

Original Paper

Emotional Context and Color Perception and Recognition by 12- and 16-years-old Children

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Abstract

Will the emotional context in which a painting is placed impact how well adolescents remember the colors in it? Will there be differences in color perception and recognition based on age and gender? Specific materials had to be designed to answer this question: (a) an abstract, themeless painting composed of twelve colors, each covering the same area with the same number of pixels, and (b) four texts with different emotional connotations (fear, anger, happiness, and sadness) describing the lives of fictitious painters. After being pretested, the material was proposed to 142 seventh-grade students and 71 tenth-grade students. Each subject studied a painting and heard one of the four texts. Next, the painting was taken away; after this, the subjects ordered the twelve colors based on how much area they thought each one covered the painting. It was hypothesized that the subjects would give greater importance to specific colors depending on the emotional context induced by the associated text. The results confirmed this hypothesis, although the tenth graders were less affected by the emotional context than the seventh graders. There was no statistically significant effect of gender in either population.

Keywords

memory, color, emotions, adolescents, recall

1. Introduction

The French language is full of color-based expressions like rouge de colère (red with anger) and vert de peur (green with fear), or blanc comme neige (white as snow, unblemished). Both intuitively and culturally, then, colors could conceivably have a positive or negative emotional value that would

depend on personal and social factors. Furthermore, this value could affect the perception and memory of colored objects.

The combination of hue, saturation, and brightness, constituting a color, also influences the physiological level, impacting arousal, skin conductance, and heart rate (Wilms & Oberfeld, 2018). Different colors elicited different amounts of arousal and attention (Mukherjee, J. & Mitra, 2012), and color presentation had a systematic effect on a subject's emotional state (Wilms & Oberfeld, 2018). These effects of colors on human behavior can be understood in an evolutionary perspective (King, 2005) and a context-dependent effect, based on the interaction between emotion, culture, and context (Kuniecki, Pilarczyk, & Wichary, 2015). Color choices are also driven by mood; in their research, Jonauskaite et al. (2019) showed that correspondences between colors and felt moods were systematic and resembled conceptual evaluations of colors to emotions. The mood is also known to impact color perception and judgments of color attractiveness. For example, Vorsobin and Zhidkin (1980) showed that a preference for specific colors like red, orange, or yellow was more significant in 5- to 7-year-old children when they were in a happy mood. Conversely, colors affect a subject's mood on a psychological level through perception, emotion, and feeling (Hanada, 2018), which is widely used by marketing.

Relationships between color perception and emotions are necessarily governed by cognitive processes (learning, analogies), and as such, they can be approached in terms of information-processing operations, where memory plays the principal role (Ovalle-Fresa, Ankner, & Rothen, 2021). In past research, Bornstein (1976) suggested that colors are built into memory networks and may form the basis of mental representations. They were starting from the idea that a dual pictorial-verbal encoding process generates a link between figures and their colors (Allen, 1983).

There is evidence of color-emotion (Kurt & Osueke, 2014; Takahashi & Kawabata, 2018) and color-memory links (Clewett, DuBrow, & Davachi, 2019). As postulated in several memory-organization both classical (Bower, 1981; Beck & Emery, 2005) and recent theories (Cooper & Ritchey, 2019; Tyng et al., 2017), memory and emotions closely interact. So, there might be a triple relationship between memory, color perception, and emotions. Following this conception, colored material and emotional stories in four different emotional contexts (happiness, sadness, fear, and anger) were designed. First, the material was presented in association, and then recognition of the material was tested. Our goal was to show that the emotional context at encoding time can affect subjective color perception, reflected at recognition. First emotional priming associated with color was expected to elicit an attentional bias for color congruent to emotion, which tended to encode an overestimation of the color in memory. This process can be compared to the emotional priming effect on cognitive schemas (Dadomo et al., 2018).

2. Method

2.1 Participants

The experimental population consisted of 142 seventh-grade students (68 girls and 76 boys, all 12 years old) and 71 tenth-grade students (37 girls and 34 boys, all 16 years old). None of whom had a color-perception disability.

