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Applying FaceReader to Recognize Consumer Emotions in Graphic Styles

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Abstract

Products reinforcing positive consumer emotions can promote purchasing desire. The following emotional effects also can influence consumers' recognition and feelings. In design field, understanding consumer emotions and the reasons behind can help designers establish emotional communication between consumer and product, and create consumer demands. This study elaborated various relations between emotion and graphic style. We conducted an emotion recognition experiment to understand participants' emotional reactions toward graphics with four levels of stylization. FaceReader, an automatic facial expression recognition software, was used to recognize 120 participants' emotions by one-way repeated measures ANOVA. Meanwhile, emotional adjectives and self-reports from participants were compared with those aroused emotions from viewing stylized graphics. The results indicated (1) participants showed significant emotional differences in happiness, anger, surprise and disgust toward different levels of stylized graphics. (2) Graphics with a simple element and sharp edge could attract participants' attention. (3) Realistic graphics could inspire more associate ideas from participants. (4) Participants had higher positive evaluations on colorful graphics, and graphics with single color can attract their attention. Furthermore, we generalized limitations and precautions in applying FaceReader: (1) interpreting participants' emotions toward static images might result in lower statistical values of negative emotions. (2) When participants concentrated on the images, their facial expressions could be interpreted as angry emotion. (3) The neutral facial expression could be interpreted as sad emotion. (4) Participants' self-reports were supplementary to explain the plausibility of generated emotions from FaceReader. This research has demonstrated practical implications of graphic style. FaceReader could be an effective tool to evaluate consumer emotion in the field of design research. Furthermore, the importance and practicality of using facial expression recognition to evaluate participants' emotions in response to different graphic styles have been confirmed. This approach provides a preferable basis in relevant fields of design practice and marketing.

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Keywords: graphic styles; emotions; facial expression recognition; FaceReader

1. Introduction

In design field, understanding consumer emotions and the reasons behind can help designers establish emotional communication between consumer and product, and create consumer demands. Both verbal and nonverbal behaviors enable humans to communicate emotions. Nonverbal communication includes all forms of communication other than languages and consists of physical behaviors commonly referred to as body languages, gestures, and facial expressions. Among these, facial expressions are considered to be essential to the expression of emotions because human faces provide useful information about feelings and the inner state of an individual [1,2,3]. Some facial expressions convey a particular emotion across contexts [4] and can be used as references for emotion recognition. Recent researchers have suggested that human emotions could be aroused differently by various design components. Furthermore, human emotions in response to the content of design can serve as a guide for designers [5]. This study elaborated different relations between emotion and graphic style. FaceReader, an automatic facial expression recognition software program, was used to analyze the participants' emotions. Examination of these data by a facial expression recognition paradigm enabled the interpretation of

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the emotional responses to graphics with different stylized levels, which can provide a preferable basis for researchers and designers in graphic design practice.

2. Prior Knowledge

2.1. Emotion and facial expression

Emotions are caused by numerous factors, such as evaluating an unexpected situation, memorizing, talking about a past emotional experience, or seeing the emotional reactions of another. Ekman [6] proposed six common emotions shared by all humans: happiness, sadness, anger, scared, surprise, and disgust. Despite the common wisdom that nonverbal communication is the prime medium for emotion and the dominance of nonverbal channels for communicating emotion in the research literature, the verbal expression of emotion is also crucial [7]. Some see emotional expressions as the manifestations of internal emotional states [8,9]. Emotional experience is produced by an interaction of physiological arousal and an appropriate cognition associated with situational determinants or cues [10]. Our evolutionary development has contributed significantly to the shaping of our emotional responses. Darwin proposed that humans continue to display facial expressions because they have acquired communicative value throughout evolutionary history [11]. Regarding human communications, 55% rely on facial expressions, 38% rely on tones of voice, and only 7% rely on verbal exchanges [12]. The results of previous facial recognition studies have suggested that people can identify psychological states based on facial expressions [13,14,15]. Facial expressions serve an important function, communicating changes in affective states [16]. When a unique facial feature is recognized as a particular emotion, it expresses the feelings of that person and provides social information [17]. In daily life, facial expressions are used to open or close communications, convey verbal or nonverbal reactions, even change the meaning of a conversation [18].

