

# A STUDY ON STRESS REDUCTION USING INTELLIGENT EMOTIONAL INFORMATION SYSTEM

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## ABSTRACT

Stress is an integral part of modern life, and everyone experience it at some point. The stress experienced by teens has a wide range of mental and physical effects. This study examines an intelligent emotional information system that applies color therapy to measure the degree and cause of stress among adolescents with the goal of relieving it. Various types of emotional information can be gathered through emotional information design, which is important in understanding the end user as part of human-centered design, whereby a color information design method is proposed for each emotion using fuzzy neural networks.

**Keywords:** *Emotional Information System, Stress Reduction, Color Therapy, Fuzzy Neural Network*

## 1. INTRODUCTION

Everyone experiences stress at some point in their lives, as it is an integral part of modern life. Adolescence is a period of rapid physical and psychosocial change, characterized by instability and numerous conflicts. In addition, adolescents are exposed to stress because of entrance exams, with frequent changes in the education system forcing them to study, which interferes with the development of their other aptitudes [1], [2]. South Korea's adolescents are also living stressful lives, but they have neither the time nor the know-how to relieve stress, which has led to a decline in life satisfaction. The best way to alleviate stress in teens is to remove the source of the stress. If this is not practical, easily applicable ways should be devised to alleviate stress. Stress management methods include exercise, leisure activities, meditation, consultation with a professional, progressive functional relaxation, cognitive-behavioral techniques, biofeedback, and even medication [3], [4]. However, these methods are limited in their applicability to individuals in stressful situations or require traveling to another location or setting aside time away from the stressful environment, which can also be stressful if the limitations are not addressed.

This study investigated the causes and extent of stress among adolescents and used smartphones, which are widely used by adolescents, as a way to relieve stress. Colors have unique wavelengths and frequencies that affect health. Using colors to treat illness or stress is called color therapy, which involves measuring user stress through color body

information, to provide appropriate color therapy based on the result. This study proposes an emotion-specific information design method using color and fuzzy neural networks to relieve stress by applying color therapy using smartphones [3]. This paper is organized as follows. Chapter 2 reviews relevant studies on adolescent stress and solutions. Chapter 3 discusses in detail the stress measurement method and the intelligent emotional information system that uses color therapy, proposed in this paper. Finally, Chapter 4 presents the conclusions of this study.

## 2. CAUSES AND SOLUTIONS FOR STRESS IN ADOLESCENTS

In this chapter, the nature and causes of stress, including definitions and characteristics of stress and solutions to stress in adolescents are discussed.

### 2.1 Causes of Stress

The word stress originates from the Latin word *stringere*, which means 'to tighten', and refers to external stimuli that disrupt the rhythm of life. Hans Selye defined stress as a response to a stimulus that threatens to disrupt mental and physical balance and stability, a response that resists the stressor to maintain one's own state of equilibrium, thereby setting the framework for future stress research [2]–[4]. Domestic and international research on stress in adolescents suggests that the main cause of stress for adolescents is the daily stresses found at school, home, and in their social lives. In particular, the level of stress related to school, including grades, career, and academic worries, is very high. Specifically, more than 70% of the concerns of adolescents were related

to school or career. This indicates that the problems of Korean adolescents are caused by the entrance examination-oriented education system, excessive study time, and endless competition [5]. As a result, they are exposed to significant stress factors. Therefore, stress management measures are needed to help adolescents overcome and cope with the stresses they face so that they can adjust to school and establish their own identity [6].

## 2.2 Stress Relief Measures

Adolescents in middle and high schools experience a lot of stress because of a variety of psychological pressures, including demanding classes and homework, pressure to perform well, blind parental expectations and demands, and peer pressure. Adolescents are also in a transitional stage of development, with up and down in emotions and moods [6]. Therefore, they tend to experience and express stress in ways that are different from other age groups.

