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How different shades of red T-shirts enhance the perceived attractiveness of Asian women in digital photographs

Hye Rim Hong[1*] and Young In Kim[2]

*Correspondence:
lonnykh@gmail.com
[1] Dept. Beauty Arts, Jeonghwa Arts College, 21 Toegye-ro 16-gil, Jung-gu, Seoul 04631, Republic of Korea
Full list of author information is available at the end of the article

Abstract

This paper investigates whether different shades of red clothes increase women's perceived attractiveness to men and women in digital photographs. We also examined whether there was any variance in perceived attraction according to the color shade of clothes due to personal physical color traits based on Personal Color Analysis System. Participants evaluated a woman's attractiveness presented in a photograph featuring different skin and hair colors and t-shirts in four red shades. The results indicate that the four different red shades—low chroma/high value, low chroma/medium value, high chroma/medium value, and low chroma/low value—examined in this study can enhance female attractiveness on a digital photo. Significantly, the high chroma and medium value—often considered vivid—red had a greater appeal to males and females in most skin and hair color types. This study is the first to investigate the perceived attractiveness of Asians wearing red in the context of digital photographs. The findings give insight to people and marketers with a better understanding perceived attractiveness of red clothing in digital photos. Additionally, this study confirms that the value and chroma of color, which was overlooked in previous research, should be considered as variables in studies of clothing color meanings.

Keywords: Appearance, Attractiveness, Clothing color, Digital fashion communication, Digital photography, Perception, Social networking

Introduction

Social networking has become central to social interaction. The primary functions of social networking services, such as Facebook and Instagram, can be self-presentation and social connection for users (Lee & Hwang, 2020). In traditional face-to-face venues, multiple communication channels, including words, tone of voice, facial expressions, gestures, and immediate feedback, are offered (Daft & Lengel, 1986). People make inferences about others based on these gleaned scraps of information. On the other hand, in social networking, a type of computer-mediated communication, only featuring people's digital photographs, the cues are much more restrictive (Howlett et al., 2013). Nevertheless, people continue to make inferences about others in digital social contexts based on insufficient cues (Ellison et al., 2006; Walther, 1992).

Over the past decade, different social media channels have encouraged users to portray themselves through photographs in the context of online communities. In terms of face-to-face interaction, theories of interpersonal judgments have historically highlighted the significance of physical attributes (Dion et al., 1972; Walster et al., 1966). Therefore, with insufficient information on social networking platforms, profile information would contribute to the judgment of impressions, including attractiveness. In particular, photos (serving as substitutional information of appearance in face-to-face interaction) were a strong predictor of the inferences as a whole. The asynchronous nature of computer-mediated communication emphasizes the role of pictures as nonverbal communication cues. Users' photos of profiles on online dating sites can increase potential dates (Whitty and Carr, 2006). Similarly, a user's profile with a picture on LinkedIn can benefit from creating social attractiveness, which may increase an individual's chances of getting hired, compared to a profile without a photo (Edwards et al., 2015).

Attractiveness or attraction emotion, defined as a quality that arouses interest, desire in, or gravitation to an object, elicits momentary reactions of liking and disliking. Liking or attraction is occasioned by reacting positively toward an appealing object, while aversion or dislike is occasioned by reacting negatively toward the object. In comparison to other emotions, attraction appears to be more instantaneous, spontaneous, and less impacted by accessible cognitive processes (Ortony et al., 1990).

Attractiveness is a significant factor in many choices in daily life. However, since each choice involves different problems and stimuli, no general definition of attractiveness is applied to all stimuli (Buss, 2005). According to Ortony et al. (1990), charm and physical appearance almost certainly influence the intensity of attraction toward a person.

Attractiveness has received much attention in research on the impressions of physical traits, especially faces. Many social psychologists have identified attractiveness, leading to inferences that more attractive people are more sociable, competent, confident, and healthier than their less attractive peers (Eagly et al., 1991; Feingold, 1992; Langlois et al., 2000; Miller, 1970; Zebrowitz & Mcdonald, 1991). Moreover, researchers have found that these judgments are accompanied by preferential treatment of attractive people in work place and personal relationship. Attractive people are more likely to be hired, more effective in work prospects, have higher wages, and healthier personal relationships than less attractive people (Benzeval et al., 2013; Hakim, 2010; Hamermesh and Biddle, 1994; Hosoda et al., 2003; Ruffle and Shtudiner, 2015).

People tend to infer personality traits from individuals' appearances. The judgement about confidence, success, salary, flexibility are affected by clothing style (Howlett et al., 2013). Clothing, type of suit, shoes, colour and fit of garments affect perceptions of personal behaviors, biological traits, health and hygiene, and social roles (Johnson et al., 2002). Perceived attractiveness, are often judged by nonverbal factors including height, weight, face, and hair color, as well as grooming and adornment practices such as clothing and color style (Burgoon et al., 2011).

