

Committee Members:

Randall Osborne, Chair

Crystal Oberle

John Davis

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ACKNOWLEDGEMENTS

The author would like to thank his mother, father, and younger brother for their unwavering support during this master's program. The progress and success I have had thus far has been for them, to advance my career enough so I can support them to the best of my ability. The author would like to thank Dr. Osborne for his assistance and encouragement thus far, in developing and guiding the execution of this thesis. His allowance for me to work at a faster pace and praise for when I met my self-imposed deadlines is very much appreciated. I would also like to thank the other members of my committee, Dr. Oberle and Dr. Davis, for providing feedback and help regarding the formatting, phrasing and feasibility of this document.

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ABSTRACT

While subtle, color is a dominant aspect and influence in day-to-day life. Colors can carry meanings within certain contexts (e.g., red traffic light being associated with anger) and can shape how people perceive others. The associations color has with emotion and perception of others have been the subject of research in a variety of areas, including combat sports. Four Olympic combat sport events, including Tae Kwon Do, require participants to wear either red or blue gear, as a method for distinguishing athletes for referees and judges. Previous research in this area has found that there is a preference for red-wearing athletes, with red-wearing athletes being awarded more points, winning matches more frequently, and being perceived as more aggressive and more likely to win. However, while previous research has demonstrated the existence of this red preference within combat sports, no study has assessed the relation of person-based factors to the bias. The current study explored this area of research; participants were assessed for color-emotion associations by watching clips of Tae Kwon Do matches, and they completed the Big Five Inventory. With personality traits being among the most notable form of individual differences, the Big Five traits serve as a good foundation for this expansion of research, due to their relation to cognitive biases. Paired-samples t-tests and mixed model regressions were used to measure color-emotion associations and the relation of person-based factors to said associations, respectively. The study found that there were no differences in ratings of red-wearing versus blue-wearing fighters for aggression, strategic ability, or likelihood of winning among a sample of college students.

Additionally, the Big Five personality traits were not found to be predictive of the difference in ratings of the red-wearing and blue-wearing fighters. Limitations associated with the current study are discussed, as well as future directions for related research to pursue.

I. INTRODUCTION

Color is a subtle, yet dominant aspect of everyday life. The color of an object can carry a particular meaning, as color serves as symbols. This power that a color possesses can be seen in areas such as baby gender, traffic lights, and emotions. In regard to baby gender, a commonly held assumption is that an infant wearing pink is a girl, while an infant wearing blue is a boy, thereby allowing the color to influence a person's perception of a situation. For traffic lights, every person from an early age is conditioned to attribute specific meanings to the following colors: red (stop), yellow (slow) and green (go). With the symbolism and meaning that particular colors carry, questions regarding the influence of color on perception, emotion and behavior have developed recently, leading to the expansion of research into the association between color and psychology.

Background of Color Psychology

Color psychology is the melding of two sciences: color science and psychological science. Color science refers to conceptualizing color processing involving the movement of light onto the retina and the cascade of physiological stage and structures involved in seeing a color image (Elliot et al., 2015). Psychological science understands color as a central part of visual perception, with the subjective perception of the world being a crucial area of research within the field (Elliot et al., 2015).

The term "color emotion" has risen in popularity over recent years due to an increase in research interest. Color emotion refers to the relationship between a color and the affect response produced by either the color, an environment that contains the color or a product that possess the color (Li-Chen, 2015). Li-Chen (2015) explains that colors that are similar, such as having similar hues, are likely to invoke similar responses. The most

general example of colors producing specific affect responses revolves around the warm/cool dynamic; colors with more red-orange hue are typically regarded as "warm", while those colors that adhere more towards blue hue are interpreted as "cool" (Li-Chen, 2015). The color-emotion response to color was found to have three factors associated with it: a hue-related factor (color temperature, as just discussed), a lightness-related factor (color potency) and a chroma-related factor (color impact; Li-Chen, 2015). The lightness-related factor refers to the potency of the color, as colors with high lightness tend to feel softer, whereas colors with low lightness factors are perceived as heavier colors (Li-Chen, 2015). The chroma-related factor refers to the saturation of the color; colors with high chroma are interpreted as being active and vibrant, while low chroma colors are perceived as inactive and dull (Li-Chen, 2015). These three factors are independent of one another and the level of each factor in relation to a color can affect the emotional response or emotional perception that a person can interpret from a color.

Expanding upon this color-emotion response, other studies have narrowed the scope and assessed whether colors can evoke specific emotions or perceptions. Wu and Lin (2016) explored the idea that color can evoke certain personality associations, a phenomenon they referred to as color-personality association. Participants were shown colors and asked to rate the personality association they related with the given color(s). Participants rated the personality association using a 7-point bipolar scale, with one mode of the trait being on one end of the scale, and the opposite mode on the other end (e.g., extraversion-introversion, agreeable-disagreeable). These researchers found that personality association could, in fact, be represented by specific colors. In the study, the personality traits studied for their association with colors were the Big 5 traits:

extraversion, conscientiousness, agreeableness, neuroticism, and openness to experience. In the results, warmer colors (e.g., red, yellow), lighter colors, and more vibrant colors were associated with extraversion, moodiness (i.e., high neuroticism), wide selection of interests (i.e., high openness to experience), and disorganization (i.e., low conscientiousness), whereas cooler colors (e.g., blue, green), darker colors, and duller colors were more often associated with introversion (i.e., low extraversion), a lack of emotion (i.e., low neuroticism), a narrow selection of interests (i.e., low openness to experience), and organization (i.e., high conscientiousness). The color association with agreeableness differed from the other four traits. The color-personality association for agreeableness was based on the lightness-related factor, as lighter colors were associated with agreeableness, whereas darker colors were associated with disagreeableness.

