Application of Cognitive Neuroscience in Color Composition in Graphic Design

Yuanxin Shan

ABSTRACT
Color as a unique sentience human has is ubiquitous in graphic design and art. It can make graphic design more gorgeous with an ingenious idea. This paper aims to discover the relationship between color composition and cognitive neuroscience in attempt to fully exert the advantages of colors in graphic design. Here the important role of colors in graphic design and the relationship between color composition and cognitive neuroscience are first elaborated. Next, several impact factors affecting graphic design is blended with the color concept to explore how they impact each other.

Key Words: Cognitive Neuroscience, Color Composition, Graphic Design, Color Recognition

Introduction
A study on cognitive neuroscience aims to expound how the brain mechanism of cognitive activity (D’Esposito et al., 2016; Lloyd, 2014), namely the human brain, invokes its components at all layers, including molecules, cells, brain tissue regions, and the whole brains, to achieve various cognitive activities. Some branches of traditional neuroscience (Havins et al., 2011; Goknil et al., 2014), such as neuropsychology, psychophysiology, physiological psychology, neurobiology, and behavioral pharmacology, as blended with the theories of cognitive science and new technologies of neuroscience, have gradually formed some subsiences of cognitive neurosciences, such as cognitive neuropsychology, cognitive psychophysiology, cognitive physiological psychology, cognitive neurobiology, and computational neuroscience, etc. Graphic design, in general, refers to the artistry and specialty, where the "vision" is deemed as a means of communication and representation. To be creative in a variety of ways and combine symbols, pictures, and texts, a kind of visual performance is thereby captured to convey human ideas or messages. Graphic designers may get to what they desire by using professional skills such as typography, visual arts, and page layout. Graphic design usually refers to the production (design) process, as well as finally finished works. Color composition as a very crucial foundation course with a vital role in graphic design, is finding wider and wider application in our daily life. Because physiological characteristics of human vision often do not objectively reflect the original appearance of colors, a disparity between feeling show and reality is created. It is of great guiding significance to learn the color composition if we know well the laws of human vision physiology before learning the composition of colors. It has been more than one hundred years of history since the inception of color vision theory (Ott, 2015). T. Young, a medical doctor and physicists in the United Kingdom, initially proposed that the human eye had three kinds of false scents of nerve fibers in the retina, i.e. the trichromatic theory (Seitamaa et al., 2016).

Corresponding author: Yuanxin Shan
Address: Academy of Fine Arts, Zhengzhou Normal University, Zhengzhou 450000, China
e-mail: shanyuanxin@163.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 28 March 2018; Accepted: 4 May 2018
The application of color in advertisement design

Colors play a role in expressing information and conveying emotion in graphic design

In graphic design, colors that exhilarate human are often used to stimulate the watchers' sense organs and excite audience's sensory nerve, which further makes them pay more attention to advertising and generate great interest in it, thus making a profound impression. Relatively speaking, product advertisements with higher technological content are often tinted as tranquil colors to reflect the rigor of science and present the reliable performance of products. With the advancement of semiology, color not only expresses emotions, but also conveys the information more directly, for example, the principle of traffic lights reminds to represent Forbidden in red and Allowed in green in the print ads, and so on. The two major brands, Pepsi and Coca, respectively select red and blue as their representative colors. When they appear in print ads, the public can quickly respond to the brands represented by different colors. As shown in Table 1, the visibility of various pure colors on black and colorful backgrounds.