In design field, modern researchers have indicated that adopting facial expressions as references in design could be effective. Recent research suggests that participants from various cultural backgrounds perform identically in tasks that require the pairing of colors with facial expressions. The researchers proposed that human's facial expressions in response to single color and color combinations could serve as a guide for designers [5]. It has also claimed that color information may improve facial expression recognition due to the complementary characteristics of image textures [19]. Additionally, the relationship between modern product design and emotions has been discussed. Facial expression recognition has been recommended by many researchers as superior to other recognition methods, such as speech, as a way to interpret a person's emotions [20,21,22].

The best-known approach to research on facial expressions is the Facial Action Coding System (FACS), which allows researchers to distinguish facial muscle movements to identify the emotions that participants may be conveying [23]. The fundamental theory underpinning FACS has been applied in a variety of studies to enable researchers to identify participants' emotions, while related techniques for improving the recognition method have been developed. An action unit (AU) is defined in FACS as the minimum visible, anatomically based action involved in the movements of a face. A facial expression is described as particular AUs that produce facial movements either alone or in combination [24,25].

2.2. FaceReader

FaceReader is a commercially available software program which can automatically analyze facial expressions regarding seven emotional states: happiness, sadness, anger, surprise, scared, disgust, and neutral, which refers to the absence of any significant emotion. FaceReader allows researchers to analyze participants' facial expressions quantitatively. In this study, we applied FaceReader to recognize participants' emotions in different graphic styles under the experimental condition. The analysis of FaceReader is based on the definitions and recognition principles of FACS. Furthermore, recent studies have indicated that the software is an efficient tool for analyzing emotions with an accuracy rate of 90% [26]. Another study used FaceReader to test the usability of computers and examined the applicability of the software to the study. Significant similarities were found between the data obtained by FaceReader and the participants' self-reports together with the researchers' observations [27]. These studies suggest that the emotional status analyzed by FaceReader can provide an instant representation of the participants' emotions. Although FaceReader can record all changes in facial expressions, the results are restricted to the six basic emotions plus the neutral state, and more complex emotions cannot be analyzed. A previous study found the participants began the experimental task with seriousness, but FaceReader explained their emotion as anger [27]. The findings outlined above have proved that FaceReader can objectively detect immediate and subtle changes in facial expressions, and arrives at judgments based on potentially representative components of emotions with high accuracy rate. Nevertheless, researchers' observations and participants' oral responses are required for understanding the participants' feelings and for further discussion on the results of facial expression recognition.

The primary task in a facial expression recognition experiment is distinguishing the emotional changes. The duration of each emotion is short, approximately 0.5–4 seconds [6], rendering it difficult to quantify differences among data points; therefore, each frame of a video of the participant is not necessarily analyzable [28]. In a study that quantitatively analyzed participants' individual emotions in FaceReader to determine whether different emotions appeared when the participants tasted different juices, it was suggested to calculate the maximum numerical value associated with each emotion displayed by each member [29]. In summary, FaceReader is a reliable tool for analyzing emotions by examining participants' facial expressions; however, researchers' observations, participants' self-reports, and an appropriately executed experiment are also required to minimize possible contradictory results.

2.3. Graphic style

The purpose of images is to transmit information, to provide instruction, and to prepare for human memories. Humans tend to show emotional reactions and attach feelings to objects that connect to them [30,31]. People continually compare their self-identities with graphics of objects, accommodate and assimilate ones that have similar or desired identities to their self-concepts [32]. Panofsky [33] proposed three levels of recognizing graphics: primary or natural subject matter, secondary or conventional subject matter and intrinsic meaning or content. In summary, when recognizing graphics, its pure form attracts viewers immediately, then realizing the concepts of forms and figures. Finally, they reveal interpretations to graphics and build emotional experiences.