As Wu and Lin (2016) assessed color association with specific personality traits, Takahashi and Kawabata (2017) assessed whether similar associations could be found between colors and the perception of emotion. Participants were presented an emotional word, such as "anger", and were then asked to imagine a color associated with said word. Participants were then given a color palette and were asked to select which color they imagined. These researchers found that specific emotions such as anger, sadness, joy, surprise and no emotion were most frequently connected to a certain color or shades of color. Anger was most frequently associated with 5-R, the most saturated red. Both emotions of joy and surprise were most associated with 4-Y, a fully saturated yellow. The emotion of sadness was heavily associated blue and associated shades of blue, while no emotion was associated with achromatic colors, namely white. This research illustrated the significance that the color red has with anger, an association that has been further

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associated with certain behaviors and perception.

With the color red being shown to invoke an association with anger, additional research has been conducted to determine whether this influence can be extended into assumptions of objects of a particular color. Wiedemann et al. (2015) attempted to assess whether the color of clothing can bias perception, namely red-biased perception of aggression and dominance in a non-competitive setting. Participants were presented 20 images of males wearing either a red shirt, a blue shirt or a grey shirt. Participants were asked to rate each male image on two separate 7-point scales: aggression (1 = *extremely aggressive*, 7 = *extremely friendly*) and dominance (1 = *extremely submissive*, 7 = *extremely dominant*). The results revealed that female participants assessed the red-wearing males in the images to be more aggressive than the grey-wearing males, whereas male participants judged red-wearing males in the images to be more aggressive than both blue-wearing and grey-wearing males. Additionally, male participants were influenced by red in terms of dominance as red-wearers were rated as more dominant than both blue-wearers and grey-wearers. However, in dominance assessment, female participant's perception of the men in the images was not influenced by color.

With Wiedemann et al. (2015) assessing the bias towards aggressiveness and dominance in a relatively neutral setting that the color red can provide an individual, this influence of color has been also assessed in situations of competitiveness. Little and Hill (2007) assessed participant perceptions of red and blue in both aggressiveness and dominance, similar to Wiedemann et al. (2015). However, Little and Hill (2007) included physical competition as a color assessment item, asking participants to indicate which color would be most likely to win in a physical competition. With this new variable of

physical competition context, red was found to be favored over blue in all three perceptions: dominance, winning physical competitions and aggression. With the findings of both Little and Hill (2007) and Wiedemann et al. (2015) illustrating the influence the color red has on the perception of situations in terms of aggression, domination and physical competition, this color-based bias would likely be present in competitive and combat sports, as well.

Color Psychology and Combat Sports

There were six combat sports represented at the past Olympic Games: Tae Kwon Do, wrestling (Greeco-Roman and freestyle), boxing, judo and fencing. Of these sports, participants in boxing, wrestling and Tae Kwon Do are randomly selected to wear either red or blue in each match. Judo athletes wear either white or blue and fencing athletes are not required to wear a distinguishing color. Given the previous research identifying the role and influence a particular color can have in the perception of a person wearing it, it stands to reason that this effect would be evident in combat sport competitions.

Krenn (2015) conducted a study to assess the role uniform color has on a perception of a fighter and prediction for the fight outcome. In this study, 210 participants were recruited and shown 108 photos of either a boxing match, a wrestling match or a Tae Kwon Do match. The two fighters displayed in each photo displayed one of six possible color conditions: red-blue, green-blue, red-green, and vice versa. For each photo, each participant had to select the fighter in the photo they believed was more aggressive, the fighter they felt was most likely to win the match and the fighter they believed fought more fair. The results of the study showed that in boxing and wrestling photos, fighters wearing red were judged to be more likely to win the match and were perceived to be

more aggressive. Photos of Tae Kwon Do matches did not reveal a significant effect. This lack of effect for Tae Kwon Do matches must be taken into context, however. The fighters in the boxing and wrestling matches were fully chromatic (i.e., wore an entirely red, blue or green uniform), whereas fighters in the Tae Kwon Do photos wore a predominately white uniform, with only the chest protector being the chromatically colored area. The minimization of the chromatic area for Tae Kwon Do fighter photos compared to the fully chromatic uniforms of boxing and wrestling likely influenced the resulting effect. This assumption is warranted due to the results found by other research studies that focused solely on Tae Kwon Do matches.

Hill and Barton (2005) likewise conducted a similar study to Krenn (2015), but instead of assessing participant's perception of fighters using photographs, Hill and Barton (2005) used real-life results of four combat sports that utilized red/blue athlete distinction of the 2004 Olympic Games: boxing, Tae Kwon Do, Greco-Roman wrestling and freestyle wrestling. Among the four events, athletes wearing red won more matches compared to the athlete in blue. For the Tae Kwon Do event, only the athlete's chest protector and head gear had color (i.e., red or blue). Moreover, this red advantage would be significant when other fight factors (speed, flexibility, skill) were relatively equal, as the red fighters winning was significantly higher in matches with fighters of equal capabilities. Hill and Barton argued that this red advantage bias is attributed to a cultural link between aggression and dominance with the color red. This study's utilization of real-life data found that red influenced outcomes of four Olympic-level combat sports, including Tae Kwon Do, a result that ran contrary to the results of Krenn's (2015) study that only employed photographs of combat sport matches. The fact that Hill and Barton

(2005) used results from live Tae Kwon Do matches and did find a significant red advantage, leads to the idea that evaluation of the in-progress Tae Kwon Do matches is crucial.

Much like the previously mentioned studies, Hagemann et al. (2008) evaluated the significance of the red color advantage in combat sports, but solely focused on Tae Kwon Do. Rather than recruiting and assessing a general population, they recruited 42 experienced Tae Kwon Do referees and they further assessed the significance of head gear and chest protector color in videos of Tae Kwon Do matches. Videos were randomly ordered and shown to participants twice: once with one fighter wearing red gear and the other wearing blue, and then again but with each fighter's gear color flipped red to blue or blue to red. Participants were instructed to award points as they normally would during a live match as a referee: 1 point was awarded for striking the chest protector with a foot or fist, 2 points for striking the head or face with a foot only. Results indicated that among the referee participants, 13% more points were awarded to the athlete in red compared to the points awarded to the blue fighter. For videos where the originally blue fighter was transformed into red, more points were awarded to the "new" red fighter and less points were awarded to the "new" blue fighter. Similar to Hill and Barton (2005), Hagemann et al. (2008) utilized actual moving footage which resulted in significance results.

