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The Effects of Color Hue-Tone on Recognizing Emotions of Characters in the Film, *Les Misérables*

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Abstract

This study investigated whether people experience a correspondence between color hue-tone and the main characters' emotions in the 2012 British musical drama film, Les Misérables through three practical experiments. Six screen images, which represent the characters' different emotions (Parrot's six primary types including *love, joy, surprise, anger, sadness*, and *fear*) were selected. For each screen image, participants were asked to judge the degree of the character's dominant emotions evoked from 17 varied screen images, which consisted of original chromatic and achromatized images as well as 15 color-filtered images (5 hues X 3 tones of the IRI color system). These tasks revealed that a chromatic color scheme is more effective to deliver the characters' positive emotions (i.e. *love* and *joy*) than an achromatic one. In addition, they proved that the hue and tone dimensions partially influence the relationships between the character emotions and colors.

Key words: Film Color, Film Character's Emotion, Color Hue-Tone, Primary Emotions

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1. Introduction

Expressing film characters' psychology and emotion in delicate and sophisticated ways is one of the most critical success factors in the film industry (Picard, 1997; Wang and Cheong, 2006). Given color's emotional effects, noted film directors have focused on expressing the changes in characters' psychology by using the right color schemes on the screen (Brown et al., 2012; Vacche and Price, 2006). Therefore, the symbolic meaning and psychological association of screen colors have been examined (Chu et al., 2009; Glebas, 2013; Kim, 2006); however, there is little empirical evidence to identify the effects of film colors on recognizing characters' emotions, each of which largely contributes to conveying the film's stories and messages (Alderson, 2012).

In this vein, this study aimed at investigating whether people experience a correspondence between color hue-tone and characters' emotions in film.

1.1. Color-Emotion in Films

People pick content (i.e. movies and music) based on its' affective characteristics (Malandrakis et. al., 2011); therefore, it is important for filmmakers to characterize their movies by effectively defining relevant emotions that will be communicated with the audiences. In regards to the emotional response to films, Emmy-Award-winning director and editor Ian Maitland addressed his thoughts as follows (Picard, 1997): "A film is simply a series of emotions strung together with a plot. It is the filmmaker's job to create moods in such a realistic manner that the audience will experience those same emotions enacted on the screen, and thus feel part of the experience."

To date, a lot of studies towards the emotion responses or recognition in movies have been performed in various fields. In particular, several social scientists have used films for eliciting emotional responses in the laboratory due to their relatively high degree of ecological validity (Gross and Levenson, 1995, McHugo et al., 1982; Philippot, 1993). On the other hand, these approaches for emotion recognition or tracking in movies have been developed using emotional cues obtained from visual and audio features (Hanjalic et al., 2005; Hanjalic, 2006; Malandrakis et al., 2011; Wang and Cheong, 2006). In 2011, Srivastava et al. analyzed facial expressions and dialogs of multiple actors for enhancing recognition accuracy of the emotions evoked from the movie scenes. In 2009, Giannakopoulos et al. examined 1500 speech samples from more than 30 films and then estimated their emotional states using a 2D emotional wheel (arousal-valence axes) with sufficient accuracy. Besides the audiovisual cues, the motion variations of cameras or frames can represent the moods of scenes, particularly, in the case of dynamic speedy movies including sports videos (Wang et al., 2006).

Meanwhile, studies with visual color stimuli have indicated that individuals associate colors with emotions (Clarke and Costall, 2008; Mahnke, 1996; Manav, 2007; Ou and Luo, 2004). In light of the color-emotion association, several researchers have been interested in the affective understanding of films through investigating the use of color, which enhances audiences' aesthetic level (Lin and Lin, 2008), forces their attention to shots/scenes (Truong et al., 2002), and evokes their moods or emotions (Chu et al., 2009; Wang, 2010), as one of essential film languages. According to Zettl (1999), color perception and lighting are important contributors to the mood tones that directors want to bring forward in any scene along with the dialogues. In order to maintain mood consistency, filmmakers consider the colors (hues, value, and saturation) of the costumes

and backgrounds (Wei et al., 2004). In addition, light source color, called illuminant, is very important in defining a scene character. Canini et al. (2009) addressed that a scene with a yellow polarized illuminant that evokes a pleasant sensation, while the one with a grayish illuminant suggests a quite offish feeling. In 2005, Ionescu et al. proposed a statistical color-based approach for semantic characterization of animation movies with the following analysis parameters; pure color distributions, light/dark color ratio; hard/week color ratio; warm/cold color ratio, complementary color ratio, adjacent color ratio, and color diversity ratio. This approach was meaningful in terms of allowing animation directors to analyze the color-based artistry concepts. Two years later, Ionescu et al. (2007) expanded their research by classifying 52 animation movies according to their predominant hues, the Itten's color contrasts, the color harmony schemes and color relationships.