Colors in the graphic design play a very powerful rendering effect

Color can intensify the advertising effect by texts in graphic design materials. A floor plan includes many elements. Sometimes it is difficult to maximize the workout by solely relying on text and language in graphic design although both can convey some information more directly. Color can show the image, texture, and sense of quantity of subject content more vividly than texts. The fact that the rendering image in the graphic design can be truly demonstrated is inseparable from the color. It is the third dimension that can inspire the majority of the audiences' confidence and goodwill on the propaganda in the graphic design renderings. With the help of color charm, designer can achieve the theme function and purpose of graphic design renderings. Once more, color can intensify the propaganda effect symbolized in graphic design renderings where text and image are dominant. The blend of color can highlight this symbolized effect in that any color can influence people's physical and mental processes such as feeling, perception, memory, association and emotion. On this basis, they can produce specific psychological effects, such as cold and warm, light and heavy, far and near, strong and weak, dynamic and static, gorgeous and simple effects, and so on. Some specific colors correspond to different psychological reactions and also have different symbolic meanings. The role of this intensified symbol of color is very important. A good graphic design rendering is also to influence people's psychological activities by using the emotional symbols of colors. The unique color language of the advertising subject makes the audience more easily cognitive and intimidated, so as to achieve the advocacy function of advertising.

Color in graphic design better improves the sense of tableau and enrich the amount of information

In addition to intuitive features, color has its own unique "charm". The world in our life is full of colors. In general, the graphic design with simple black and white tones is far less glamorous than that with the strong colors. Of course, we do not rule out the super excellent graphic design. In relation to the general "sketch" floor plan, the colored one is often more life-like, gorgeous and vivid so as to express the advertising information more comprehensively. The color of the graphic design is undoubted an eye-catching important element when watching from a far distance.

Color strengthens brands and ideas in graphic design

Color usually can well forge a brand with a standard visual effect (Wang et al., 2011), which impresses the market with a distinct image in a short time. It's naturally critical for the establishment of brand image, especially for Pepsi and Coca, as described above. The inclusion of color not only improves the brand awareness but also enhances the brand recognition. Of course, it is certain that color orientation will undergo a number of complicated procedures such as survey, analysis, evacuation, and development. Only in this way can we target at audience market to select and apply appropriate colors for creativity and maximum communication.

The relationship between cognitive neuroscience and color composition

Overview of cognitive neuroscience

The study on cognitive neuroscience aims to interpret the brain mechanism of cognitive activities, that is, how the human brain invokes its components at all layers, including molecules,
cells, brain tissue regions, and the whole brain to achieve a variety of cognitive activities (Iacono et al., 2017). Since the late 1980s, scholars have made great strides toward the cognitive neuroscience in a short time, bringing about a tremendous impact on the theoretical architectures of traditional cognitive psychology and developmental psychology as well as various content domains.

**Generation of color vision**

Vision is created from a joint effect of the physical characteristics of light and the physiological mechanism of the human eye. It is classified into two parts, i.e. visual sensation and visual perception. The visual sensation refers to the component of the visual physiological feelings; visual perception is the advanced treatment further performed by the brain based on the visual sensation, enabling human to organize the acquired visual information and recognize the surrounding world. Sensation is the process that the brain converts physical energy into neural code recognizable. Any sensation is caused in the way that a certain stimulus affects a certain receptor. Visual physiological sensation is derived from the effects of light stimulation on the eyes. The recognition distance of various colors on a plain color background is shown in Figure 1.

Under the conditions of the visual formation, when the light in the wavelength range recognizable by the human eye is directly emitted by the luminescent object or reflected by the object to the human eye, it will inspire human with basic visual sensation, mainly reflected in light and shade colors. Sensation influences human greatly, and a tiny deviation will disturb human behaviors (Volk et al., 2014). The leading way the human gets to know the world is by the vision. The visual physiology process includes two phases: one is that light reflects or is emitted from an object to the human eye where an “image” is eventually formed on the retina under the actions of various structures of the eyes; the other is that the brain judges and interpret this image after the optic nerve passes it into the brain tissue. The physiological organs involved in this process are the human eyes and the brain. The composition of the human eye includes the cornea, the iris and the pupil, the lentil, the vitreous body, and the retina. Fig. 2 shows the visual effects of humans in different background colors as demonstrated in the test.

**Relationship between color vision and cognitive neuroscience**

"Visual image" is a vivid representation of a specific object, extremely similar to human’s veridical perception. For example, when we imagine an apple, then its color, shape, and exact size are accurately characterized. The “spatial representation” is by far poor because it characterizes an abstract spatial relationship and is a "schematic map”. For example, when we say “the apple is on the right of the orange and the pear is on the left of the orange”, we may simplify concrete objects such as apples to an abstract circle or point. Knauff et al. believed that what human was really dependent on in the inference.
process was just abstract "spatial representation" rather than concrete "visual image". In fact, the "visual image" not only discourages the inference process, but also interferes with it. The impact of different factors on color perception is shown in Figure 3.