As the color red has been shown to be given bias towards winning matches in combat sports, Dijkstra and Preenen (2008) assessed whether a similar bias exists within a combat sport, Judo, which does not utilize red gear or uniforms. In Judo, one athlete wears a blue uniform, while the other wears a white uniform. Results of the study

revealed that there was no significant effect with this blue-white color pairing within Judo matches, implying that this color pairing could be considered a method of athlete distinction that reduces any potential bias in scoring. These findings suggest a possible solution for the illustrated red bias by providing a methodology to reduce the red-associated effect.

Individual Differences: Color and Hostility

The previously described research has demonstrated the weight that color psychology carries in both general life and more specifically, perception of athletes within the realm of combat sports. Yet, the influence of color on the perception of people, objects and/or actions may not be the same across all individuals, meaning that color can influence one person's perception a great deal, while only slightly influence another person. Given that there are individual differences in personality, temperament, sociability and behavior, these differences may amplify or diminish the influence of particular colors on a person's perception, emotionality or behavior.

Fetterman et al. (2015) assessed preferences for the color red and individual differences in participant's perceptual biases, namely differences in interpersonal hostility. With a total of 376 participants, four related studies were conducted. In the first study, participants who preferred red had higher degrees of interpersonal hostility compared to the participants who preferred blue, the control color. In the second study, participants who possessed higher degrees of interpersonal hostility had a bias towards seeing the color red. Additionally, in the third study, the results of the second study were replicated, but with a task to separate red bias from a bias to perceive the control color, green. Finally, in the fourth study, red was associated with hostile responses from

participants in a decision-making task.

Given that Fetterman et al. (2015) established the significance of individual differences in interpersonal hostility in a sample's perception of red, bias for red and the received influence of red, it raises the idea that other person-based factors could similarly affect a person's color psychology or color-emotion association.

Individual Differences: Big Five Personality Traits

Whereas the previously mentioned research highlights the importance of both situation-based factors (combat sports) and person-based factors (interpersonal hostility), more research is needed to assess other possible social or personality constructs that may be related to or moderate this color-emotion bias. Similar to interpersonal hostility, a certain set of variables have been evaluated on their relatedness to color-associations and seem likely to have some predictive capability in determining said bias in decision-making: the Big Five personality traits.

Personality traits are widely held to influence many aspects of a person such as their behaviors, their emotionality, and their cognitive processes. Referring to personality, the big five factor model, which is the most accepted interpretation of personality divides personality into five traits: extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience. As previously mentioned, personality is held to have an influence over aspects of psychology, including cognitive style and decision-making. Given that color-emotion association is a form of cognitive processing and that the previously described studies required participants to make decisions involving color-emotions, personality traits would likely have a role in the processes involved. While all five of the Big Five traits likely have some form of association with color-emotion

association described earlier, three are of particular interest: neuroticism, extraversion, and openness to experience.

Neuroticism refers to the anxiousness and/or emotional stability of a person. Higher scores have previously been found to be associated with disorders, such as depression, as well as attentional bias (Ramos, 2019). Generally, neuroticism has been found to have links to negative biases in attention, interpretation and recall of information (Ormel et al. 2013). Such negative biases in information processing could likely extend into assessment of two fighters in a match, one distinguished by red, the other by blue. Highly neurotic individuals would likely observe a Tae Kwon Do match, and even though the fight is relatively "even" as far as temperament, skills and ability, they may process and interpret the actions of the red fighter as more aggressive, for example, due to the main distinction being gear color, thereby influencing perception and leading the observer to believe that the red fighter is more aggressive than the other.

Extraversion is the extent to which a person is sociable and outgoing. Lower scores in this trait indicate more introversion, withdrawnness, and less social engagement. Fajkowska and Eysenck (2008) found that individuals that are extroverted are more likely to be influenced by biases and cues than introverted individuals. Ramos (2019) expanded upon these biases and specified network extroversion bias (Feiler & Kleinbaum, 2015) and serving bias (Wansink & van Ittersum, 2014) as being two biases that extraverts are more susceptible towards. Extending upon this general line of reasoning that extraverts are more easily influenced and more susceptible to bias, there would likely be a similar association with color-emotion association bias demonstrated in Hagemann et al. (2008), for example. Hagemann et al. demonstrated a bias involving awarding more points to

fighters wearing red, even when shown the exact same video clip again with the colors of the fighters flipped. Given that this bias has been demonstrated, extraverts would likely follow this biased form of reasoning in linking red fighters with increased aggressiveness and higher likelihood of winning, and blue fighters with increased strategy.

Openness to experience refers to the tendency of someone to be open towards new experiences and appreciating novel experiences. People that are high in openness to experience are more likely to wish to experience new places, cultures, foods, etcetera, while those with low levels are likely to be intolerant of ambiguous situations (Ramos, 2019). Ramos further described that those with low openness would make decisions regarding unfamiliar situations rather quickly to avoid distress. Xu (2020) conducted a study in which the Big Five traits were assessed for the predictive capabilities for ambiguity aversion in a career decision-making context. Openness to experience was found to be a significant, negative predictor of ambiguity aversion, whereby people who are more open to experiences were more receptive or tolerant of informational ambiguity in decision-making. Given that Tae Kwon Do matches are a relatively niche sport, when participants are asked for their assessment of such a sport that they are not familiar with, those with low openness would make a decision quickly or rely on implicit associations, such as relating a fighter wearing red with anger or success.