2.2 Material

The color material for the study was an abstract, computer-generated painting made up of 41 colored “dots” taken from a set of 12 colors (blue, red, yellow, orange, green, purple, pink, beige, grey, brown, white, and black). In a previous study, these 12 colors were efficiently and correctly identified and differentiated by the general French population (Hautekeete-Sence, 1990). There were three or four dots of each color in the painting, and all colors occupied the same amount of space, with the same number of pixels. The judging method was used in a pre-experiment to ensure that none of the colors in the painting, which was not associated with a particular emotional context, seemed to cover more area than the others. The locations of the colors were counterbalanced across several versions of the painting. No significant difference was found across versions.



Figure 1. Abstract Painting Composed of Twelve Colors of Equal Size

In order to put the painting in a particular emotional context (happiness, sadness, fear, or anger), four texts (note 1, 2, 3, 4) were written in a dictionary-definition style. Each text described the life of a fictional painter; this story was designed to show and elicit one of the four emotions. The texts were a few sentences long (150 words). They described powerfully emotional times in the artist's life and also talked about the possible meaning of the painting. To ensure that the texts were easy to understand and representative of the desired emotion, they were judged in advance by 20 same-age children. They all found these stories clear and understandable, and all the words used were familiar to them.

2.3 Procedure

The recruitment was done, with the school's agreement where the children were schooled. The unanimous consent of the parents and the child was necessary to participate in the study. It was specified that the children and the guardians could stop participating in the study without justification and that all the data would be anonymous. The consent form's information flyer also asked the guardians if their child suffered from a color perception disorder. If the child suffered from a deficit of the perception of the colors, it was indicated that the study required a standard vision of the colors and that for reasons of medical secrecy, it was not necessary to announce it to the experimenter, but not to take part in the study, without indicating the reason of this refusal. No justification was ever requested from the parents or the children in case of non-response or explicit refusal to participate. The contact details of the experimenter and the principal investigator of the study were permanently available to the custodians of parental authority and the teaching team to answer any questions raised by this research. The school doctor was also informed of this research and had the contact information of the experimenter.

After a school day and a 20-minute break, all the subjects were tested not to disrupt their learning day. Four classes were randomly assigned to a specific emotional condition for the seventh-grade students. There were 35 subjects in three groups and one group of 37 subjects. Two classes were divided into two groups for the tenth-grade students, forming four groups randomly assigned to an emotional condition. The experiment took place in their regular classroom, and each of the four classes composed of the subjects participating in the study was randomly assigned to a specific emotional condition. The experimenter told them they would be given a memory test based on a painting and a text (the two items were equally emphasized). First, each subject was given a copy of the painting. Then, a minute later, one of the four texts was read aloud twice by the experimenter in a voice that was loaded with the corresponding emotion. The reproduction was said to be a genuine painting exhibited in a local museum, and the text was alleged to be taken from the painting's cartouche. Then the paintings were taken away, and the subjects were instructed to "think" about the author and his painting for five minutes. Five minutes were expected to be enough to guarantee that the information was no longer being processed in short-term memory.

When the thinking period was over, the subjects received a set of 12 cards (12 cm x 5 cm), one of each color in the painting. They were asked to rank the cards according to how much area they thought each color took up in the painting. The rank given was used as the score for that color (first place = 1, second place = 2, ...).

After retrieving the results, the purpose of the study was explained to all participants, specifying that the stories were fictional. During these explanations, the experimenter was positively reinforcing, with a joyful and positive voice tone, to induce a slight positive emotional activation. This positive tone of voice was intended to bring the children back into a positive emotional state to cancel a potential

negative activation of the mood following telling stories with a negative emotional tone. Custodians of parental authority were immediately informed of the objective of this study as soon as it was completed.

3. Result

Statistical analysis was performed with Jamovi, version 2.0.1. Only some of the many results are reported here. The mean ranks of the colors are presented in Table 1.