**Figure 3.** The influence of different factors on color cognition

Color words influence color perception, in which part of the brain does this occur? Cerebral hemispheres have functional asymmetries. Phonetic text recognition is relative to the left hemisphere of the brain. Gilbert, Regier, Kay, and Ivry (2005) argued that, if language influenced cognition, this would be more concentrated on the right visual field (corresponding to the left hemisphere) since the language zone of the human brain lay in the left cerebral hemisphere. Influence of language on cognition presents as follows: the language zone in left hemisphere enhances the influence of different classes of vocabulary IDs on visual discrimination, but blurs the influence of the same classes on it; while the right hemisphere has no such effect. They validated this hypothesis using the sub side color identification task. The results show that the stimuli appear in the right visual field (projected to the left hemisphere), the color word influences the color discrimination, between-class colors are judged faster, and the inter-class colors are responded slower. To further confirm that this influence originates from the left hemisphere language region, they adopted the sub side identification under linguistic interference, and the interference task was digital memory occurred in the left hemisphere where they occupied the cognitive resources (Huber, 2011). The results reveal that the judgment response of between-class color in the right visual field gets slow, while the response of inter-class color is faster because of less influence of language. It turned out that language influences color cognition in the language zone of left hemisphere. Tan et al., (2008) applied FMRI technology and found that during the test on discrimination of color blocks, in relation to color blocks which are difficult to be named, the stronger activation occurs in the rear part of left superior temporal gyrus and the parietal lobe foliule when identifying easily-named color blocks. These two encephalic regions are related to vocabulary recognition. The relationship between cognitive neuroscience and color composition in the case of different factors is shown in Fig. 4.

With reference to the existing pertinent literature at home and abroad, based on the available theories on the relationship between color words and cognition, we appropriately absorb the outlooks of perceptual processing theory and connectionism to propose an interaction theory between color words and perception. Color cognition involves both bottom-up data-driven and top-down concept-driven processing. There are six factors that affect color perception: physics, physiology, cognition, intelligence, language, and culture.

**Figure 4.** Research on the relationship between different factors in cognitive neuroscience and color formation

These six factors are divided into three levels, i.e. physical-physiology, cognitive-intelligence, and socio-culture. Color words are not only an integral part of a national color culture, but also lead children to appreciate the borders of color perception that the culture of the nation respects,
thus contributing to the formation of color cognition style that is compatible with the color culture of the nation.

Conclusions
The creative design for print ads can’t do without the cognition of the basic color attributes. With the palette of hue, lightness, and purity, the arrangement of color shapes, sizes, and positions, the master of the visual and psychological feelings of cold and warm tones make print ads produce visually dynamic gradient, sense of orderliness, and feelings of heavy and diaphanousness. The cultural and creative designs in color will endow ads with emotional symbol, improve the implications of the works, and fully play the role of colors in attracting attention, conveying information, and persuading the audience. Human cognition of colors is determined neither by a factor alone, nor by multiple factors in parallel, but by the resultant product of cognitive development based on innate biological factors under the influence of postnatal language and culture. It is the interaction of the six factors such as physics, physiology, cognition, intelligence, language, and culture that human cognition of colors has both humanity and national character; both commonalities and specificities; both objectivity and subjective; both sensation and conceptuality. Color cognition are therefore the integrations of the above attributes. Color recognition is a multi-factor, multi-level psychological phenomenon, colorful in the boundless universe. The color world in human hearts is even more colorful. The relationship between color words and cognition can neither simply attributed to the principle that color words determine color cognition, nor ignore the relationship between the two to conclude that color words and color cognition are independent of each other. With the in-depth study on the relationship of color words and color cognition with cognitive neuroscience, we must unveil a richer world of color psychology.

References