There are many ways of relieving stress, including art therapy, aromatherapy, and mentoring programs. The benefits of art therapy are as follows. First, art stimulates the expression of thoughts, which leads to a creative process. Second, art is a non-verbal medium, thus less controlling and amenable to reducing defenses [4]. Third, art can immediately provide specific tangible resources, building a bridge between the therapist and the counselor, thereby facilitating communication. The aromatic oil method involves selecting the type of aromatic essential oil that most effectively expresses the desired mental function and skin condition from among nearly 300 types of aromatic essential oils, and the form of synergistically branded fragrance oil used can maximize the therapeutic effect [7], [8].

Mentoring programs have been developed as a way to help adolescents recognize and change the stressful situations they encounter at school, including self, peer, and interpersonal issues, to help them improve their coping skills and lower their perceived stress levels. Color therapy is a combination of color and therapy, harnessing the energy and properties of color for therapeutic purposes. The type of holistic healing that uses the visible spectrum of light and color to influence a person's mood and physical and mental health, is called 'chromotherapy' or 'color treatment'. Using color, chromotherapy can restore the body's functions, such as the autonomic nervous system and immune system, to their normal state. Moreover, it can also affect the emotions and the mind, stabilizing mood, emotions, and even harmonize the soul [8].

It argued for the psychological and physical

effects of each color on humans [8], [9]. Table 1 summarizes the effects of color.

Table 1: Effects of color [10]

Color	Psychological	Physical
Red	- Increases self-esteem and vitality - Drives motivation	- Improves blood circulation - Relieves depression, mental and physical weakness
Orange	- Helps reduce anxiety and sadness by providing relaxation and enjoyment of life	- Promotes blood circulation - Relieves constipation and sclerosis
Yellow	- Provides mental freedom and positive thinking - Increases focus and creativity	- Positively affects the nervous, endocrine, and digestive systems, as well as the spleen
Green	- Relieves anxiety and prolonged stress	- Lowers blood pressure and reduce fatigue and anxiety
Blue	- Relieves depression and stress through the subconscious	- Relieves muscle aches and pain - Induces rest
Purple	- Helps with meditation - Encourages creative activities	- Relieves headache and feelings of weakness and anxiety

Psychologically, red is said to boost self-esteem and vitality; physically, it increases blood pressure and improves blood circulation. Orange is said to provide psychological relaxation and enjoyment of life; physically, it helps circulation, which can affect constipation and sclerosis. Yellow is said to promote positive thinking, creating a positive effect on the nervous and endocrine systems [8]. Green has the psychological effect of reducing anxiety and prolonged stress; physically, it lowers the blood pressure and reduces fatigue. Blue relieves anxiety and stress; physically it is relaxing and can help with muscle pain and asthma. Psychologically, purple is said to encourage creative activities, aid in meditation, and alleviate headaches [9]. There are many ways of using color therapy in daily life, such as changing the color of your bedding, wallpaper, or using colored light. The color of clothes and accessories can be changed to help feel better, or favorite colors can be displayed in pictures nearby. This study uses the method of applying color therapy through smartphones [10].

## 2.3 Relationship between Color Therapy and Stress

Stress that accumulates without being relieved, can

escalate to chronic stress. Moreover, if homeostasis is disrupted, it can cause diseases and social problems. Color is associated with human emotions, feelings, and psychological states. Color therapy uses colors to influence and assess human metabolic processes in the body [9]. Using color selectively, as needed, can stimulate, revitalize, relax, and soothe. With regard to the relationship between color therapy and stress, Hong [6] found that high-stress individuals were more likely to respond to color therapy as relieving tension and inducing relaxation compared to low-stress individuals [10]. Sohn [8] examined the effects of flower colors on elementary school children's moods. Children reported that red and yellow were flower colors that they wanted to receive as gifts when depressed or very tired from exams. Lesley [7] found a significant decrease in stress in nursing students after conducting color therapy using blue and pink, demonstrating that blue is more effective in reducing stress levels [11].

7	Not having close friends								
8	Sense of competition with friends								
9	Appearance or physical deficiencies								
10	Lack of teacher understanding								

The stressors for teens were categorized into three areas: school, home, and interpersonal relationships. The questionnaire consisted of 10 questions, and stress levels were measured using a 5-point Likert scale [12] for each question. The total stress score ranged from 5 to 50, with higher scores indicating more stress. Table 3 shows the scores for each stress survey question.