Table 1. Mean Ranks of the Colors Given by 12 Years old Subjects as a Function of Emotional Context

	Joy	Sadness	Fear	Anger
Blue	4,25	5,27	5,45	5,02
Red	4,52	4,11	4,40	3,62
Yellow	4,80	6,02	6,25	4,74
Orange	4,88	5,75	5,88	6,85
Green	6,00	6,27	5,45	7,42
Purple	6,80	4,72	4,91	7,11
Pink	6,83	8,00	7,65	8,60
Beige	7,58	7,38	7,85	7,28
Grey	9,08	7,77	7,94	8,08
Brown	7,55	6,77	6,28	6,88
White	7,75	8,33	8,02	6,28
Black	7,91	7,30	7,82	6,08

ANOVAs indicated no statistically significant effect of gender in either population. For the seventh graders, the emotional context had a significant main effect for four colors: blue ($F_{3-108} = 2.862$, $p < .05$), orange ($F_{3-108} = 3.428$, $p < .02$), green ($F_{3-108} = 3.391$, $p < .05$), and purple ($F_{3-108} = 4.308$, $p < .01$). Contrast analyses between the emotions were conducted for each color to understand this effect further. The effects were significant for seven colors: blue, yellow, orange, green, purple, white, and black. This result validates the idea that emotional context impacts color recall. There were no significant differences between others colors.

For the tenth graders, there were fewer significant results: the emotional context only had a main effect on two colors, pink ($F_{3-63} = 3.254$, $p < .05$) and grey ($F_{3-63} = 2.948$, $p < .05$). Moreover, fewer contrasts were significant and concerned three colors: pink, beige, and grey.

4. Discussion

The analyses conducted on the data obtained in this experiment validated our general hypothesis: the emotional context in which the colors of a painting are perceived affects their recall. However, this effect may decrease or change with age. In our post-experimental interviews used to inform the participants about the experiment's true purpose, most of them asked to watch the original painting, so they found it hard to believe there were some differences in color's spaces. Between the presentation of information and its retrieval, multiple cognitive processes can account for these results. Firstly, how an emotional context affects the recall (Kosti et al., 2017) of a painting's colors may stem from information selection processes that direct the observer's perceptual attention to specific information. Given that there is an acquired cultural association between specific colors and certain emotions (Davidoff, 2015), the text presented with the painting may have focused the subject's attention on a particular emotion and could act like emotional priming.

It is also possible that the concerned emotion influenced the cognitive encoding of information rather than directly affecting information selection. For example, choosing colors to memorize might modulate the cognitive load balance between the phonological loop and the visuospatial sketchpad (Ikeda & Osaka, 2007), which led to different results. While the visual modality involves short-term encoding and storage, both of these processes depend on the working memory module, whose capacity is limited in two ways: in the number of items, it can contain and in the amount of processing time those items are allocated (Frick, 1988; Morris, 1989). Accordingly, specific colors may have been processed more deeply, which may have generated particular long-term memory configurations that linked information together (Bower, 1981; Lang, 2019). Such configurations may or may not have included emotional information because it was not necessarily present in the configuration driven by it. However, it is also possible that the emotional context did not take effect until the information was retrieved. Since the subjects in the experiment did not know what tasks were ahead, they may have ordered the colors based on posterior interpretations of the painting during a cognitive reconstruction process. While ranking the colors, the subjects may have asked themselves: "What colors would get the painter's message across?" In this case, the memory processes at play would no longer be directly related to the perception of the material presented but to the subject's past emotion-color experiences. This question can already be resolved: if the subjects had ordered the colors in that way, then their rankings would have been similar to the results obtained by Meerum-Terwogt and Hoeksma (1995) and Hautekeete-Sence (1990), who asked American 11-year-olds and French 12-year-olds, respectively, to rate the degree of correspondence between colors and emotions. Their results differed from ours on every emotion studied. For example, in the Hautekeete-Sence (1990) study, the colors most highly associated with fear were black, brown, and grey and the colors least associated with fear were pink, yellow, and orange. In a similar population but with a different experimental operationalization, we obtained results indicating that red, purple, blue, and green were highly associated with fear and that

white, grey, black, and beige were weakly so. Thus, remembering a color perceived in a particular emotional context is very different from assigning an emotional weight to that color.