Based on the key findings of the aforementioned previous studies, this research focuses on the relationship between visual features (i.e. scene color hue and tone) and emotion (i.e. character emotion) in film.

1.2. Goals and Hypotheses

To provide more empirical evidence that shows the robust relationships between the character emotions and film colors, this research aims to investigate whether people experience a correspondence between color hue-tone and main characters' distinctive emotions and how consistent these relationships are. In order to reach the above research aim, three hypotheses were formulated:

[Hypothesis 1] A chromatic color scheme delivers film characters' emotions more strongly than an achromatic one.

[Hypothesis 2] The hue dimension influences the correspondences between character emotions and color filters.

[Hypothesis 3] The correspondences between character emotion and color filters vary by the tone dimension.

For verifying these hypotheses, three experimental tasks were conducted with six screen images captured from the 2012 British film, *Les Misérables*. They represent six different emotions of main characters: (1) task 1 - a comparative experiment between achromatic and chromatic color schemes; (2) task 2 - a direct character emotion-color matching test for revealing their comparative links; and (3) task 3 - an impact rating test of color hue-tone on character emotions for exploring their dimensional relationships.

2. Character Emotion-Color Correspondence Experiment

2.1. Materials

2.1.1. Character Emotion Stimuli

Les Misérables is a 2012 British epic romantic musical historical drama film that tells the story of ex-convict Jean Valjean, who was hunted by police inspector Javert, and his adopted daughter Cosette (Fantine's biological daughter), who fell in love with Marius one of young revolutionary students during the June Rebellion of France. The film received favorable reviews in terms of the passionate, emotional acting of leading actors/actresses.

Meanwhile, numerous researchers have been trying to categorize fundamental emotions systemically (Parrot,

20001, Plutchik, 2011, Robinson, 2009). Among them, this research adopted a list of primary emotions described by Parrot (2001) including love, joy, surprise, anger, sadness, and fear. According to Robinson (2009), those emotions can also be categorized into positive (i.e. *love, joy*, and *surprise*) and negative (i.e. *anger, sadness*, and *fear*) emotions.

In this circumstance, about 100 close-up shots, which well represented the main characters' different facial emotions expressions, were captured. The captured images were screened with consideration of the main characters' dominant personalities and outfits through the whole film. Eventually, six screen images, which represented six primary emotions respectively, were chosen (See Table 1).

Table 1. The selected six emotional screen images

Emotion type	Selected screen shot
1. Love (Cosette and Marius)	
2. Joy (Jean Valjean)	
3. Surprise (Jean Valjean)	
4. Anger (Javert)	
5. Sadness (Marius)	
6. Fear (Fantine)	

Note: ( ) marks the names of main characters for each screen image.

2.1.2. Color Stimuli

The achromatic screen samples of the six original (chromatic) images, shown in Table 1, were created for the first task by using the Grayscale Mode of Photoshop CC. For the second and third tasks, color filters were made by RGB values of 15 colors (5 hues X 3 tones) selected from the Image Research Institute (IRI) Hue and Tone System[1]: (1) hues - red (R), yellow (Y), green (G), blue (B), and purple (P), and (2) tones - vivid, pale, and dark. Table 2 represents the RGB of the 15 color filters.

Table 2. RGB data of 15 color samples

	R	Y	G
Vivid			
R, G, B	202, 0, 63	243, 217, 0	0, 164, 109
Pale			
R, G, B	244, 205, 201	240, 231, 173	181, 228, 199
Dark			
R, G, B	104, 82, 82	94, 89, 69	49, 86, 68

1) The IRI Hue and Tone system was developed by adjusting the Hue and Tone System by Kobayashi to represent South Koreans' emotional responses to colors (I.R.I., 1997).