Table 3: Scores for each stress test question

Question	1	2	3	4	5	6	7	8	9	10
Total Score	28	19	27	34	32	15	17	20	21	20

### 3. INTELLIGENT EMOTIONAL SYSTEM

#### 3.1 Measuring and Analyzing Stress

In this study, 50 males and females were randomly selected from the third grade of junior high schools to measure stress. To measure adolescents' daily stress, a modified version of the Adolescent Stressors and Experiences Questionnaire utilized was administered [10]. Table 2 shows the stress index questionnaire.

Table 2: Stress index survey [12]

	Questions					
		no stress at all	slight	normal	strong	severe
1	Heavy homework and frequent tests					
2	Teacher bias and favoritism					
3	Education and career choices					
4	Grades not as good as expected					
5	Parents' excessive expectations from studies					
6	Romantic relationship problems					

When the surveyed students' stress levels for each question were analyzed, "grades not as good as expected" scored the highest, followed by "parents' excessive expectations from studies," whereas questions about romantic relationships and friends had relatively low scores. In the survey, many students responded that they were slightly (25%) or moderately (37.5%) overwhelmed, indicating that they felt less than overwhelmed by studying.

#### 3.2 Intelligent Emotional Information System

Color information displayed through the PC and mobile phones has been shown to have an immediate appeal, with a significant impact on the psychology of the individual. This study is on intelligent information systems and is based on the users' emotional information, employing color information design to assess user stress. The study provides a customized information service, and the generated color information is tailored to the user's stress, allowing the user to use color therapy from a psychological perspective. Figure 1 shows the overall organization of an intelligent emotional information system.

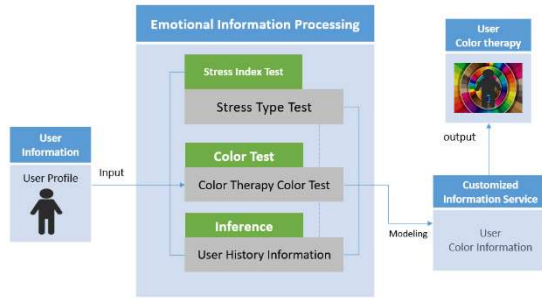


Figure 1: Intelligent Emotional Information system

The emotional information on the system that supports color therapy according to personal profile is read as the user enters the information, whereby the personal emotional information is analyzed using the stress index test and color information in color therapy throughout the test. The information inferred from personal history is modeled as a customized information service and delivered to the user as a color in color therapy. Emotional information extracted through the analysis according to user characteristics is stored in the user's color database and used as personal history information. Figure 2 shows a breakdown of color therapy information.

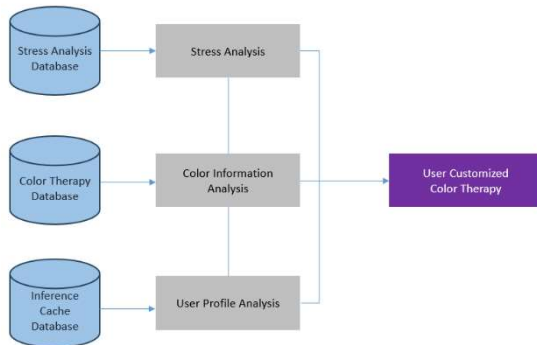


Figure 2: Analyzing Color Therapy Information

Color therapy information is extracted from the user's personal information analysis, and the database on the results and stress analysis information is analyzed to provide customized color therapy [13], [14].

**3.2.1 Designing color therapy information using fuzzy neural networks**

In this study, the color therapy information was designed using five primary colors and Newton's seven colors (red, orange, yellow, green, blue, indigo, and violet) as foundation colors, as shown in Figure 3.