Impressions are formed unconsciously based on nonverbal signs of communication. Willis and Todorov (2006) revealed that it only takes 100 ms to form an impression of a stranger from their faces. Furthermore, a longer exposure time does not significantly alter these impressions. Personality, social status, behaviors, and physiological and biological traits are inferred from people's appearances. People make immediate judgments

about the likability, attractiveness, trustworthiness, and competence of a person based on their appearance and dress cues (Johnson et al., 2002; Willis & Todorov, 2006).

Whether we are aware of it or not, color significantly affects our behavior, emotions, and social communication (Hill & Barton, 2005; Maier et al., 2013; Pazda et al., 2014; Roberts et al., 2010). On this basis, skin color also influences the perception of attractiveness (Fink et al., 2006; Jones et al., 2004). Moreover, some studies have examined the effect of clothing color on courtship perception and behavior (Elliot & Niesta, 2008; Elliot & Pazda, 2012; Peperkoorn et al., 2016). While genetic skin color differs significantly, human beings alter it by different types of ornamentation, such as makeup, tanning, and dying their hair or clothing. As subtle variations in skin color influence social perception (Stephen et al., 2012a, 2012b), altering the colors of clothing can change people's perspectives. Mahannah (1968, cited in Radeloff, 1990) found that clothing color is one of the most significant factors in forming impressions, expressing themselves, and evaluating others. Radeloff (1990) discovered that clothing colors are more important in forming impressions than facial expressions or clothing styles. Clothing color can, therefore, profoundly affect impression formation.

Many studies have examined the influence of clothing colors, especially the color red, believed to enhance women's attractiveness in a face-to-face context. Only a few studies have examined this phenomenon in an online context. However, some studies have used photographs as stimuli in face-to-face red clothing experiments (Elliot & Niesta, 2008), leading to uncertainty in the results. The red color can come in hundreds of variations. Many studies have paid less attention to ensuring that the range of hues and shades in red are clear-cut, making substantial application vague. Some studies of clothing color effects in cyber circumstances did not use computerized color values, nor did they control other variables such as facial expression, color saturation, and shade on the stimuli (Guéguen & Jacob, 2013; Saito, 1996).

Other studies have investigated color appropriateness and impressions regarding individual physical colors based on color hue, lightness, and chroma. They insisted that the lightness and chroma of the clothing color harmonize with an individual's physical color characteristics, such as skin or hair color, and increases their attractiveness and self-esteem in the first impression (Jackson, 2011; Nicholson & Lewis-Crum, 1986; Revelli, 1982). Based on personal color analysis, a particular red tone might not suit some people. Even when wearing the same color, different impressions might result from individual physical color differences, resulting in inconsistent research findings on the effect of red clothing. According to Francis and Evans (1987), a change in clothing value has the most significant effect on assessing an individual's traits. Bright-colored clothes tend to give a more favorable impression than dark-colored ones. Thus, we need to consider the systematic chroma and value of colors when researching the influence of clothing colors on digital photos.

People try to create a good impression by strategically performing appropriate behaviors following conventions in social contexts (Goffman, 1959). These self-presentational management behaviors are also found in online communication (Shafie et al., 2012). Based on previous research, clothing color, primarily red, may help people look more attractive, leading to being beneficial in computer-mediated communication, which is now mainstream. Thus, the purposes of this study are as follows:

1. Examining the changes in attractiveness ratings perceived from different shades of red clothes regarding the wearer's skin and hair colors in digital photographs.

2. Comparing the differences of attractiveness ratings perceived from different shades of red clothes by males and females.

Literature review

Red color

Red is associated with positive concepts such as excitement, love, romance, warmth, activity, and strength. However, it is also associated with negative images such as danger, fear of failure, blood, and Satan (Mahnke, 1996). Historically, red has been an aristocratic color for clothing in Western and Eastern cultures. Pastoureau (2017) suggested that the color's elite status stems from the cost of the dye. The red fabric was historically expensive; hence only rulers and nobles could afford it.

On the other hand, red has also been affiliated with prostitution for a long time. By the end of the medieval era, some municipal regulations required prostitutes to wear garish-colored clothing, usually a loud red, distinguishing them from decent women (Pastoureau, 2017). In the early twentieth century, prostitutes advertised their services with red lights and red garments in many countries. The neighborhoods of prostitutes became known as red-light districts (St Clair, 2016).

Red is a color often affiliated with sexuality because red has remained the color of seduction. Previous research has shown that the color red signaled greater sexual receptivity (Pazda et al., 2012). Pazda et al. (2012) revealed a link between the color red, attractiveness judgment, and perceived sexual receptivity. This is supported by nonhuman primates' use of red to indicate fertility (Deschner et al., 2004; Dixson, 1983). Recent surveys show that men find feminine red underwear more attractive than black or white (Pastoureau, 2017).