Graphic styles are determined by how designers interpret the original object and design theme. Meyer and Laveson [34] simplified visual styles into five levels between existed objects to abstraction (see Figure 1):

1. Natural photography reproduces the object by photography. It provides the most visual clues among all stylized levels, and the appearance is highly similar to the existed object.
2. Pictorial illustration represents nice visual appearance. The complexity of pictorial illustration is similar to neutral photography in figure, texture, and color.
3. Graphic rendering preserves the object's shape and figure, and lower the complexity of color and texture to be a simple pattern.
4. Graphic symbology simplifies the object's form and figure while all details are omitted. It only provides essential elements for viewers to recognize the objects.
5. Abstract symbology uses different design elements such as geometric figures or free drawings to elaborate the designer's concepts.

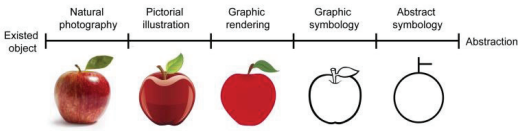


Fig. 1. Five levels of graphic styles [34].

Berlyne [35] evaluated consumer preference to objects with different visual complexities and found that consumers were less attracted to the objects that were too simple or over complicated. The objects with medium visual complexity attracted the consumers' attention and raised their positive emotions. Therefore, designers may use various techniques in the design process to enhance graphic details, to transmit information and concepts. Eroglu, Machleit et al. [36] referred to cognitive states as everything that goes in the consumers' minds concerning the acquisition, processing, retention, and retrieval of information. The cognitive state in evaluating graphic styles relates to how viewers assess visual form, and how they formulate their attitudes toward graphics based on incorporated design elements, and most importantly, how they transfer their experiences toward the theme of graphics.

3. Method

3.1. Participants

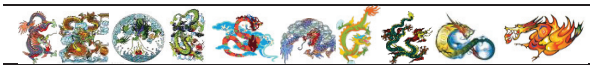
The participants consisted of 120 Taiwanese students with a mean age of 22.6 years (standard deviation = 1.7 years). The corrected vision of all of the participants was 0.8 or higher.

3.2. Stimuli

In this study, the differences in participants' emotional responses to graphics with different stylized levels were discussed. We chose graphics of Chinese dragon as experimental samples. The reasons were as follows: (1) the dragon is a virtual animal, which provides more flexibility in design than other existing animals. (2) Taiwan has inherited ancient Chinese culture in which the dragon is a totem considered as a symbol of dignity, bravery, and authority. Furthermore, its associated cultural beliefs and practices are familiar to the Taiwanese. Thus, participants should have pre-existing ideas associated with the dragon. Also, the application of different stylized levels could enhance or transform their impressions. 204 images of Chinese dragon from books and online databases were collected, and backgrounds of the images were unified. Seven experts in the design field with at least two years of working experience were invited to the focus group to classify the images based on the definition of stylization: pictorial illustration, graphic rendering, graphic symbology and abstract symbology. After all images had been classified as four levels, it was found that the visual appearances of the graphics in the same level could differ, which might confuse the participants when they tried to distinguish between graphics. Consequently, the focus group chose ten representative graphics in each level with higher visual similarities as sample images. Table 1 lists the sample images for the experiment.

Table 1. Sample images with different levels of stylization

Pictorial illustration

Graphic rendering

Graphic symbology

Abstract symbology


3.3. Procedure

FaceReader can overcome several limitations associated with the use of FACS for facial expression analysis, such as labor intensiveness and difficulties in standardization. A

pretest to determine the analytical capacity of FaceReader under the experimental conditions was conducted to verify the reliability and validity of the software in recognizing the participants' facial expressions. After interviewing the pretest participants, we collected their feedback and discussed potential problems with the experimental platform and principles. Finally, the within-subject design experiment was preceded so that each participant can express their feelings verbally about graphics with different styles. The experiment procedure is as follows: (1) the participant viewed the introductory video. (2) The participant viewed a set of sample images. (3) The participant was instructed to verbalize their feelings. (4) Repeat Steps two and three until the participant had viewed four sets of the sample images. All sets of sample images displayed in Latin square to avoid the continuous effect. There could be only one participant proceeded the experiment at one time. The durations of the experiment was recorded and analyzed using FaceReader to yield numerical values. We extracted the maximum numerical value for each emotion and each participant to identify emotional differences to the four levels of graphic style.