The other two Big Five personality traits, conscientiousness, and agreeableness, have little literature relating these two traits with cognitive biases, but some association may exist due to the nature and definition of the traits. Conscientiousness refers to the level of organization and discipline that a person possesses (Ramos, 2019). People that are highly conscientious tend to be responsible, be methodical, create goals and follow

the rules and/or social norms. This general definition of conscientiousness posits that those high in conscientiousness would be less likely to succumb to cognitive biases, as they are more likely to plan and organize their thinking to guide their decision-making process. Agreeableness refers to the degree a person relates to others with kindness, altruism, and overall amicability (Ramos, 2019). Low agreeableness scores relate to selfishness, while higher scores indicate modesty and compassion. Kokkinos et al. (2017) related both low agreeableness and low conscientiousness to poor self-regulatory control and while that particular study specifically related them to self-regulatory control regarding aggressive behaviors, cognition undoubtedly plays a role in executing those behaviors, so this cognition may result in other manners. In addition to finding significant predictive capabilities for openness on ambiguity aversion in career decision-making, Xu (2020) also found that participants who were highly agreeable and/or highly conscientious were also more tolerant of ambiguity. While conscientiousness and agreeableness have not been directly linked to cognitive biases in an abundance of studies, the associations of each with both self-regulatory control and ambiguity aversion warrant exploration into how these two traits may be linked to the color-emotion associations found in observing combat sports.

II. PURPOSE AND HYPOTHESES

Given the previous explanation regarding the gravitas of color psychology, the role of color-emotion associations in both everyday life and combat sports, and the lack of research regarding possible influences on the specific color-emotion bias, additional research is needed in this area. The current study assessed the color-emotion bias in participants watching videos of combat sport matches with one fighter wearing red and the other blue, while also assessing participants on personality traits that could exhibit influence on this decision-making bias described in previous literature.

In the context of the present study, two primary hypotheses are held:

1. Color-emotion association biases are expected, whereby participants will be more likely to choose the red fighter as the more aggressive fighter and more likely to win the match, and the blue as the fighter as the more strategic fighter.

2. Low openness, high neuroticism, high extraversion, low conscientiousness, and low agreeableness scores will be significant predictors of these color-emotion associations.

III. METHOD

Participants

Participants were recruited using the SONA Subjects Pool through Texas State University. Participants were undergraduate students at Texas State University and had to be at least 18 years of age. A power analysis was conducted and found that a minimum of 92 participants would be necessary for the study and planned analysis.

A total of 213 students participated in this study. Of the participants, the majority were female (72.3%; 25.8% male, 1.9% non-binary/third gender) and were freshmen (63.4%; 20.2% sophomore, 9.9% junior, 6.5% senior). Furthermore, the average age was 19.2 years old ($SD = 2.2$), and a majority of the participants were Caucasian (43.7%; 36.2% Hispanic/Latin American, 11.7% African American, 3.3% East Asian, 1.9% Native American, Middle Eastern or Pacific Islander, 3.3% other race). Additionally, a majority of participants did not have any combat sport experience (77.7%) nor Tae Kwon Do experience (87.7%).

Procedure and Measures

Upon providing informed consent (see Appendix A), participants completed an online survey through the Qualtrics software system. The first part of the survey included questions asking about demographics, and participant experience with both combat sports and Tae Kwon Do, specifically. The remaining sections of the survey asked participants to complete a personality inventory and watch videos of Tae Kwon Do matches and rate each fighter's aggressiveness, strategy, and likelihood of winning. After completing the survey, participants were thanked for their participation and time, and were automatically granted one research credit toward the research participation requirement for their

introductory psychology course.

Demographics. Participants were asked to self-report the following information: age, gender identity, ethnicity, year in college, previous experience with combat sports in years, and previous experience with Tae Kwon Do in years. The age question was open-ended, while the gender identity, ethnicity, and year in college items provided predetermined categories for participants to choose from. Furthermore, the gender identity and ethnicity items had the option for respondents to self-identify with an open-ended response option if their identity was not represented in the provided categories. For the sport experience questions, participants were provided a 4-point Likert scale, ranging from 0 (*0 years*) to 3 (*5+ years*). Using this Likert scale, participants indicated how many years of experience they had with both combat sports and Tae Kwon Do.

Tae Kwon Do matches. Participants were provided with 14 total video clips of Tae Kwon Do matches. In each match, both fighters wore white uniforms, which is a long sleeve top and full-length pants, with their black belt tied around their waist. One fighter wore wear red gear (i.e., chest protector and head gear) and the other wore blue gear. Of the clips, there were two versions of 7 different sparring matches. One version of a match had one fighter wearing red gear, while the other fighter wore blue gear. The other version of the same match had the color of the fighter's gear be flipped; red to blue and blue to red. Images of both versions of one match are presented in Appendix B. All the clips were in low contrast (black and white) with the exception of the fighter's gear; the gear was chromatic, either red or blue. All graphics and score cards were digitally removed as to not sway perceptions of the fighters. Video clips showed a clash between fighters and an equal exchange of strikes. Video clips were selected from the following

prominent Tae Kwon Do competitions: 2012 Olympic Games, 2013 WTF World Tae

Kwon Do Championships, 2017 World Tae Kwon Do Championships, 2018 Roma

World Tae Kwon Do Grand Prix, 2018 Fujairah World Tae Kwon Do Grand Prix and

2019 World Tae Kwon Do Championships. Video clips were an average of 6.29 seconds

long, with the shortest clip being 5 seconds long and the longest clip being 9 seconds

long. After each clip was shown, participants were asked to assess the red fighter and

blue fighter, using a scale of 1 to 10, on their respective aggressiveness, strategy, and

likelihood to win the match. Video clips were sequestered into two sets: set A and set B.

Set A contained the 7 video clips with the fighters wearing their original colors. Set B

contained the 7 video clips with fighters wearing the opposite color. A single randomized

order was used in set A and in set B for all participants. This ensured that the last video in

set A and first video of set B were not different versions of the same fight, which could

be noticed by the participants. Additionally, it ensured that both versions of the same

fight were equidistant from one another in the survey for all participants. Participant

assessments of fighters across all 14 video clips were summed to find the total color-

quality rating, such as "total aggressiveness rating for red" and "total aggressiveness

rating for blue".