	B	P
Vivid		
R, G, B	0, 125, 163	117, 52, 142
Pale		
R, G, B	180, 224, 235	223, 209, 235
Dark		
R, G, B	53, 81, 92	87, 68, 98

Six original screen images were manipulated with the 15 color filters using the Blend Mode and the Opacity slider of Photoshop CC. For layering color filters on the original chromatic images naturally, the following methods were applied: (1) vivid colors - Normal layer mode, Opacity (15%); (2) pale colors - Screen blend mode, Opacity (15%); and (3) dark colors - Multiply blend mode, Opacity (25%). For enhancing the subjects' discrimination performance among different toned filters, dark colors' opacity was slightly elevated compared with the others[2]. Table 3 presents some examples about how the original screen image (related with the emotion of *love*) was gray-scaled and manipulated by different tone filters (vivid-R, pale-R, and dark-R).

Table 3. Examples of the manipulated screen images of the selected screenshot related with the emotion of love

Gray-scaled image	Vivid-R filtered image
	
Pale-R filtered image	**Dark-R filtered image**
	

2.1.3. Subjects and Procedure

The subjects majoring in visual studies were recruited from Kongju National University. All of the subjects had normal vision and had watched the film Les Misérables and had a general knowledge in the film's story and main characters' features. The experimental data was collected from 32 uiversity students (8 men and 24 women), ranging in age from 18 to 26 years old (Mean age = 21.41, SD = 2.08).

During the tasks, screen image samples were always displayed on a black background via a 19-inch LCD computer monitor whose brightness and contrast levels were calibrated and optimized. In order to satisfy visual comfort conditions, glare and shadow on the observed color samples were prevented. In the first and third tasks, the screen images were automatically suggested at an interval of 3s for each emotion case: (1) the first task - de-saturated and original screen images were displayed separately and (2) the third task - 15 color-filtered screen images. Subjects were asked to rate the degree of a character's emotion evoked from each screen sample on a 10-point scale (e.g. 10 = "very joyful" and 1 = "not joyful at all").

For the second task, six screen image samples, which

2) (1) Screen blend mode works by multiplying the light pixels and makes blacks disappear while keeping the white: Math = 1-(1-A) X (1-B) (Active layer inverted multiplied by background layer inverted, and the product is inverted.) and (2) Multiply blend mode works by multiplying the darker pixels and creates shadows and remove whites while keeping the darker colors): Math = A X B (Active layer multiplied by background layer).

were manipulated by five vivid color filters and a de-saturated option, were provided at the same time on the test display for the subjects' comparative judgment for 6s. Each subject selected three samples by prioritizing them according to the degree of the associated emotion.

3. Results and Discussion

3.1. Comparison Between Achromatic and Chromatic Color Schemes

In the first task, for each emotion, a paired t-test was performed to compare the degree-of-associated emotions between the achromatic and (original) chromatic screen images. Relevant statistics in Table 4 show significant differences for all the emotions: the cases of *love* and *joy* ($P < 0.001$), *fear* ($P < 0.005$), surprise and *anger* ($P < 0.01$), and *sadness* ($P < 0.05$). This task showed that the subjects associated stronger emotions from chromatic images than achromatic ones for all of the emotion cases. More noticeably, the association degree of positive emotions (especially, *love* and *joy*) increased much more for the chromatic samples, whereas negative emotions were less affected by the achromatic-chromatic transitions.

Contrary to those results, about one-fourth of subjects associated even stronger negative emotions for the achromatic images than the chromatic ones (i.e. anger: 8 subjects, sadness: 9, and fear: 8). This findings support the hypothesis that chromatic color scheme enhances the expression of character emotions (especially, greater impact on positive emotions) [Hypothesis 1]

Table 4. Comparison of the mean ratings of the evoked characters' emotions between achromatic and chromatic color screen samples and the relevant statistics

Emotion type	Achromatic screen image (A)		Chromatic screen image (C)		(C) – (A)		Paired t-test P-value
	M	SD	M	SD	M	SD	
1. Love	4.50	1.81	7.25	1.22	2.75	1.76	0.000****
2. Joy	3.56	1.08	6.78	1.24	3.22	1.10	0.000****
3. Surprise	5.78	1.72	6.78	1.24	1.00	2.26	0.010**
4. Anger	5.44	2.03	6.56	1.65	1.13	2.17	0.006**
5. Sadness	6.59	1.83	7.59	1.32	1.00	2.06	0.010*
6. Fear	4.97	2.13	6.37	1.83	1.41	2.17	0.001***

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.005$, **** $P < 0.001$

3.2. The Direct Matching Between Character Emotion-Color Hue

In the second task, subjects undertook a direct character emotion-color hue matching test by selecting three screen samples by prioritizing them; therefore, this research computed a weighted frequency sum of each vivid color-filtered sample (including achromatic one) by applying hierarchical weights (3, 2, and 1). For each emotion case, the total frequencies of the six vivid color-filtered samples were illustrated in Table 5.