4. Result

4.1. Facial Expression

A one-way repeated measures ANOVA was conducted to compare the effect of participants' neutral and six basic emotions toward graphics with four levels of stylization. Table 2 and Figure 2 were the results of the facial emotion recognition.

Table 2. Data of facially recognized emotions (N=112).

		Pictorial illustration		Graphic rendering		Graphic symbology		Abstract symbology	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Neutral	112	.856	.173	.854	.181	.875	.149	.876	.153
Happiness	112	.512	.350	.450	.347	.507	.343	.731	.217
Sadness	112	.344	.250	.326	.257	.329	.267	.331	.262
Anger	112	.103	.128	.103	.118	.236	.219	.105	.140
Surprise	112	.067	.133	.075	.158	.122	.194	.066	.138
Scared	112	.009	.029	.015	.057	.009	.031	.008	.026
Disgust	112	.130	.225	.106	.173	.048	.117	.066	.172

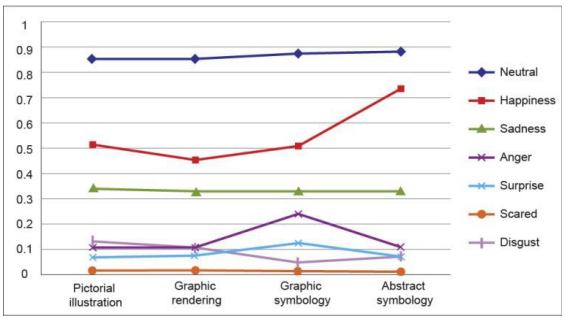


Fig. 2. Graph of facially recognized emotion data.

- Neutral

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(5)=24.412$, $p<.001$, and therefore, a Greenhouse-Geisser correction was used. There was not a significant effect of participants' neutral emotion during the experiment ($F(2.632, 292.141)=1.397$, $p=.247$). The result indicated that when participants saw different levels of stylized graphics, the values of neutral emotions did not have a significant change, which stayed around 0.8-0.9.

- Happiness

According to the result, Mauchly's Test of Sphericity indicated that sphericity had been assumed, $\chi^2(5)=3.960$, $p=.555$. The test of within-subjects effects showed there was a significant effect of participants' happy emotion toward different levels of stylized graphics, $F(3,333)=29.32$, $p<.000$. Pairwise comparisons were used to understand the participants' emotion differences between levels of graphics. The result showed that when participants were watching pictorial illustration (M=.512, SD=.350), their happy emotions were significantly different from graphic rendering ((M=.450, SD=.347), p=.036), and abstract symbology ((M=.731, SD=.217), p=.000). Abstract symbology (M=.731, SD=.217) also had significant differences between graphic rendering ((M=.450, SD=.347), p=.000) and graphic symbology ((M=.507, SD=.343), p=.000).

- Sadness

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(5)=11.608$, $p=.041$, and a repeated measures ANOVA with a Greenhouse-Geisser correction determined there was no significant effect of participants' sad emotion during the experiment ($F(2.802, 310.973) =.311$, p=.804).

- Anger

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(5)=62.930$, $p<.001$. A repeated measures ANOVA with a Greenhouse-Geisser correction determined there was a significant effect of participants' angry emotion during the experiment ($F(2.116, 234.858) =.311$, p=.000). The result of pairwise comparisons showed that participants were significantly angrier when watching graphic symbology (M=.236, SD=.219). The numerical value was higher than pictorial illustration ((M=.103, SD=.128), p=.000), graphic rendering ((M=.103, SD=.118), p=.000) and abstract symbology ((M=.105, SD=.140), p=.000).