      The Big Five Inventory (BFI). The BFI (see Appendix C) is a 44-item measure

of a person's big five traits: extraversion ($\alpha = .88$), agreeableness ($\alpha = .79$), neuroticism

($\alpha = .84$), conscientiousness ($\alpha = .82$) and openness to experience ($\alpha = .81$; John &

Srivastava, 1999). The inventory is measured on a 5-point Likert scale, ranging from 1

(*disagree strongly*) to 5 (*strongly agree*). Those who take the inventory are asked to

assess their feelings of relatedness to each item in the inventory. Example items include

"is talkative", "can be moody", or "has few artistic interests" (John & Srivastava, 1999).

Attention and Manipulation Check. After the data collection process began, the researcher realized that including attention and manipulation checks would better ensure a higher-level quality of data for the analysis. Halfway through the video section, participants were provided three questions: "What are the people in these videos doing?", "Please select 'Neither agree nor disagree'", and "What is it called when two people are speaking to one another?". To pass this attention check, participants had to respond with "fighting", "neither agree nor disagree", and "talking" for the previously described questions. Two participants did not initially pass the attention check. However, these participants fully completed the survey items, and their responses did not differ from participants who passed the attention check, so their responses were included in analysis.

Additionally, at the end of the survey, participants were asked "What do you believe the purpose of this research study is?". This provided insight into whether data from a given participant should be included in analysis, particularly if they correctly determined the purpose of the study. Given that the listing for the present study on SONA was "Personality and Perception of Fighters" participant responses for the manipulation included "perception" and "personality". With that, two participants correctly guessed the role of fighter gear color in the study and their responses were not included in subsequent analyses. After the exclusions, 211 viable sets of participant responses were used for analyses.

Analytic Strategy

First, in order to assess differences in selection of fighters for aggressiveness, strategy and likelihood of winning, three separate paired-samples t-tests were used.

Paired samples t-tests assessed the difference in total scores given to the red fighters and blue fighters for each of the three qualities: aggressiveness, strategy, and likelihood of winning. Any statistically significant difference would indicate that a color-associated bias was employed by participants.

Next, mixed model regression was used to assess the influence of the Big Five on red fighter and blue fighter assessments. The mixed model regression included participant's Big Five personality trait scores as fixed effects, while participant id number functioned as a random intercept, allowing outcome variable to differ by participant. Three separate mixed model regressions were conducted, one for each dependent variable: aggression ratings, strategy ratings, and likelihood of winning ratings. Correlation coefficients were also provided, indicating the degree and direction of association between the predictor variables and the outcome variables, the difference in scores given to red fighters and blue fighters for aggressiveness, strategy, and likelihood of winning.

Given the present study will need to employ a total of six statistical tests, alpha inflation is a concern. With this in mind, the Bonferroni correction was used. This correction reduces the probability of Type I error by reducing the desired p-value criterion. For this study, the desired p-value for statistical significance is .008.

IV. RESULTS

The statistical program, *R* (R Core Team, 2021), was used for statistical analyses. Three separate paired samples t-tests were conducted to assess the differences in total ratings for red fighter versus blue fighter on aggressiveness, strategy, and likelihood of winning. There were no significant differences between any of the rating contexts: aggressiveness [$t(203) = -.72$, $p = .471$], strategy [$t(203) = -.38$, $p = .705$], and likelihood of winning [$t(204) = .49$, $p = .627$]. Means and standard deviations for each video condition can be found in Table 1.

Table 1.
Mean (and Standard Deviation) Values for Each Video Condition

Dependent variable	Blue fighters	Red fighters
Aggression rating ($n = 204$)	84.42 (16.36)	84.73 (15.76)
Strategy rating ($n = 204$)	81.02 (15.57)	81.21 (15.86)
Chance of winning rating ($n = 205$)	85.13 (16.03)	84.86 (16.72)

Three separate mixed effects models were created; one for differences in aggression ratings, one for differences in strategy ratings, and one for differences in chance of winning ratings. For all three models, the fixed effects were participant's Big Five personality trait scores, and the random intercept was the participant id number, allowing variability in intercepts for the outcome variable to differ by participant. Difference variables were calculated by subtracting total red scores from total blue scores (e.g., total aggression scores for blue fighters minus total aggression scores for red fighters), with positive values for these difference variables representing higher blue fighter ratings, while negative values meant red fighters were rated higher for the given characteristic.

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Mixed effects models were created using the "lme4" package (Bates et al., 2015) on *R*. When creating the models, all three models failed to converge, even after rescaling the variables and using a different optimizer, "nlminbwrap". Due to these convergence issues, cluster robust standard error estimation using the "sandwich" package (Zeileis et al., 2020) and "lmtest" package (Zeileis & Hothorn, 2002) were employed with the models. Set up for the models remained the same; the Big Five personality traits served as predictor variables, while participant id number functioned as the cluster variable.

For the aggression model, openness to experience ($B = .15$, $SE = .07$, $p = .041$) was initially found to be a significant predictor of the difference between ratings of red fighter and blue fighter aggression. However, with Bonferroni's correction this predictor was considered nonsignificant. The four other Big Five personality traits were found to be nonsignificant as well: agreeableness ($B = -.03$, $SE = .09$, $p = .717$), conscientiousness ($B = .04$, $SE = .09$, $p = .610$), neuroticism ($B = .02$, $SE = .08$, $p = .839$), and extraversion ($B = -.08$, $SE = .08$, $p = .321$).

For the strategy model, both openness to experience ($B = -.23$, $SE = .10$, $p = .020$) and agreeableness ($B = .21$, $SE = .11$, $p = .048$) were found to be significant predictors of the difference between ratings of red fighter and blue fighter strategic capabilities before Bonferroni's correction; after the correction, these two predictors were considered nonsignificant. The remaining three Big Five traits were additionally found to be nonsignificant: conscientiousness ($B = -.07$, $SE = .08$, $p = .421$), neuroticism ($B = -.09$, $SE = .09$, $p = .307$), and extraversion ($B = -.12$, $SE = .09$, $p = .197$).