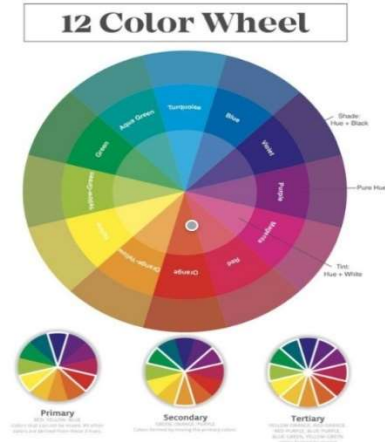


Figure 3: Color wheel [13]

The composition of the color wheel is regularly arranged, and colors facing each other have complementary relationships. The selected colors were organized by going through a step of grouping similar colors. The grouping of images of the five senses was performed by inference based on fuzzy relations, and the fuzzy relations were defined as a function by placing black, white, and 12 other colors on the color wheel at 30° intervals [9]. The affiliation of each color group was calculated using Mamdani's IF THEN rule, which is an inference method for color grouping that calculates the fitness of each affiliation.

$$R_n : \text{if } X_n \text{ is } A \text{ and } Y_n \text{ is } B, \text{ then } Z_n \text{ is } C \quad (1)$$

Formula (1) shows that the degree of the linguistic values input belonging to the two propositions in the antecedent of an If then inference rule is similar to the fuzzy inference belonging function. The input value of each item in the domain of the reference item is used to obtain the belonging function for the input variable. Here, A, B, and C are linguistic values of fuzzy affiliation functions; X<sub>n</sub> and Y<sub>n</sub> are input variables of items that are input to extract color information; and Z<sub>n</sub> is the output variable of the fuzzy controller. A method based on fuzzy theory is required for inferring colors similar to humans. Hue refers to the type of color, which determines the color between 0° and 360°. Table 4 shows the band definitions.

Table 4: Definition of Hue affiliation [10]

Section	Boundary values
Cosign	
Red (R)	[330°, 30°]
Yellow (Y)	[30°, 90°]
Green (G)	[90°, 150°]
Cyan (C)	[150°, 210°]

Blue (B)	[210°, 270°]
Magenta (M)	[270°, 330°]
Sign	
Red-Yellow (R-Y)	[0°, 60°]
Yellow-Green (Y-G)	[60°, 120°]
Green-Cyan (G-C)	[120°, 180°]
Cyan-Blue (C-B)	[180°, 240°]
Blue-Magenta (B-M)	[240°, 300°]
Magenta-Red (M-R)	[300°, 360°]

In Table 4, the cosine curve is used in addition to the sine function because the boundaries between colors are clear, making it difficult to determine the affiliation of the middle color. Since sine and cosine curves have one period between 0° and 360° and negative values exist, the formula for finding the degree of affiliation  $f(x)$  for a real input value ( $\theta$ ) is given in formula (2).

$$f(x) = | \cos(3\theta) |, f(x) = | \sin(3\theta) | \quad (2)$$

In the analysis of user color therapy information inferred from a personal profile, the personal profile file is read as input and the resulting value is calculated from the user's color therapy information. An inference rule for the language variable is set using the If Then inference rule in formula (1), in a way similar to the false color image scale in the color information measurement for personal color therapy. Color inference expresses the color space of blue, red, yellow, white, and black based on the analyzed personal color information and provides the extracted color information as personalized information. The color information design in color therapy is based on the information analyzed using the stress index test and extracted based on the color in color therapy and personal information analysis. Figure 4 illustrates the emotional information analysis process of intelligent emotional color therapy.

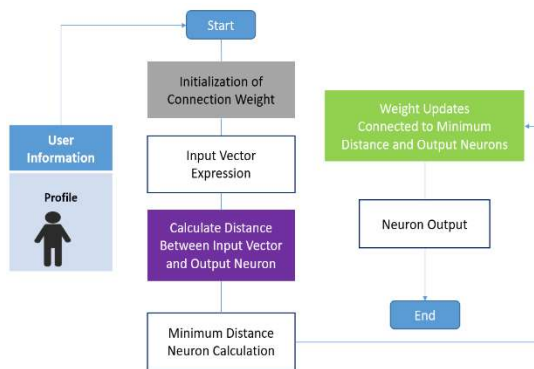


Figure 4: Emotional Information analysis Process of Intelligent Emotional Color Therapy

Based on the user information, the distance of the connection strength vector to the input vector between each vertex is calculated, thereby determining the closest neuron as the winner neuron. This winner neuron can send an output signal, and only neurons adjacent to this neuron are allowed to learn about the presented input vector [15], [16]. In Step 1, the connection weights are reset. In Step 2, the new input vector is presented to the input neuron. In Step 3, the distance between the input vector and all output neurons is computed.