- Surprise

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(5)=57.928$, $p<.001$. A repeated measures ANOVA with a Greenhouse-Geisser correction determined there was a significant effect of participants' surprise emotion during the experiment ($F(2.175, 241.410) =6.675$, p=.001). Pairwise comparisons showed that when participants watching graphic symbology (M=.122, SD=.194), their angry emotions were significantly different from pictorial illustration ((M=.067, SD=.133), p=.002),

graphic rendering ((*M*=.075, *SD*=.158), *p*=.007) and abstract symbology ((*M*=.066, *SD*=.138), *p*=.002).

- Scared

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(5)=146.370$, $p<.001$. A repeated measures ANOVA with a Greenhouse-Geisser correction determined there was no significant effect of participants' scared emotion during the experiment ($F(1.639, 181.935) =1.676$, $p=.195$).

- Disgust

Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(5)=35.539$, $p<.001$. A repeated measures ANOVA with a Greenhouse-Geisser correction determined there was a significant effect of participants' disgust emotion during the experiment (F(2.561, 284.232) =10.581, p=.000). Pairwise comparisons showed that when participants were watching pictorial illustration (*M*=.130, *SD*=.225), their disgust emotions were significantly different from graphic symbology ((*M*=.048, *SD*=.117), p=.000) and abstract symbology ((*M*=.066, *SD*=.172), *p*=.000). Moreover, when participants watched graphic rendering, their disgust emotion also occurred significant differences between graphic symbology (p=.001) and abstract symbology (*p*=.001).

4.2. Practical implications of graphic style

This study classified verbal contents of participants into five attributes: (1) Styles: the verbal content that participants described the visual appearances of sample images. (2) Design elements: the verbal content that participants specified the elements used in sample images. (3) Feelings: the verbal content that participants described their feelings about sample images. (4) Description: the verbal content that participants used an adjective to describe sample images. (5) Association: the verbal content that participants mentioned any associate ideas with sample images.

By collating the result of facial expressions and verbal responses, it was found that pictorial illustration was not able to arouse participants' emotions. However, it inspired participants' associated thoughts and ideas (association: 38%), such as temples, religions. In short, pictorial illustration could not attract participants but could inspire their ideas about Chinese dragon. The result of facial expression suggested there was no notable emotion occurred when participants were watching graphic rendering. Although 43% of participants noticed the style of graphic rendering is very colorful, there were only 9% of them referred positive feelings about graphic rendering. Graphic symbology attracted participants by its visual appearance (style: 38%). According to participants' verbal responses, they considered graphic symbology as "simple" and "strong," which reminded them of commercial icons or tattoos. It was assumed that graphic symbology brought visual impacts to participants and resulted Facereader recognized "angry" emotion. Abstract symbology used different design elements to introduce the concept of the Chinese dragon. In this study, the focus group chose ink painting style as the sample images in abstract symbology. Participants regarded the styles and design elements in abstract symbology were uncommon among others (style: 30%; design element: 32). Furthermore, they felt happier when watching abstract symbology.

5. Conclusion

We conducted an evaluation of automated facial expression analysis for use in graphic design research. Using thematic images of the Chinese dragon as stimuli, we demonstrated the possibilities of using facial expression recognition to evaluate participants' emotional reactions to graphics in different stylized levels. Regarding participants' emotional responses to graphic, we found that the participants seldom displayed exaggerated facial expressions in conversations or while viewing the static images, which caused anger, surprise, fear, and disgust emotions to remain at low numerical values (<0.3). The results showed that the participants experienced differences happiness, anger, surprise and disgust emotions between different levels of stylized graphics. That is, the participants felt significant positive emotions while viewing the images with abstract symbology. Moreover, they felt considerably happier while viewing pictorial illustration compared to graphic rendering. Regarding negative emotions, the participants showed significant emotional differences in the states of anger, surprise, and disgust. When the participants viewed graphic symbology, they were angrier and felt more surprised emotion. Also, participants felt more disgusted while viewing pictorial illustration and graphics rendering. After integrating participants' facial expression and verbal content, it was found that graphics with a simple element and sharp edge could attract participants' attention. Furthermore, realistic graphics could remind participants of related occurrence or circumstance based on their living experiences, which can inspire more associate ideas. When concerning participants' evaluation about colors, they had higher positive evaluations on colorful graphics. On the contrary, graphics with single color can attract their attention. These findings can be practical implications of graphic styles. In commercial design, designers can use a single color with sharp edges in graphics as a distinguishing feature for attracting consumers' attention; when creating a certain atmosphere, images with nice visual appearance are necessary for inspiring consumers' associated thoughts and ideas.