Lastly, for the likelihood of winning model, none of the Big Five traits were found to be significant predictors of the difference between ratings of red fighter and blue

fighter likelihood of winning. Results of the model were as follows: openness to

experience ($B = .01$, $SE = .10$, $p = .927$), agreeableness ($B = -.11$, $SE = .12$, $p = .353$),

conscientiousness ($B = .08e-2$, $SE = .10$, $p = .994$), neuroticism ($B = -.06$, $SE = .10$, $p =$

$.530$) and extraversion ($B = -.12$, $SE = .10$, $p = .229$). Results of the preliminary

correlational analyses can be found in Table 2.

Table 2.
Correlational Analyses

Variable	1	2	3	4	5	6	7	8
1. EX	–							
2. AG	.19	–						
3. CON	.13	.32***	–					
4. NEU	-.43***	-.34***	-.30***	–				
5. OP	.23*	.20	.06	-.18	–			
6. DiffA	-.06	-.01	.02	.03	.12	–		
7. DiffS	-.09	.13	-.001	-.04	-.18	.25**	–	
8. DiffW	-.09	-.08	-.02	.01	-.02	.34***	.63***	–

Note. EX = Extraversion, AG = Agreeableness, CON = Conscientiousness, NEU = Neuroticism, OP = Openness to Experience, DiffA = Difference in Aggression, DiffS = Difference in Strategy, DiffW = Difference in Likelihood of Winning.
*$p < .05$. **$p < .01$. ***$p < .001$.

V. DISCUSSION

The present study aimed to explore whether color-emotion bias could be found among participants watching videos of combat sport matches, in which one fighter wore red and the other blue, while also determining whether personality traits could predict the difference between ratings of red fighters and blue fighters.

It was hypothesized that there would be color-emotion associations among participant ratings of fighters. Specifically, it was believed that participants would rate red fighters higher for aggression and likelihood of winning than blue fighters, while rating blue fighters higher for strategic ability than red fighters. The results did not support these hypotheses and differed from the findings of Hagemann and colleagues (2008); ratings for red fighters and ratings for blue fighters were not significantly different from one another for aggression, strategy, or likelihood of winning. With this, it could not be determined whether the color of combat gear that a fighter was wearing was associated with different perceptions of aggression, strategic ability, or likelihood of winning.

The lack of significant findings might be attributed to the difference in sample demographics between the present study and the study conducted by Hagemann and colleagues (2008). The sample recruited for the present study consisted of college students, the majority of whom did not have experience with combat sports nor Tae Kwon Do. Hagemann and colleagues (2008) recruited experienced Tae Kwon Do referees, who likely have been involved in Tae Kwon Do for a significant amount of time. The difference in samples and subsequent findings may be due to the fact that knowledge or experience with Tae Kwon Do may provide a context in which red fighter-

blue fighter assumptions may develop and thrive. For example, if this referee had some

assumptions regarding gear color that developed during their experiences sparring or

training, this may have influenced the findings of Hagemann and colleagues (2008).

Similarly, Hill and Barton (2005) utilized the results of the 2004 Olympic Games combat

sport events, including Tae Kwon Do. These results and mean rankings were determined

by experienced referees and judges, who also likely had profound experiences with Tae

Kwon Do.

For the current study's sample, the majority was female while the sample of

Hagemann and colleagues (2008) was majority male. With the findings of Wiedemann

and colleagues (2015) in mind, women did not demonstrate the same level of color-

emotion association biases that men did (i.e., female participants did not assess red-

wearing males to be more aggressive than the blue-wearing males, only grey-wearing

males; male participants assessed red-wearing males to be more aggressive than both

blue-wearing and grey-wearing males). With this, gender differences may provide some

insight into color-emotion association biases in Tae Kwon Do and other combat sports.

Additionally, it was hypothesized that low levels of openness, high levels of

neuroticism, high levels of extraversion, low levels of conscientiousness and low levels

of agreeableness would be significant predictors of the color-emotion associations.

Results similarly did not support these hypotheses. When taking Bonferroni's correction

into account, the Big Five personality traits did not serve as significant predictors for the

differences in aggression ratings, difference in strategy ratings, or difference in likelihood

of winning ratings.

Interestingly, of the relationships that were significant prior to Bonferroni's

correction, some predictors followed the predicted direction, while others did not, depending on the perception variable of focus. For example, openness to experience was a positive predictor for aggressiveness ratings. Keeping in mind that that higher difference scores meant blue fighters were rated as more aggressive than red fighters, the finding that openness was a positive predictor implies that lower openness scores were associated with negative difference scores (i.e., higher aggression ratings for red fighters than for blue fighters).

For strategy ratings, openness to experience and agreeableness were significant predictors at the .05 level; openness was a negative predictor and agreeableness was a positive predictor. Openness to experience was a negative predictor, meaning that as difference scores increased (i.e., higher strategy ratings for blue fighters than for red fighters), openness to experience scores were lower, which supports the hypothesized relationship between openness and cognitive biases. Blue fighters were hypothesized to be rated as more strategic than their red counterparts, and low levels of openness were believed to be associated with the color-emotion association bias of perceiving blue fighters as more strategic.

Additionally, agreeableness was a positive predictor of strategy rating differences, running contrary to the predicted direction of the relationship. These findings suggest that low agreeableness was more readily associated with red fighters being rated as more strategic than their blue counterparts. This finding implies that agreeableness was predictive of a color-emotion association biases (red fighter more strategic), but not the exact bias the researcher hypothesized (blue fighter more strategic).

Limitations

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There are limitations with the current study. First, response attrition was likely present due to the online nature of the study. The main part of the survey consisted of fourteen total videos, with six questions provided for each video. Given the amount of videos, the sole incentive being one point of extra credit, and that the average time it took to complete the survey was an hour, some participants may have become disengaged even if they answered the attention check questions correctly.

Second, attention checks and manipulation checks were included after the data collection process was underway. With that, some participants were not exposed to the checks, while others were; 7.6% of the participants completed the survey before the attention checks were included, and 28.4% of the participants completed the survey before the manipulation check was included. Participants who completed the survey before the addition of the checks were nonetheless included in analyses, as fighter ratings did not differ significantly between participants who were not exposed to the checks and participants who were exposed to the checks. Regardless, inclusion of the checks after data collection began is a limitation.