Red is a color that attracts attention. Highly saturated red attracts attention by making human vision feel closer than other colors because of its long wavelength (Egusa, 1983). Theater curtains were traditionally blue in the eighteenth century. They changed to red when new lighting demonstrated the best benefit for actors to be a red ambiance. Subsequently, the curtains, stage, and the whole hall remained red. Red became the emblematic color of theater and opera (Pastoureau, 2017) and remains so today.

While red may no longer be a symbol of prostitution today, it continues to be a color of sensuality and femininity. Furthermore, red remains one of the most vital and distinctive colors.

Attractiveness and red clothing

Previous studies found that red can have both positive and adverse effects on perceived attractiveness, depending on the social context. In many circumstances, red has a positive impact on women's perceived attractiveness. Elliot and Niesta (2008) found that women dressed in red are found to be more attractive than women wearing blue. Men also tend to sit closer to women wearing red, suggesting a physical attraction (Niesta et al., 2010). Moreover, men offered more rides to female hitchhikers dressed in red than to those wearing other colors (Guéguen, 2012). Guéguen and Jacob (2014) found that waitresses dressed in red received relatively higher tips from male customers than

female customers. However, Lynn et al. (2016) found the opposite; in their study, waitresses dressed in red received relatively lower tips from men than waitresses dressed in white or black. Waiters dressed in red received smaller tips from female customers than waiters dressed in white or black. Even though the experiments were conducted in the same context, the studies did not control red shades, skin/hair color, facial expressions, and other variables, which could have caused differences.

Personal color analysis

The personal color analysis system, also referred to as color analysis, skin-tone matching, or seasonal color analysis, is often used in the fashion, cosmetic, and image consulting industries. It is a valuable tool for proposing clothing and makeup that complements a person's skin, hair, and eye color for individual wardrobe planning and image consulting. The color analysis system creates optical illusions to show how particular colors can be flattering or unflattering by placing specific colors next to a person's face that clashing colors will accentuate flaws, such as wrinkles, irregular skin texture, and complexion, while complementary colors will naturally enhance personal beauty, making people look healthier and fresher (Jackson, 2011; Nicholson & Lewis-Crum, 1986; Revelli, 1982; Brown & Rojas, 2014).

Researchers have investigated dress colors that focus on personal coloring differences (Abramov, 1985; Francis & Evans, 1987; Hilliker and Rogers, 1988; Radeloff, 1990). Indeed, some studies found that a clothing color that harmonizes with an individual's physical characteristics, such as skin or hair color, increases their physical attractiveness (Jackson, 2011; Nicholson & Lewis-Crum, 1986; Revelli, 1982). Moreover, Gibson and Balkwell (1990) found that appropriating clothing colors can increase employment possibilities by affecting creativity perceptions. Furthermore, color appropriateness was also correlated with the gender of job seekers and respondents. It impacted women who sought sales positions were given improved ratings by other women's perception of loyalty (Gibson & Balkwell, 1990). Therefore, this study aims to examine how individual skin and hair color types are affected by different shades of red based on the personal color system.

Three components of color

Color is determined by three fundamental attributes: hue, lightness (value), and chroma (saturation). The hue is the color itself, such as red, orange, or yellow. Human eyes differentiate between hues by wavelength. In common understanding, warm colors—red, orange, or yellow—have longer wavelengths than cool colors—blue, green, or purple. Pure red has the longest wavelength. Lightness, also known as value or brightness, is the white-to-black color state. Chroma, also called saturation or colorfulness, refers to the intensity of color purity (Jalil et al., 2012). Any of these attributes can affect our emotional reactions (Camgöz et al., 2004; Suk & Irtel, 2010; Valdez & Mehrabian, 1994).

People's preferences and effects of color can be different according to to the color attributes. Radeloff (1989) found that college students preferred warm hues to cool hues. Regarding chroma, they preferred dull colors to others. An earlier study found that, after hair color, the color value of clothing had the most significant impact on assessing an individual's traits. That bright colors tended to give a more favorable impression than

dark colors (Francis & Evans, 1987). Francis and Evans (1988) discovered that when college recruiters are interviewing for jobs, the interviewee's garment color lightness had a more significant effect than hue on employment suitability. Radeloff (1990) found that gender is another factor that can determine emotional reactions to color stimuli. Men preferred higher chroma and darker colors for themselves to a much higher degree than women. Men preferred blue, and women favored magentas.

However, some studies have examined the effects of clothing colors and color stimuli based on unregulated variables; they evaluated the influence of hue without controlling for lightness and chroma (Guéguen, 2012; Maier et al., 2013; Roberts et al., 2010). An alteration of more than one variable at a time could lead to distorted results.