Table 5. Visualizing the total frequencies of vivid color-filtered samples (including achromatic sample) for each emotion case

Emotion type		Vivid color-filtered screen sample					Achro-matic sample
		R	Y	G	B	P	
Posi-tive	1. Love	28	51	5	14	85	9
	2. Joy	21	58	5	26	80	2
	3. Surprise	41	6	16	34	70	25
Nega-tive	4. Anger	63	7	7	32	48	35
	5. Sadness	15	6	19	57	55	40
	6. Fear	29	5	30	59	44	25

A couple of distinctive patterns were found in hue across emotions. First, positive emotions (*love, joy*, and *surprise*) were more strongly imagined when vivid R, Y, and P filters were layered on the screen samples. This finding suggests that more yellowish scenes tend to evoke more pleasant feelings (Canini et al., 2009). Moreover, the subjects judged that the degree of negative emotions, except the *anger* case, increased for the vivid G, B, and P filtered samples. Given that P is a neutral color, these findings support that warm colors increase positive emotions, whereas cool colors reinforce negative ones, generally. That is, the degree of the evoked character emotions can be characterized by hue dimension (i.e. warm-cool colors), through not for all emotions, partially supporting [Hypothesis 2]. For the achromatic samples, the subjects associated more negative emotions than positive ones. This result shows a consistent tendency of the general notion that grayish images presented more offish feelings (Canini et al., 2009).

3.3. The Degree of Correspondence Judgment Between Character Emotion and Color Hue-Tone

3.3.1. The Correspondences Between Character Emotions and Color Hue-Tones

This research analyzed whether the degree-of-correspondence between the evoked character emotions and color varies across the hues. In order to exclude the tone variable within each hue group, the correlation ratings of colors with emotions in different tones (vivid, pale, and dark) within the same hue group were averaged. A representative correlation rating of each hue per subject was then computed using Eq. (1):

$$H_x = \frac{(C_{x1} + C_{x2} + \cdots + C_{xn})}{n}, \quad (1)$$

where H_x, C_{xi}, and n denote the averaged correlation rating for the xth hue (1 x 5), the color stimulus in the xth hue and the ith tone, and the total number of tones in each hue (n = 3 in this experiment), respectively. For each emotion, a one-way repeated measures analysis of variable (ANOVA) was performed (factor: 5 hues). As presented in Table 6, differences of mean correspondence ratings across the five hue groups for all the emotions were statistically significant at alpha levels of 0.001 (i.e. *love, joy, anger,* and *fear*) and 0.005 (i.e. *surprise* and *sadness*).

Table 6. The mean correspondence ratings of the five hue groups for the six emotion and the relative statistic results

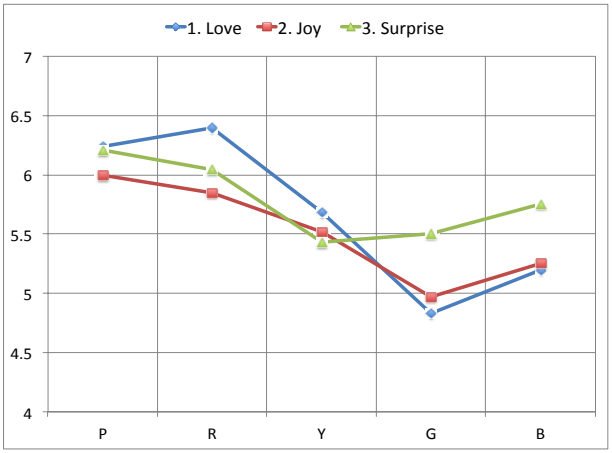
	Emotions					
	1. Love		**2. Joy**		**3. Surprise**	
Hues	M	SD	M	SD	M	SD
R	6.40	0.87	5.85	1.23	6.04	0.903
Y	5.68	1.09	5.52	0.93	5.43	1.22
G	4.83	1.24	4.97	0.81	5.50	1.19
B	5.20	1.15	5.25	0.81	5.75	1.25
P	6.24	1.29	6.00	1.22	6.21	1.08
F Stati-stics	F (4.00, 124) = 21.25 - P = 0.000****		F (3.06, 94.77) = 10.20 ε: 0.86 P = 0.000****		F (2.95, 91.46) = 4.37 ε: 0.74 P = 0.007**	
LSD results	R, P > Y > B > G		R, P > B > G P > Y > G		R > Y, G P > Y, G, B	