Third, the current study may have had low power due to its design and the circumstances of research at the time of this study. Insight provided by Westfall et al. (2014) indicated that higher numbers of stimuli (i.e., videos) would be needed to detect an effect, while increasingly larger sample sizes would have a negligible impact on power. As the COVID-19 pandemic made in-person data collection difficult, an online data collection methodology was used to ensure the safety of the participants and researchers. With the online format of the survey, a high number of videos would not have been feasible and would have ultimately led to more attrition than what may have

already been present.

Lastly, the current study was the first to quantitatively determine factors related to the previously found perceptual differences between red-wearing fighters and blue-wearing fighters. With this, there was no previous literature to base the current study's approach from. The findings of both Hill and Barton (2005) as well as Hagemann and colleagues (2008) found that fighters in red gear were more successful or were awarded more points that their opponent, while no insight had been provided for potential factors that could explain this phenomenon. The current study branched off in a new direction to explore potential factors of influence but was primarily based on theory and insights on cognitive biases. Fetterman et al. (2015) highlighted the significance of individual differences influencing a person's perception of the color red, while Ramos (2019) and others have emphasized the role of personality in cognitive biases. While this limitation ultimately does not diminish the value of this study, it is worth noting that it was the first to explore this specific area of research.

Future Directions

Given the null findings and limitations associated with the current study, the primary need would be to replicate this study while addressing the flaws in its design and execution. In-person data collection would be needed to ensure that participants were fully engaged throughout their participation, while also allowing for more videos to be shown to the participants during their session, increasing the power of the study.

Aside from the replication, more insight would be needed into how characteristic associations may arise with knowledge of Tae Kwon Do or combat sports. The current study utilized a college student sample, the majority of which had no experience with

combat sports nor Tae Kwon Do. Hill and Barton (2005) used the judging results from Tae Kwon Do events of the 2004 Olympic Games, while Hagemann and colleagues (2008) recruited actual Tae Kwon Do referees as participants, so in both studies, the data were from those with an extensive knowledge of Tae Kwon Do. While the current study came with limitations, the lack of findings among a college student sample may indicate that knowledge of or experience in Tae Kwon Do or combat sports may play a role in the perception of fighters' gear color.

Additionally, the future research in this area should focus on the role of gender on color-emotion association biases. The present study's sample consisted of a majority female participants and had null findings regarding the color-emotion association biases. Hagemann and colleagues (2008) had significant findings in this area, while using a sample that was majority male. In addition to this, Wiedemann and colleagues (2015) found that women endorsed less color-emotion association biases than males did when assessing the emotionality of males wearing either red, blue, or grey shirts. Given the discrepancies in detectability of the biases, gender may have an effect. Investigating whether gender groups differ in terms of their rating difference scores, for example, is worthwhile to area for further exploration.

Conclusion

The current study aimed to determine whether there was a difference in perception of fighters wearing either red or blue combat gear, as well as if personality traits could predict the difference in ratings for the red fighters and blue fighters. The null findings of the study run contrary to the results of previous studies in which red fighters were found to be more successful against their blue geared opponents. These null

findings could be attributed to a few factors, such as the population that the sample was recruited from or the online nature of the study. The insights and experiences gained through this study will inform future attempts of this type of research. Further understanding on the commonality of red fighter bias across populations is needed to determine if this is a phenomenon centered on those with knowledge of Tae Kwon Do or combat sports. Additionally, awareness as to whether person-based factors, like personality, are related to gear color bias in a sample that is knowledgeable about Tae Kwon Do or combat sports is vital.

APPENDIX SECTION

APPENDIX A: CONSENT FORM

Donald Christopher Garcia MacPhail, a graduate student at Texas State University, is conducting a research study to learn more about the role of personality traits in biased Tae Kwon Do scoring. You are being asked to complete this survey because you are an undergraduate student at Texas State University.

Participation is voluntary. The survey will take approximately 30 minutes or less to complete. You must be at least 18 years old to take this survey.

This study involves no foreseeable serious risks. We ask that you try to answer all questions; however, if there are any items that make you uncomfortable or that you would prefer to skip, please leave the answer blank. Your responses are anonymous.

Possible benefits from this study include the creation of possible solutions towards the improvement of judging for Olympic combat sports, as well as the promotion of fairness in competition.

Reasonable efforts will be made to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team, the funding agency (remove funding agency if study is not funded), and the Texas State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name will not be used in any written reports or publications which result from this research, (remove this sentence if not applicable to your study). Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

You will receive automatically receive one research credit toward the research participation requirement for your introductory psychology course.

If you have any questions or concerns feel free to contact Donald Christopher Garcia MacPhail, or his faculty advisor:

Principal Investigator:
Donald Christopher Garcia MacPhail
Graduate Student, MAPR
dcm166@txstate.edu

Co-Investigator/Faculty Advisor:
Dr. Randall Osborne
**Professor of Psychology**
ro10@txstate.edu

This project 7644 was approved by the Texas State IRB on March 2, 2021. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB chair, Dr. Denise Gobert

512-716-2652 – (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

If you would prefer not to participate, please do not fill out a survey.