Methods

Participants

Online social media usage surveys show notable differences in the use of social media by age. Younger generations, especially those between 19 and 24 years of age, stand out for social media consumption compared to older groups (Aaron & Monica, 2018; Shin et al., 2017). Thus, we recruited men and women respondents born between 1995 and 2000 who live in Seoul or other metropolitan areas of South Korea. An online research agency, http://embrain.com, recruited participants. The agency approached the respondents via an email link to the survey website. Once logged on to the site, each participant assesses the attractiveness range of the pictures presented below in random order. The participants were informed that the survey aimed to examine the relationship between fashion, color, and image. They were notified that the data collected from the questionnaire would only be used for the study. Four hundred thirty-one undergraduate students participated in the study, with 52.2% of the respondents being female and 47.8% male (227 females and 204 males). Their ages ranged from 19 to 24 years, with a mean age of 21.8 (SD = 1.609). This age group is the most comfortable with digital media and the most common users of social media (Aaron & Monica, 2018).

Color system

In the field of colorimetry, the Munsell Color System is internationally known for its reliable identification process (Valdez & Mehrabian, 1994). The Munsell Color System is a numerical scale based on a three-dimensional model depiction of the Munsell color tree. According to this system, each color, composed of hue, value, and chroma, has a logical and visual relationship with all other colors. This system has five principal hues: red, yellow, green, blue, and purple, placed at equal intervals around a circle. It inserts "yellow–red, green–yellow, blue–green, purple–blue, and red–purple" as intermediate hues for a total of ten hues. It uses initials to designate the ten hues: R, YR, Y, GY, G, BG, B, PB, P, and RP. The value indicates the color's degree of lightness or darkness. The scale of value ranges from 0 (pure black) to 10 (pure white). The third property of color is chroma, the degree of purity or vividness of a hue. Colors with low chroma are said to be "weak," while those with a high chroma are "highly saturated," "strong," or "vivid" when compared with a neutral gray of the same value. The chroma scale starts at 0 for neutral colors, and the scale of all units is constant. If a gray started at zero chroma, and red was

gradually added until the chroma was vivid red, the chroma value would have increased ("Munsell Color," n.d.).

In this study, red stimuli were selected in the range of R, following the Munsell Color System, to examine the changes in perceived attractiveness caused by different shades of red t-shirts combined with women's physical colors in photographs. This study compares how different shades of red influence different perceptions of attractiveness in men and women.

Selection of hair and skin colors used for stimuli in the experiment

For consistency of stimuli manipulation, we employed the Personal Color Design System (PCDS). Like other color analysis systems, the PCDS was designed for face-to-face color analysis and was not optimized for online experiments. Therefore, we used the mobile application of PCDS, recreated by Hong and Kim (2019), transforming the numerical digital color data from the analog color analysis system.

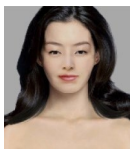
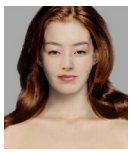
Nicholson and Lewis-Crum (1986) and Flusser (2002) have suggested that it is possible to enhance attractiveness based on the level of contrast between a person's skin tone, hair and eye colours. The PCDS also classifies people based on the value contrast between an individual's skin and hair color and suggests flattering colors for clothing or makeup. However, it focused on Asian. In general, regarding personal color analysis system, low contrast indicates that the values of hair and skin blend into each other. A high contrast indicates a sharp difference between the skin and hair values. Flattering colors complement the level of contrast (Flusser, 2002; Hong & Kim, 2019; Nicholson & Lewis-Crum, 1986). For example, for light hair and light skin, which is low-contrast, tints are suggested as flattering colors. Flattering colors for very high-contrast levels would be pure (Hong & Kim, 2019).

PCDS classifies Asian into four types. It provides nine skin color sample combinations of base colors (reddish, yellowish, and neutral) and brightness (bright, medium-bright, and dark). It also provides seven hair color samples, focusing on the brightness and color of the hair. PCDS Types 1 and 2 include people with fair skin, further classified by their hair color. People with high contrast between light skin and dark hair (Type 1) can wear vivid, intense colors which complement the high-contrast level between skin and hair color. However, light hair and light skin (Type 2) appear more attractive when they wear pale colors of low contrast with hair and skin colors. Type 3 includes people with medium color skin and medium hair color. This group's most flattering colors are dull colors of low contrast with hair and skin colors. Type 4 consists of dark skin and dark hair, for whom dark colors are the most aesthetically enhancing (Kim et al., 2003; Matsuura, 2004). We used neutral base skin color only to control for the impact of a reddish or yellowish base (see Table 1).