	Emotions					
	4. Anger		5. Sadness		6. Fear	
Hues	M	SD	M	SD	M	SD
R	6.40	0.94	6.19	1.27	5.97	1.07
Y	4.60	0.94	5.23	1.01	4.91	0.88
G	4.87	0.99	5.34	1.51	5.59	1.10
B	5.30	1.16	5.54	1.26	5.71	1.26
P	5.49	1.07	5.92	1.00	5.68	1.07
F Stati-stics	F (4, 124) = 32.03 - P = 0.000****		F (2.35, 72.71) = 5.80 ε: 0.586 P = 0.003***		F (4, 124) = 6.56 - P = 0.000****	
LSD results	R > B, P > G, Y		R, P > Y, G R > B		R, G, B, P > Y	

Factor: 5 hue groups, ε: corrected by Greenhouse-Geisser,
** P < 0.01, *** P < 0.005, **** P < 0.001
Hue group differences significant at P < 0.05 by the LSD post hoc test

By illustrating the averaged correspondence ratings of positive and negative emotions across five hues in Figure 1, distinctive hue distribution features were found. The dominant colors of the *love* and *joy* cases ranged from purple to yellow, and their mean correspondence ratings dropped in the range of green and blue (cool colors). The *surprise* case showed less variation across hues. Like positive emotions (i.e. *love* and *joy*), negative emotions were dominantly correlated with purple and red; however, they were evoked the most lightly from yellow. It can be assumed that red's energetic, assertive force reinforced the strength of the negative feelings whereas yellow's optimistic, bright characteristics diminished those feelings. For example, the subjects showed extreme responses to two warm colors (red: 6.40 and yellow: 4.60) for the *anger* case. Moreover, in the range of green and blue, the subjects indicated somewhat higher association for the negative emotions as compared with the positive ones. Thus, these analysis results partially support the hypothesis that the correspondences between the character's positive emotions and colors have characteristic hue distribution in terms of warm and cool color images [Hypothesis 2].

[1] Positive Emotions



[2] Negative Emotions

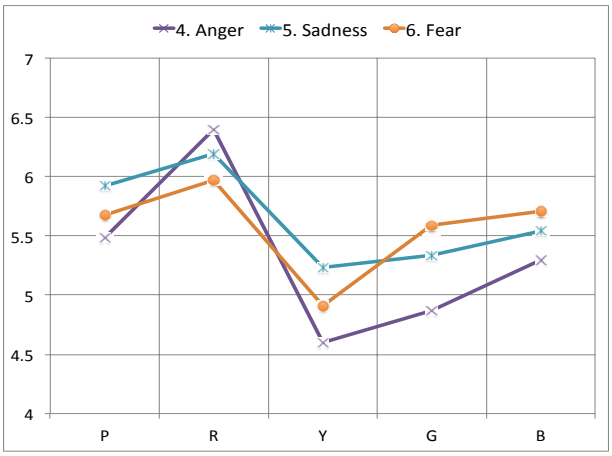


Figure 1. The mean correspondence ratings of the six emotions across the five hues: (1) positive emotions: *love, joy* and *surprise*; and (2) negative emotions: *anger, sadness*, and *fear*

3.3.2. The Correspondences between Character Emotions and Color Tones

Along with the color hues, this study analyzed whether color tones affect the degree-of-correspondence between character emotion and color. For this purpose, the correlation ratings of colors with the perceived emotion that belong to the same tone group were averaged using Eq. (2):

$$T_x = \frac{(C_{1x} + C_{2x} + \cdots + C_{nx})}{n}, \quad (2)$$

where T_x, C_{xi}, and n denote the averaged correspondence rating for the xth tone (1x3), the color stimulus in the ith hue and the xth tone, and the total number of hues in each tone (n = 10 in this experiment), respectively. The averaged correspondence ratings for the three tone groups were analyzed in a one-way repeated measures ANOVA (factor: three tone groups). Relevant statistics in Table 7 show significant differences in the correspondence ratings across the three tones.

