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Psychological Analysis of the Use of Color in Urban Environmental Graphics Based on Rudolf Arnheim's Aesthetic Perception Theory (Case Study: Graphic Design of Tehran Metro)

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Abstract

Urban environmental graphics, as one of the most effective tools of visual communication in public spaces, play a significant role in wayfinding, identity formation, and enhancing citizens' perceptual experience. Among the fundamental elements of graphic design, color has a direct and often unconscious impact on users' behavior, emotions, and perception. This article, based on Rudolf Arnheim's theory of visual perception and aesthetics, explores the psychology of color in urban Environmental Graphic Design (EGD). Arnheim's theoretical framework—which emphasizes the relationship between form, perception, and meaning—provides a solid analytical foundation for examining the role of color in the visual systems of urban spaces. In the case study section, the graphic design of Tehran Metro stations and signage is selected as an example of urban environmental graphics. Through the analysis of color schemes used in routes, murals, maps, and directional signage, the psychological and perceptual effects of color on space users are investigated. The findings show that a purposeful application of color, aligned with principles of visual perception, can enhance user experience, increase the sense of safety, and improve navigation efficiency in public environments.

Keywords: Environmental graphic design, Urban graphics, Color psychology, Rudolf Arnheim, Tehran Metro.

1 | Introduction

In today's world, cities function as complex visual systems that directly influence the daily experiences of their inhabitants. Within this context, urban environmental graphics play a fundamental role in wayfinding, visual

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organization, identity formation, and even the evocation of emotions in public spaces. From directional signage to metro murals and the color schemes of transitional areas, all contribute to shaping the perceptual experience of citizens. One of the key elements in this experience is color, an element that carries both aesthetic value and psychological and behavioral implications. According to studies in environmental psychology, colors can evoke feelings of security, calmness, anxiety, vitality, or even confusion in individuals [1]. In urban environments characterized by high visual density and everyday stress, the selection and combination of colors in graphic design is not merely an aesthetic choice but a functional necessity. In analyzing the effects of color on perception and emotion, Rudolf Arnheim's theories hold a prominent place. Arnheim, by emphasizing the relationship between form, visual balance, and meaning, demonstrates that human visual perception is not limited to the superficial reception of colors.

Instead, it involves a cognitive and unconscious process through which meaning, spatial understanding, and emotion are derived [2]. From this perspective, environmental graphics are not only a visual language but also a psychological language through which humans interact with space. A clear example of such a graphic environment, widely frequented by the public, is the urban metro network. The Tehran Metro, as one of the most heavily used public transportation systems, serves as a rich context for analyzing the application of color and its effects on users' perception and behavior. The colors used in routes, maps, directional signage, and station design can either facilitate or hinder the experience of being in this space. This study, grounded in Arnheim's theory of aesthetic perception and within the framework of Environmental Graphic Design (EGD), investigates the psychological and functional role of color in the design of the Tehran Metro.

The primary goal is to analyze the impact of color on spatial perception, sense of security, and the wayfinding experience of users. This research is applied in nature and follows a descriptive-analytical approach. The data collection methods include a combination of library research, visual content analysis, and field observations, aiming to demonstrate how the intentional use of color in urban design can improve the quality of urban experience. Although efforts have been made in the design of the Tehran Metro to distinguish lines, guide routes, and enhance aesthetic appeal, key questions remain; Has the use of color in this space been based on the principles of perceptual psychology and scientific graphic design? Do the colors contribute to wayfinding, the reduction of anxiety in enclosed spaces, or the reinforcement of order and calm? This article seeks to address such questions through an interdisciplinary and analytical approach.

2 | Research Background

Numerous studies have been conducted in the fields of EGD and color psychology, forming the theoretical and empirical foundation for the present research. Frank Mahnke, in his book Color, Environment, and Human Response, explores the psychological impacts of color in architectural and public spaces, demonstrating that color plays a significant role in influencing users' emotions and behavior. Galor and Van Eeden, in their book Signage and Wayfinding Design, highlight the importance of EGD in public transportation systems and the impact of color on effective wayfinding.

A domestic study titled the role of color in EGD of metro stations [3] investigated several Tehran Metro stations as case studies. However, this research lacked a coherent psychological framework and did not offer analysis based on perception theories. Additionally, studies in visual aesthetics suggest that form and color must be meaningfully aligned with human perception [1]. Yet, to date, no independent research has been found that applies Arnheim's theory specifically to metro design in Iran.