Selection of red shades for stimuli

The PCDS recommends different flattering colors for each skin-and-hair color combination. Out of these, we removed one left within the red hue range in each group to reduce the survey length and prevent respondent fatigue. The colors left were low-chroma/high-value, low-chroma/medium-value, high-chroma/medium-value, and low-chroma/low-value red (Fig. 1). Since the PCDS flattering colors were analyzed based on the color

Table 1 Photographs for types of skin and hair color

Type	Type 1 Bright skin/Dark hair		Type 2 Bright skin/Bright hair		Type 3 Medium-bright skin/ Medium-bright hair		Type 4 Dark skin/Dark hair	
Photo								
	Skin	Hair	Skin	Hair	Skin	Hair	Skin	Hair
Munsell H/ VC	4YR 8/3	8YR 2/1	4YR 8/3	4YR 3/6	4YR 8/4	4YR 3/4	5YR 7/4	10YR 2/3
RGB	237.206. 186	62.56.53	237.206. 186	131.83.55	132.194.171	110.75.57	199.164.141	79.46.45

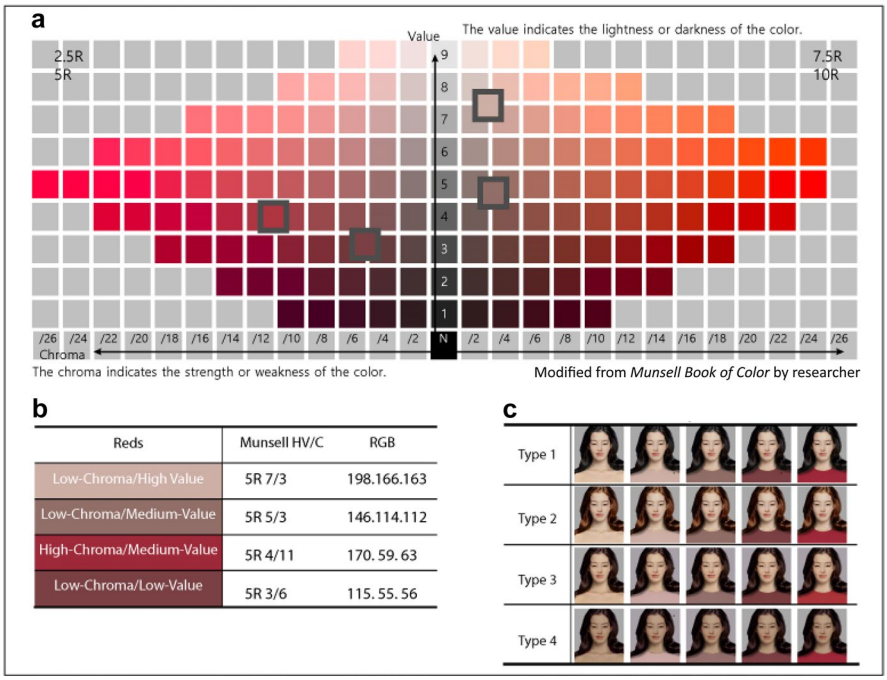


Fig. 1 The color dimensions of four reds as stimuli. **a** The color dimensions of four reds as stimuli. **b** Munsell color codes with RGB of four reds. **c** The combinations of the photo stimuli

data gathered from the investigation of actual skin/hair color measured using a spectrocolorimeter (Lee et al., 2003), they were not evenly distributed in chroma and value. Nevertheless, to verify the personal color principle, we decided to use the red color without modifying the PCDS.

We used 20 digital photos of women (measuring 480 pixels * 553 pixels) with the four types of skin and hair color combinations as stimuli. We manipulated the skin, hair, and t-shirt colors on the same woman using Photoshop to control for face, facial expressions, and posture. The pictures all had the same face and hairstyle from the upper chest to the top of the head. The four photos had four different shades of red t-shirts, and in one photo, the woman is naked for comparison.

Some researchers have found background color to affect stimuli perception. For this reason, all the photos' background color was neutral gray (Munsell N5) to avoid such effects (Camgöz et al., 2004; Elliot et al., 2010; Elliot & Niesta, 2008; Nunnally & Bernstein, 1994). Twenty combinations (5 × 4) of the photo stimuli are shown in Fig. 1.

Perceived attractiveness scale

We employed Elliot et al.'s (2010) perceived attractiveness scale for the survey questionnaire. One item was a statement, and the other two items were questions. We modified the questions into statements for consistency. The statement items were: "The person in this picture is attractive," "When I look at the person in this picture, I feel pleasant," and "If I were to meet the person in this picture face to face, I would think she is attractive." Items were measured on a Likert-style scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicated that the respondents felt more attracted to the person in the picture.

The participants were shown 480 * 553 (pixels) size stimuli photos on the computer screen and were required to rate three questions of the perceived attractiveness scale. Each page on the computer had only one stimulus photo in the center, and questions were placed below the photo. When participants clicked "next," a randomly ordered photo was shown.

Data analyses

All analyses were performed using SPSS software, version 25.0. We analyzed the data using ANOVA, *t*-test, Cronbach's reliability, and Duncan's Multiple Range Test to examine the influence of different shades of red clothing on a woman's perceived attractiveness.