In this study, when the participants viewed the sample images under experimental conditions, they received information in a non-interactive fashion. As a result, the participants seldom showed notable facial expressions while viewing the sample images. The most prominent emotion was the neutral state, and the values for other emotions changed frequently but remained at lower levels. In contrast, the participants' verbal responses and emotional reactions to the sample images were accompanied by distinctive facial expressions, and the line chart produced by FaceReader showed that different emotions co-occurred. Thus, in addition to supplementing communication, verbalization of feelings enhanced the emotional intensity conveyed by facial expressions. Moreover, participants' verbal responses were

supplementary to explain the plausibility of generated emotions from FaceReader. By examining existed theories and our findings, we found that when participants concentrated on the images, their facial expressions could be interpreted as angry emotion. Therefore, a higher level of concentration might cause the participants' higher value for angry emotion towards the graphic symbology. Besides, the neutral facial expression could be interpreted as sad emotion due to the camera angle under experimental condition. This research has demonstrated that FaceReader could be a useful tool to evaluate consumer emotion in the field of design research. Also, the importance and practicality of using facial expression recognition to assess participants' emotions in response to different graphic styles have been confirmed. This approach provides a preferable basis for graphic design, commercial design, and product design. Future plan to implement the remaining intelligence principles includes discussing consumers' emotional responses through other design skills, such as personification design, the use of shading and texture. By collecting and measuring consumers' emotional signals and verbal responses, designers can understand consumers' emotions regarding certain design elements that might stimulate purchasing behaviors. It will help designers to build emotional communication with consumers and to link design with consumer interests to promote marketing activities.