### 3.2.2 Discussion of the effects of color therapy on psychological characteristics

The emotional intelligence of adolescents was measured using the Schutte emotional intelligence scale [8] and further modified and supplemented [9]. The emotional intelligence scale consists of 15 questions with five sub-factors: self-emotion recognition, other-emotion recognition, self-emotion regulation, other-emotion regulation, and emotional problem solving. Each statement was measured on a 5-point Likert scale ranging from not at all (1) to very much so (5). The responses ranged from 15 to 75, with higher scores indicating higher emotional intelligence in adolescents.

Form analysis was performed to analyze color expression in color therapy. The criteria for the form analysis were classified by referring to which are the criteria that represent the psychology of monochromatic and color schemes, such as color classification (colored, uncolored), color combination (colored + colored, colored + uncolored, uncolored + uncolored), color scheme (same, similar, contrast), and coloring technique (color intensity, touch) [3], [6]. The form analysis criteria are shown in Table 5.

Table 5: Formal analysis criteria for color therapy

Analysis Criteria			
Color	Achromatic	Cool colors	white, grey, black, blue, blue green
	Chromatic	Neutral colors	yellow green, green, violet, purple
		Warm colors	red, orange, yellow, pink, red purple, brown
Color Combination	chromatic + chromatic, chromatic + achromatic, achromatic + achromatic		

Table 6: Verification of pre-post differences for emotional intelligence

Variable		Pre		Post	
		M	SD	M	SD
Emotional intelligence ( <i>p</i> value = .004)	Recognition of self-emotion	3.9	0.16	4.5	0.12
	Recognition of other's emotion	4.2	0.18	4.2	0.16
	Regulation of self-emotion	4.0	0.26	4.2	0.17
	Regulation of other's emotion	3.9	0.22	4.1	0.15
	Solution of emotional problem	3.9	0.15	4.4	0.15

The analysis searched for pre- and post-test differences in emotional intelligence as a result of the color therapy experience. The emotional intelligence test was administered to determine the impact of color therapy on adolescents' psychological characteristics. The verification of pre-post differences for emotional intelligence are shown in Table 6.

Upon examining the difference in emotional intelligence of adolescents before and after the color therapy program, emotional intelligence was found to be significantly different at the  $p < .01$  level. Overall, color therapy can effectively improve emotional intelligence. When the semantic properties of colors in color therapy were examined, red was associated with passion, bright, energetic, and fearful; orange with vigor, bright, and passionate; yellow with bright, energetic, excited, and painful; chartreuse with happy and depressed; green was associated with peaceful, calm, and relaxed; and turquoise with dreamy, vibrant, and dark; blue was cool, comfortable, dark, cold, and exciting; pink was happy; maroon was safe, cozy, 67-73. dark; white was pure; gray was neutral, helpless, and dull; and black was chic, cool, dark, and dull.

#### 4. CONCLUSION

This paper proposed an efficient stress relief method to improve the academic and career stress of adolescents. The proposed method combines the efficacy of color therapy with smartphones that are frequently used by adolescents, to induce relaxation

and a calming effect through the stimulation of color. A system was designed that analyzes and processes the user's emotional information through color therapy and transmits the color therapy colors required by the user to the smartphone. The proposed system was designed in the form of a service-based mobile for ease of use. In the future, the stress improvement information obtained as a result of applying this system should be analyzed to increase the effectiveness of the developed emotional color therapy system, and to study intelligent emotional systems on various IoT devices other than smartphones.

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