Results

Estimating reliability

The reliability of the construct was evaluated using Cronbach's alpha. The attractiveness scale's three-item reliability coefficient for perceived attractiveness was 0.901, which is considered reliable (Nunnally & Bernstein, 1994).

The results of the T-test of perceived attractiveness

To compare the perceived attractiveness responses of male and female participants to each PCDS type without the influence of color stimuli, we compared the responses to the photos in which the woman was not wearing a t-shirt to the ANOVA results. Female respondents rated the attractiveness of all PCDS types higher than males. Male respondents rated Type 2 (bright skin/bright hair) as the most attractive. The female results indicate that there is no significant difference in the attractiveness of the four PCDS types. Still, the women perceived Type 4 (dark skin/dark hair) as slightly more attractive than others (see Table 2).

The relationship between shades of red and perceived attractiveness

Table 3 summarizes the responses to all types of stimuli. We have used the subscript "level of chroma/level of value" to indicate a specific red shade. For example, the

Table 2 The results of the *T*-test for perceived attractiveness

	Perceived attractiveness					
	Type 1 Bright skin/Dark hair	**Type 2 Bright skin/Bright hair**	**Type 3 Medium-bright skin/Medium-bright hair**	**Type 4 Dark skin/Dark hair**	***df***	**F**
Male	$2.22 \pm .72_{b}$	$2.49 \pm .74_{a}$	$2.24 \pm .75_{b}$	$2.22 \pm .76_{b}$	3, 404	2.984**
Female	$2.76 \pm .83$	$2.71 \pm .72$	$2.68 \pm .74$	$2.84 \pm .85$	3, 450	0.947

Table 3 F-values and means for perceived attractiveness acquired from ANOVA

		Tones of red						
		No T-shirt	**Low chroma/ high value**	**Low chroma/ medium value**	**High chroma/ medium value**	**Low chroma/ low value**	***df***	**F**
Type 1	Male	$2.22 \pm .73_{c}$	$2.57 \pm .85_{b}$	$2.74 \pm .80_{ab}$	$\mathbf{2.75 \pm .92_{a}}$	$2.54 \pm .90_{b}$	4, 506	6.549***
	Female	$2.76 \pm .83_{c}$	$2.92 \pm .81_{bc}$	$3.06 \pm .83_{ab}$	$\mathbf{3.19 \pm .81_{a}}$	$2.99 \pm .85_{ab}$	4, 562	4.224**
	Total	$2.50 \pm .83_{c}$	$2.76 \pm .85_{b}$	$2.77 \pm .90_{b}$	$2.98 \pm .89_{a}$	$2.91 \pm .83_{ab}$		9.733***
Type 2	Male	$2.49 \pm .74_{b}$	$2.53 \pm .90_{b}$	$2.62 \pm .94_{b}$	$\mathbf{2.94 \pm .88_{a}}$	$2.63 \pm .94_{b}$	4, 504	4.127**
	Female	$2.71 \pm .72_{b}$	$2.77 \pm .87_{b}$	$2.73 \pm .89_{b}$	$\mathbf{3.06 \pm .85_{a}}$	$2.80 \pm .87_{b}$	4, 563	3.265*
	Total	$2.60 \pm .74_{b}$	$2.66 \pm .89_{b}$	$2.68 \pm .92_{b}$	$3.00 \pm .86_{a}$	$2.72_{b} \pm .91$		7.170***
Type 3	Male	$2.25 \pm .75_{c}$	$2.63 \pm .82_{ab}$	$2.47 \pm .89_{bc}$	$\mathbf{2.83 \pm .1.03_{a}}$	$2.53 \pm .78_{b}$	4, 504	6.192***
	Female	$2.68 \pm .74_{c}$	$2.91 \pm .84_{b}$	$3.00 \pm .78_{ab}$	$\mathbf{3.14 \pm .81_{a}}$	$2.94 \pm .80_{ab}$	4, 563	5.116***
	Total	$2.47 \pm .77_{c}$	$2.78 \pm .84_{b}$	$2.75 \pm .87_{b}$	$2.99 \pm .93_{a}$	$2.75 \pm .82_{b}$		10.006***
Type 4	Male	$2.22 \pm .76_{b}$	$\mathbf{2.53 \pm .80_{a}}$	$2.28 \pm .80_{b}$	$\mathbf{2.63 \pm .84_{a}}$	$2.28 \pm .78_{b}$	4, 506	5.184***
	Female	$\mathbf{2.84 \pm .85_{a}}$	$2.42 \pm .86_{b}$	$2.57 \pm .83_{b}$	$2.56 \pm .78_{b}$	$2.63 \pm .82_{ab}$	4, 562	3.946**
	Total	$2.55 \pm .86$	$2.47 \pm .83$	$2.43 \pm .83$	$2.59 \pm .81$	$2.46 \pm .82$		1.451

Bold emphasis means the significantly highest average of perceived attractiveness

ANOVA: analysis of variance. Perceived attractiveness scale: 1 (strongly disagree) to 5 (strongly agree). Means were ranked by a, b, and c, ordered by the magnitude of the value

*p ≤ .01, **p ≤ .001, ***p ≤ .0001

subscript "high/medium" indicates a high chroma and medium value. All the results for the four types were significant for both men and women.