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References

[1] Borod JC, Koff E. Asymmetries in affective facial expression: behavior and anatomy. In: Fox N, Davidson R, editors. The psychobiology of affective development. NJ: Erlbaum: Hillsdale; 1984. p. 293-323.
[2] Asthana HS. Facial asymmetry in expression of emotion: a neurocultural perspective. New Delhi: Concept Publishing Company; 2012.
[3] Valstar M. Automatic facial expression analysis. In: Mandal MK, Awasthi A, editors. Understanding facial expressions in communication. India: Springer; 2015. p. 143-72
[4] Ekman P. The face of man: expressions of universal emotions in a new guinea village. New York: Garland; 1980.
[5] Pos da O, Green-Armytage P. Facial expression, colours and basic emotions. colour: design & creativity 1 2007;1(2):1-20.
[6] Ekman P. Emotions revealed - recognizing faces and feelings to improve communication and emotional life. New York: Times Books; 2003.
[7] Planalp S. Communicating emotion: social, moral, and cultural processes. New York: Cambridge University Press; 1999.
[8] Ekman P, Friesen WV. Detecting deception from the body or face. J Personality and Social Psychology 1974;29(3):288-98.
[9] Levenson RW, Ekman P, Friesen WV. Voluntary facial action generates emotion-specific autonomic nervous system activity. Psychophysiology 1990; 27(4):363-84.
[10] Schachter S, Singer JE. Cognitive, social, and physiological determinants of emotional state. Psychological Review 1962;69:379-99.
[11] Fridlund AJ. Human facial expression: an evolutionary view. London: Academic Press; 2014.
[12] Mahrabian A. Silent messages. Belmont: Wadsworth; 1981.
[13] Ekman P, Friesen WV, O'Sullivan M, et al. Universals and cultural differences in the judgments of facial expressions of emotion. J Personality and Social Psychology 1987;53:712-17.
[14] Ekman P, Sorenson ER, Friesen WV. Pan-cultural elements in facial displays of emotion. Science 1969;164:86-8.
[15] Izard C. The face of emotion. New York: Appleton-Century-Crofts; 1971.
[16] Pollak SD, Messner M, Kistler DJ, et al. Development of perceptual expertise in emotion recognition. Cognition 2009;110:242-47.
[17] Rinn WE. The neuropsychology of facial expression: a review of the neurological and psychological mechanisms for producing facial expressions. Psychological Bulletin 1984;95(1):52-77.
[18] Knapp ML, Hall JA. Nonverbal communication in human interaction. 7th ed. Boston: Cengage Learning; 2010.
[19] Lajevardi SM, Hong RW. Facial expression recognition in perceptual color space. IEEE transactions on image processing 2012;21(8):3721-33.
[20] Pantic M, Patras I. Dynamics of facial expression: recognition of facial actions and their temporal segments from face profile image sequences. IEEE transactions on systems, man and cybernetics: part B 2006;36(2):433-49.
[21] Zhan Y, Zhou G. Facial expression recognition based on hybrid features and fusing discrete HMMs. In: Shumaker R, ediotr. Virtual reality, HCII 2007, (LNCS 4563). Berlin/Heidelberg: Springer-Verlag; 2007. p. 408-17.
[22] Lau BT. Portable real time needs expression for people with communication disabilities. Paper presented at the proceedings of communication in computer and information science: intelligent interactive assistance and mobile multimedia computing, Berlin/Heidelberg, Germany; 2009.
[23] Ekman P, Friesen WV. Facial action coding system: a technique for the measurement of facial movement. Palo Alto: Consulting Psychologists Press; 1978.
[24] Ekman P, Friesen WV, Hager JC. Facial action coding system - investigator's guide. Salt Lake City: Research Nexus; 2002.
[25] Ekman P, Friesen WV, Hager JC. Facial action coding system - the manual. Salt Lake City: Research Nexus; 2002.
[26] Loijens L, Krips O. Facereader methodology. Wageningen: Noldus Information Technology; 2013.
[27] Zaman B, Shrimpton-Smith T. The Facereader: measuring instant fun of use. In Nordic Conference on Human-Computer Interaction. Olso, Norway; 2006.
[28] Cohen AS, Sean CM, Dallas AC. Computerized facial analysis for understanding constricted/blunted affect: initial feasibility, reliability, and validity data. Schizophrenia Research 2013;148:111-16.
[29] Danner L, Haindl S, Joechl M, et al. Facial expressions and autonomous nervous system responses elicited by tasting different juices. Food Research International 2014;64:81-90.
[30] Belk R. Possessions and the extended self. J Consumer Research 1988;15(2):139-68.
[31] Kleine SS, Kleine RE III, Allen CT. How is a possession "me" or "not me"? characterizing types and an antecedent of material possession attachment. J Consumer Research 1995;22:327-43.
[32] Atakan SS, Bagozzi RP, Yoon C. Make it your own: how process valence and self-construal affect evaluation of self-made products. Psychology & Marketing 2014;31(6):451-68.
[33] Panofsky E. Studies in iconology：humanistic themes in the art of the renaissance. New York: Harper & Row; 1972.
[34] Meyer RP, Laveson JI. An experience judgment approach to tactical flight training. Paper presented at the proceedings of the human factors and ergonomics society annual meeting; 1981.
[35] Berlyne DE. Aesthetics and psychobiology. New York: Appleton-CenturyCrofts; 1971.
[36] Eroglu SA, Machleit KA, Davis LM. atmospheric qualities of online retailing: a conceptual model and implications. J Business Research 2001;54(2):181.