5. Conclusion

This study demonstrated the impact of the emotional context on the recall of specific colors. This recall seems to evolve according to the age of the subjects. No formal explanation for the different effects obtained on the two populations can be given. It's presumed that subjective associations between colors and emotions are not gender-dependent but vary with age. It can be supposed that emotional contexts have different effects at different ages, maybe due to interpretation and the evolution of emotionality during adolescence. Another possibility is that the tenth-grade subjects were less naive or motivated than the seventh graders, making them less sensitive to the experimental manipulation.

Further research is needed to answer this question. In addition to the theoretical insights this experiment provided, it offers a tested and validated set of materials for future research. The hypothesis set forth here could only have been verified with materials specifically designed to reduce the experimental bias. This material exists and can be reused and operationalized in various ways. Finally, this study suffers from limitations, the sample size, a different number of participants in the two groups, and that the link between specific emotion and color recall which were not studied here. These limitations make it necessary to replicate this study to test the reproducibility of the results. The participants' motivation should be measured as their initial emotional state in future research. Future research should also investigate the usefulness of colors in the adolescent population for learning purposes and clinical applications based on their age. For example, colors could be used in mood evaluation, coupled with standard comportemental and cognitive assessment techniques.

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Notes

Note 1. Joy situation text

“Life is delightful. Let us make the most of it.” This is Alberto Papagai’s cry of joy. Alberto, born in 1952 in a happy

sunny village in Southern Italy, says he is so contented, he would not leave his village for love or money. Alberto is a happy man, always having a good time for him, everything is a source of pleasure and laughter, and each day brings new happiness, which one must make the most. Moreover, all the joy he wants to share in each one of his paintings with us is found. This painting entitled “The most beautiful instant” represents the tears of joy he shed when his little girl came into being.

Note 2. Sadness situation text

Louise Lalune (1940-1991), born in Lille, was nicknamed “Melancholy” by those that knew her. It is often said that her life was just a series of lamentable tragedies. First, she lost her family in a fire while still young, then was brought up in a mediocre orphanage. Then, pitifully, she descended into misery and boredom, a deplorable world for someone who had so much talent. This work, entitled “Complaint and Sadness,” represents the vision that she had of a doleful, morose world in which she had no reason to live. Louise Lalune finished her unhappy existence alone in a retirement home where, as she said herself, “Time seemed too long.”

Note 3. Fear situation text

Louis Tatinghen (1947-1990) lived in a sunny Alpine village as a child. Before turning seven, he was

lost for over 3 days and 3 nights in a thick forest. From then on, his dreams were no more than deplorable nightmares, filled with anguish and terrifying monsters. Louis Tatinghen tried to represent his fears and the scary nights he could not overcome in all his works. Finally, at 33 years old, Louis Tatinghen committed suicide for reasons we can only guess since he had just finished this painting called “Last Terror,” which is doubtless only a pale reflection of a nightmare more terrifying than all the others.

Note 4. Anger situation text

Jack McNooler, born in Belfast in 1947, is today considered the most committed artist in the struggle for the Republican cause in Northern Ireland. Aged 15, the day a British soldier gunned down his father, Jack took up arms and rejoined the I.R.A. He abandoned everything and fought with fury and vengeance. Then, aged 23, he was betrayed by one of his own and arrested for a crime he did not commit. Full of rage, he escaped and left Ireland, although he did not give up the struggle. Instead, he has found refuge in the United States, from where he continues to speak out against the British occupation of his country. This painting called “Storm in the Head” is, according to Jack, the memory of his powerless fury.