For Type 1, four shades of red significantly enhanced the woman's perceived attractiveness for both males and females, compared with the control photo. The perceived attractiveness of high-chroma and medium-value red was higher than any of the other reds. For male respondents, the mean of high-chroma and medium-value red was higher than any other reds. For female respondents, the mean of high-chroma and medium-value red was also higher than any other reds. The increase in male respondents' perception of attractiveness ($M_{high/medium} = 2.75$, $M_{none} = 2.22$) was higher than that of female respondents ($M_{high/medium} = 3.19$, $M_{none} = 2.76$).

For Type 2, high-chroma and medium-value red significantly increased perceived attractiveness for men and women compared with the control photo. The other three shades of red were not statistically different from the control. The mean of male respondents for high-chroma and medium-value red was the highest among the different shades of red. Female respondents also evaluated high-chroma and medium-value red as the most attractive red compared to the others. The increase of the male respondents' perception of attractiveness ($M_{high/medium} = 2.94$, vs. $M_{none} = 2.49$) was higher than that of

the female respondents ($M_{high/medium} = 3.06$ vs. $M_{none} = 2.71$), compared with the control image.

For Type 3, all four shades of red significantly enhanced the woman's perceived attractiveness in the photo for males and females compared with the control. In Type 3, both male and female respondents' mean of high-chroma and medium-value red attractiveness was the highest. Compared with the control image, the increase in the males' perception of attractiveness ($M_{high/medium} = 2.83$, $M_{none} = 2.25$) was higher than that of female respondents ($M_{high/medium} = 3.14$, $M_{none} = 2.68$).

For Type 4, the positive effect of red on perceived attractiveness was apparent only for male respondents in the high-chroma/medium-value and low-chroma/high-value reds compared with the control. The females' perception of attractiveness significantly decreased for all four shades of red compared with the control.

Different shades of red t-shirts produced different ratings of perceived attractiveness in male and female respondents. This result implies that the red-attractive effect works in photographs, and that chroma and value can affect people's perception of attractiveness differently. The results of the respondents' ratings on a 5-point scale indicate that the high-chroma/medium-value red was the most attractive clothing color for both men and women, regardless of the skin and hair types.

However, the second-highest ratings of red were different for different skin and hair types. Type 1 (bright skin/dark hair) received the second-highest rating from both genders when the woman wore a low-chroma and medium-value red. The Type 3 (medium-bright skin/medium-bright hair) image received the second-highest rating from males when the woman wore a low-chroma/high-value red. However, female respondents gave the second-highest rating when she wore a low-chroma/medium-value red. Type 4 (dark skin/dark hair) received the second-highest rating from male respondents when the woman wore a low-chroma/high-value red. These results show that personal colors could be partially related to people's perceptions of attractiveness in red-colored t-shirts.

According to the ratings of images where the woman wore no t-shirt, men evaluated Type 2 (bright skin/bright hair) as the most attractive. When the woman wore a high-chroma/medium-value red, men still rated Type 2 as the most attractive. The result implies that red t-shirts could increase a woman's attractiveness in photographs but might not exceed the perception of attractiveness influenced by her natural physical colors.

Discussion and conclusion

This study examined whether varying shades of red t-shirts worn by a woman in digital photographs boosted her perceived attractiveness. We also attempted to ascertain the effect of the red shades on personal physical color traits in four types of skin tones and hair color and investigate whether the gender of the respondents had any impact on their perceptions.

The results suggest that all four different red shades—low chroma/high value, low chroma/medium value, high chroma/medium value, and low chroma/low value–may enhance female attractiveness to men on a digital photo. Although, in this study, male respondents' perception of female attractiveness increased for all shades of red, regardless of the woman's skin and hair color, it significantly varied by shade. Women's ratings

were higher for attractiveness when wearing the high chroma and medium value red, reaching statistical significance for the overall four skin/hair types. The high chroma and medium value red, often considered vivid, had a greater appeal to males and females in most cases, except for the dark skin/dark hair type to female respondents. This result confirms that the value and chroma of color, which was overlooked in previous research, should be considered as variables in studies of clothing color meanings.

Most previous researches revealing the positive red clothing effect were conducted in face-to-face contexts outside Asia. This study is the first to investigate the attractiveness perception of red t-shirts based on Asians. In this study, Korean male respondents' attraction to four Asian skin/hair color types was measured on photos where women wore four different shades of red. It indicates that the red-attractiveness effect was found in previous face-to-face interaction (Guéguen, 2012; Guéguen & Jacob, 2013; Pazda et al., 2014; Roberts et al., 2010) found for digital photos and Asian skin/hair color types. The findings would help women posting photos online, such as on dating sites and social media profiles, decide what color to wear. For example, an Asian woman may be advised to wear vivid reddish (high chroma/medium value from this study) t-shirts, enhancing her attractiveness to men in digital communication.