3 | Environmental Graphic Design

Urban graphic design, or as it is more commonly referred to in global literature, EGD, is an interdisciplinary field that emerges from the integration of graphic design, architecture, industrial design, and environmental psychology. The origins of this field can be traced back to humanity's early efforts to mark and organize public spaces—from stone symbols in ancient civilizations, to shop signs in Europe, and street wayfinding signs in more recent centuries [3]. In the 19th century, with the industrial revolution, the rapid growth of urbanization,

and the development of transportation systems such as subways and trams, an urgent need emerged for visual communication systems at the urban scale. During this period, signs and boards were primarily informational or promotional, often lacking graphic cohesion. However, in the 1920s, with the rise of modernist movements like the Bauhaus in Germany, concepts such as order, simplicity, visual clarity, and functionalism were introduced into urban graphic design [4]. These movements emphasized that design should be not only aesthetically pleasing, but also intelligible and functional. In this context, the use of graphic grids, legible typography, and purposeful color systems became common tools for guiding people through urban environments [5].

Tehran Metro, as the most extensive urban rail transportation network in Iran, began operating in the late 1990s and today—with over seven active lines and dozens of operational stations—plays a crucial role in the daily commute of millions of Tehran citizens. With the expansion of this network, the need for a coherent, efficient, and psychologically informed graphic system to guide users through metro spaces became increasingly evident. The environmental graphic system of Tehran Metro includes a wide range of visual elements, such as: Wayfinding signs (directions, line and station names)،Route maps, Color coding for different lines, Warning and information signs ،Advertising boards, Murals, artistic graphics, and cultural symbols .In designing these elements, efforts have been made to distinguish metro lines using distinctive colors (e.g., red for Line 1, blue for Line 2), serving as a form of visual coding to facilitate user navigation.

4 | Analysis of Primary Colors in the Graphic Design of Tehran Metro

In the graphic design of the metro, colors are used to distinguish different lines (for example, red for line 1, blue for line 2, yellow for line 4, etc.) [3]. This seemingly simple function is in line with the principles of color psychology. For example, red, due to its high visual intensity, quickly makes an impression on the mind and was chosen for the main route (line 1). This choice is consistent with Arnheim's view on the power of strong forms and high contrast to guide the human eye [1]. The blue color on line 2 inspires a sense of calm and stability and reduces passenger anxiety at busy stations. One of them is Imam Khomeini, a point that has also been emphasized in Mahnek's research. Yellow is used as a warning color, in emergency signs, and on some information boards. This choice is psychologically correct, as yellow quickly attracts attention and causes greater alertness [7].

However, in some stations, such as Sadeghieh Station or Teatre Shahr, the use of contrasting or busy colors in murals or flooring has sometimes caused visual confusion or reduced legibility of routes; a point that indicates a lack of integration in EGD. Integration in EGD is a key concept that refers to the coordination and coherence between different visual elements in a space; elements such as signs, colors, typography, maps, murals, lighting, and even the architecture of the space. In complex systems such as the subway, which millions of people interact with daily, a lack of integration can lead to confusion, stress, and disruption in the user experience. The subway is a semi-closed, crowded, and fast-paced space where users must understand information and find their way in the shortest possible time [8].

In such circumstances, EGD should act as a "coherent visual language": simple, predictable, harmonious, and without contradiction. If the color of line 1 is red, this color should be repeated in all points related to that line (wall signs, signboards, maps, carriage doors, etc.). This visual consistency strengthens the audience's visual memory and accelerates their orientation [1]. Integration in the design of environmental graphic subways is not a decorative matter, but a functional and psychological issue. When graphic design is in harmony with the structure of the space, user needs, and principles of visual perception, the space becomes more understandable, safer, and more humane. In the Tehran Metro, although some efforts have been made in this direction, there is still a weakness in the coherence of color, typography style, and overall structure of the system in many stations; something that should be seriously reviewed, especially in newer lines.

5 | Evaluating the Performance of Color in Route Guidance

One of the main functions of environmental graphics in the metro is to guide users effectively. Field observations show that on main lines, the use of distinctive and specific colors has facilitated navigation; for example, color maps of routes at station entrances are legible and understandable. However, on secondary routes, connections between lines or side entrances, color signs are sometimes very faint or missing. The lack of color repetition on different surfaces (walls, floors, ceiling signs) has caused a decrease in the quality of visual guidance, while according to the principles of wayfinding design, the repetition of identity colors in different layers of space is the key to the effectiveness of the guidance system [7].