Table 7. The mean correspondence ratings of the three tone groups for the six emotion and the relative statistic results

	Emotions					
	1. Love		**2. Joy**		**3. Surprise**	
Tones	M	SD	M	SD	M	SD
Vivid	4.88	0.92	4.95	1.04	5.67	0.96
Pale	6.46	1.16	6.47	1.00	5.54	1.00
Dark	5.68	1.29	5.14	1.10	6.35	1.01
F Stati-stics	F (2, 62) = 25.08 - P = 0.000****		F (1.67, 52.52) = 28.65 ε: 0.83 P = 0.000****		F (1.67, 52.52) = 28.65 ε: 0.83 P = 0.000****	
LSD results	Pale > Dark > Vivid		Pale > Vivid, Dark		Pale > Vivid, Dark	
	Emotions					
	4. Anger		**5. Sadness**		**6. Fear**	
Tones	M	SD	M	SD	M	SD
Vivid	5.54	0.96	5.13	1.11	5.44	0.91
Pale	4.57	0.95	5.28	1.01	5.06	1.05
Dark	5.88	1.28	6.53	1.21	6.22	0.94
F Stati-stics	F (2, 62) = 20.35 - P = 0.000****		F (2, 62) = 28.71 - P = 0.000****		F (2, 62) = 19.69 - P = 0.000****	
LSD results	Dark, Vivid > Pale		Dark > Vivid, Pale		Dark > Vivid > Pale	

Factor: 3 tone groups, ε: corrected by Greenhouse-Geisser,
**** P < 0.001
Tone group differences significant at P < 0.05 by the LSD post hoc test

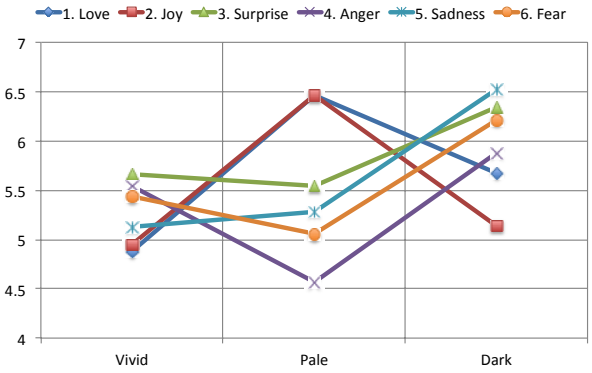


Figure 2. The mean correspondence ratings of the six emotions across the three tones

Several noticeable findings were discovered related with the correspondences between character emotions and color tones (See Figure 2). Pale colors greatly enhanced the expression of character's lovely and joyful feelings while they weakened angry, fearful, and sad feelings. Dark colors evoked stronger feelings of surprise, anger, sadness, and fear. In spite of the distinct influences of pale and dark tones on positive (except the *surprise* case) and negative emotions, vivid colors did not show a distinguishable pattern across emotions (maximum = 5.65, minimum = 4.88).

Moreover, the *love* and *joy* cases showed a similar changing tendency across the three tones (pale > dark, vivid), and the *anger, sadness* and *fear* cases also showed a noticeable tendency (dark > vivid, pale). That is, the pale and dark tones enhanced the positive emotions (except *surprise*) while the dark tone conjured up the negative emotions. Those results can support Hypothesis 3 that the correspondences between character emotion and color filters vary by the tone dimension.

4. Conclusion

The aforementioned three tasks revealed that chromatic

color scheme is more effective to deliver the characters' emotions than achromatic one. Particularly, character's positive emotions (e.g., *love* and *joy*) can be more strongly expressed in the chromatic film. This research also proved that the hue and tone dimensions influence the relationships between the character emotions and colors. Moreover, the identified corresponding patterns between the character emotion and color hue-tone can suggest practical guidelines for making emotional films as follows: (1) the degree-of-correspondence between the evoked character emotions (especially, *joy* and *love*) and colors varies by hue dimension in terms of warm-cool color images and (2) the pale tone enhances positive emotions (expect *surprise*) while the dark tone intensifies negative emotions.

Meanwhile, this research consisted of three experiments that presented about 30 Korean students with screen images captured from the film, *Les Misérables*. In the future, this research approach can be applied to a range of different movies and animations. Moreover, given the gender or cultural differences in color perception and association, more subjects can be recruited and segmented by diverse demographic data. Moreover, this research varied the color hue-tone of the experimental materials by layering color filters on the original (chromatic) screen images; therefore, the original prominent color schemes of the screen images could influence their aesthetic quality. In this sense, future research can be conducted by controlling the effects of the color schemes of the original screenshots on visualizing the color variations of their manipulated images.

In conclusion, this research will be helpful for film directors or editors who have difficulty in using appropriate colors that can express their characters' emotions in more touching and effective ways.

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