If you consent to participate, please complete the survey.
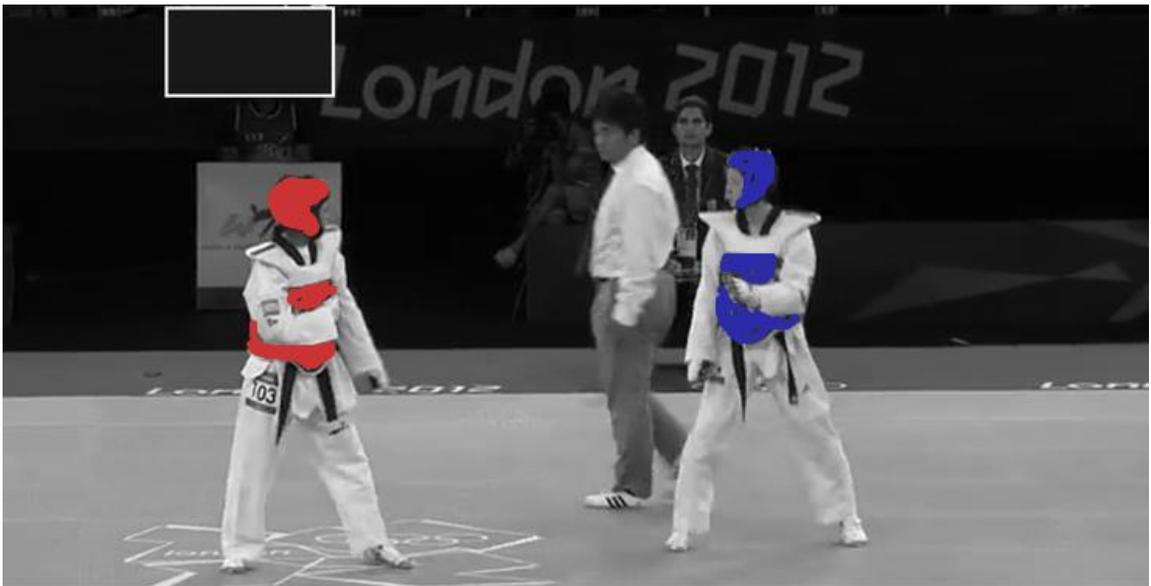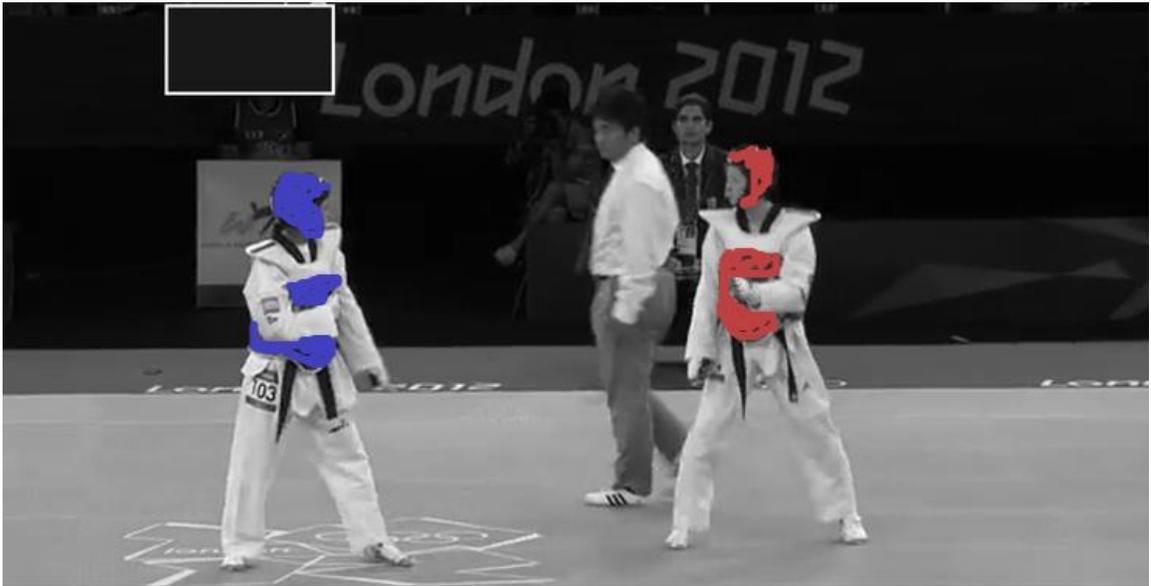
APPENDIX C: THE BIG FIVE INVENTORY

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

Disagree strongly	Disagree a little	Neither agree nor disagree	Agree a little	Agree strongly
1	2	3	4	5

I see Myself as Someone Who...

_____1. Is talkative
_____2. Tends to find fault with others
_____3. Does a thorough job
_____4. Is depressed, blue
_____5. Is original, comes up with new ideas
_____6. Is reserved
_____7. Is helpful and unselfish with others
_____8. Can be somewhat careless
_____9. Is relaxed, handles stress well
_____10. Is curious about many different things
_____11. Is full of energy
_____12. Starts quarrels with others
_____13. Is a reliable worker
_____14. Can be tense
_____15. Is ingenious, a deep thinker
_____16. Generates a lot of enthusiasm
_____17. Has a forgiving nature
_____18. Tends to be disorganized
_____19. Worries a lot
_____20. Has an active imagination
_____21. Tends to be quiet
_____22. Is generally trusting
_____23. Tends to be lazy
_____24. Is emotionally stable, not easily upset
_____25. Is inventive
_____26. Has an assertive personality
_____27. Can be cold and aloof
_____28. Perseveres until the task is finished
_____29. Can be moody
_____30. Values artistic, aesthetic experiences
_____31. Is sometimes shy, inhibited

____32. Is considerate and kind to almost everyone
____33. Does things efficiently
____34. Remains calm in tense situations
____35. Prefers work that is routine
____36. Is outgoing, sociable
____37. Is sometimes rude to others
____38. Makes plans and follows through with them
____39. Gets nervous easily
____40. Likes to reflect, play with ideas
____41. Has few artistic interests
____42. Likes to cooperate with others
____43. Is easily distracted
____44. Is sophisticated in art, music, or literature

Scoring: BFI scale scoring ("R" denotes reverse-scored items):

Extraversion: 1, 6R, 11, 16, 21R, 26, 31R, 36
Agreeableness: 2R, 7, 12R, 17, 22, 27R, 32, 37R, 42
Conscientiousness: 3, 8R, 13, 18R, 23R, 28, 33, 38, 43R
Neuroticism: 4, 9R, 14, 19, 24R, 29, 34R, 39
Openness: 5, 10, 15, 20, 25, 30, 35R, 40, 41R, 44

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