6 | Adaptation to Arnheim's Theory of Visual Perception

Rudolf Arnheim was a German-born psychologist, art philosopher, and theorist who was born in Berlin in 1904 and died in the United States in 2007. He created influential works in the fields of Gestalt psychology, art theory, and visual perception, and was one of the few thinkers who was able to make a bridge between cognitive science and artistic aesthetics. Arnheim's theories are very applicable in graphic design, especially in urban environmental graphics such as subway design. By utilizing the concepts of "visual balance," "gaze guidance," "form and color harmony," and "perceptual meaning of colors," the designer can create spaces that are not only beautiful but also understandable, usable, and relaxing.

Arnheim's theory, especially in his book Art and Visual Perception [1], is based on the principle that visual perception is not just a passive reception of sensory information, but an active, organized, and meaning-oriented process. From Arnheim's perspective, visual perception is the result of a kind of mental and meaning-oriented organization of sensory information, and he considers concepts such as tension between shapes, visual movement, and contrast to be the foundations of visual experience. In Arnheim's theory, colors are not only decorative factors, but also have cognitive, emotional, and symbolic charges. For example, the color red can induce a sense of danger, excitement, or warning, depending on the context and its relationship to other elements. These concepts are widely used in graphic design, architecture, and environmental graphics. Accordingly, color is not only a physical phenomenon, but also forms an essential part of the meaning and perceptual order of space [9].

In the subway space, when the colors are in harmony with the form, direction, and structure of the architecture, the user feels "controlled, calm, and oriented" in the space. The human eye tends to see a kind of balance, symmetry, or harmony between the elements in any visual composition. If this balance is disturbed, an unpleasant feeling is created in the audience. In some stations, it is observed that the architectural form is not in harmony with the color and graphics (for example, the broken lines in the architecture are covered with soft and vague colors), which causes a conflict in perception; that is, the eye sees something that is not consistent with its mental feeling. This disharmony is considered a kind of disturbance in visual balance in Arnheim's theory.

7 | User Reaction (Descriptive Analysis of Behavioral Observations)

In informal observations, it was seen that many new users first make decisions when faced with the metro space by looking at the color of the maps, rather than reading the texts. Also, in stations with complementary lighting and color (e.g., Tajrish station), a greater sense of security and comfort was reported. However, in some dark or pale stations, a sense of loss, anxiety, or disorder in the behavior of users was visible. These data support the central hypothesis of the research based on the effect of color on spatial experience. Data analysis shows that in many cases, the choice of colors is consistent with the principles of environmental psychology and helps to navigate better and perceive the space. However, the lack of graphic integrity and inconsistent use of colors in some stations has disrupted the perception of routes and reduced visual quality. According to Arnheim's theory, the coordination of color, form, and structure is essential in creating a practical visual experience; something that has not yet been fully realized in the design of the Tehran Metro.

8 | Conclusion

The findings of this study show that color, beyond a decorative or aesthetic element, plays a fundamental role in the perceptual and psychological experience of users in urban spaces. Within the framework of Rudolf Arnheim's theory of visual perception, it can be seen that color in environmental graphics not only helps with spatial organization and orientation but also, at a deeper level, affects the feeling of security, cognitive clarity, and the quality of users' experience. A case study of the Tehran Metro showed that color choices in this space can, in many cases, contribute to better navigation, reduce environmental anxiety, and increase the sense of order and harmony; however, in some cases, the lack of integration of graphic design in space due to the crowding and congestion of metro stations causes anxiety and reduces the audience's interaction in understanding the space. The right to strengthen visual identity and facilitate users' spatial understanding is achieved when the color design is in line with the psychological principles and visual rules intended by Arnheim. The use of complementary, contrasting, and symbolic colors in pathways and signs, and the coordination of colors with architectural form, direction, and structure, reinforces this.

Finally, it can be concluded that conscious color design in urban environmental graphics, especially in high-traffic spaces such as subways, is not only an aesthetic necessity but also an effective tool in improving the psychological and functional quality of the environment. This result reminds us of the need to pay more attention to the psychological aspects of urban design and can be used as a guide for policymakers, urban designers, and graphic artists in the future.

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Conflicts of Interest

The authors declare no conflict of interest.

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