This study also considered women's attractiveness from the perspective of the same and opposite sex. Gender affects the perception of red attractiveness; men rated the attractiveness of all types of women without t-shirts lower than women did. When asked to evaluate a woman's attractiveness without a t-shirt on the photo, men rated women with bright skin/bright hair (Type 2) the highest, while women rated women with dark skin/dark hair (Type 4) the highest. Men and women rated high-chroma/medium-value red as the most attractive, but males gave it a relatively higher increase in rated attractiveness than women. High-chroma/medium-value red had the highest attractiveness rating among the four shades, and this influence was relatively more significant for male respondents than female respondents. This shows that the impact of the red color was more significant and sensitive on men in digital photos. Smets (1982) found that chroma had the most significant effect on pleasantness judgments among the different color factors. In addition, in Radeloff's (1989) study, men preferred higher chroma colors than women. Highly saturated red clothing can increase a woman's attractiveness to the opposite sex. These findings can help marketers choose bright skin/bright hair models with vivid reddish clothing aimed at male customers while choosing different aspects for female customers in advertising.

Limitations and future research directions

Despite the contributions of this study, certain limitations promote opportunities for future studies. According to the personal color principle, certain shades and colors that harmonize with the individual's natural physical tones may serve to be quite flattering. We expected the red effect to appear differently in different skin and hair color types in women in photos. However, there were no significant differences in the red effects between the types. Such an outcome may lead to a discussion on the impact of personal color analysis. Since red has the longest wavelength, human vision recognizes red as nearer or advancing more clearly than other colors. Increasing saturation also attracts attention by making something feel visually closer (Egusa, 1983). In other words,

participants may have noticed the red color more promptly and powerfully than the actual difference in the natural body colors.

Interestingly, female respondents considered Type 4 (dark skin/dark hair) less attractive in all four red t-shirts. The results show that red may be an unflattering color for women with dark skin and hair. It suggests that red t-shirts may reduce women's appeal with the physical colors of dark skin/dark hair to other women, and that such women should avoid red clothing to attract other women. To conclude on the effect of personal color analysis, further research into other colors, shades, and gender of respondents in these terms would be required.

This study was limited to Koreans in East Asia, who are generally light-skinned Asians, to minimize cognitive and cultural differences in color perception. There is a possibility that the relatively narrow range of Asian skin and hair color may have affected the study results. Additional research should include other ethnicities to examine different skin and hair colors or cultural perspectives. This study focused solely on red hues, other colors of clothing could be examined. Based on the findings of this study, further research should consider shade changes for different hues, with more age groups or other clothing types.

Unlike previous studies that focused on the red effect in face-to-face interactions, this study significantly examined the red effect in the context of attractiveness perception in digital photographs. It also produced results that considered color value and saturation, which were not considered in previous studies.

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Authors' contributions
H.R. conceived of the presented idea and carried out the survey. Y.I. drafted the article and analyzed the data. All authors discussed the results and contributed to the critical revision of the article. All authors read and approved the final manuscript.

Authors' informations
Hye Rim Hong is an assistant professor at Jeonghwa Arts College. Her research interests include fashion design, marketing, and digital fashion. She has published research papers—Cosmetic Involvement Scale Development and Group Classification focusing on Korean Men in their 20s and 30s (2017), The Preferred Fashion Style and Self-image that Korean Career Women's Seek According to Daily Situations (2016), Communication Characteristics of Fashion Shows Using Digital Images (2014).

Young In Kim is a professor of Human Environment & Design of the College of Human Ecology at Yonsei University, Korea. She obtained her Dr. Arts et Sciences de l'Art in France. She has published books-Integrated design (2015), Color Language of Fashion (2009), Digital Fashion Design (2001), etc., research papers- Preferred Fashion Style based on the Men`s Self-image Including Fashion Involved Circumstances (2015), Characteristics of Fashion Purchases and Clothes-wearing Tendencies of Women in their 30`s Using Online Shopping (2014), etc. Her field of specializations is varied including fashion design, color, and trend.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This research was conducted under the approval and supervision of Yonsei University Institutional Review Board (IRB Approval No.: 7001988-202002-HR-790-02) regarding ethical including consent to participate.

Consent for publication
All study participants provided informed consent.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Dept. Beauty Arts, Jeonghwa Arts College, 21 Toegye-ro 16-gil, Jung-gu, Seoul 04631, Republic of Korea. [2]Dept. Human Environment & Design, Yonsei University, 50 Yonsei-ro Seodaemun-gu, Seoul 03722, Republic of Korea.

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