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A comparative study on the visual color perception of hearing and deaf people

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ABSTRACT
This research presents a fundamental tool and approach for accessible design in terms of color categories in hearing and deaf people. Participants were 12 deaf girls aged 11 to 26 from Bangkok's Setsatian School for the Deaf and 15 hearing girls aged 11 to 15 from Kasetsart University's Laboratory School Center for Educational Research and Development. A comparison of total error score (TES) revealed no significant difference between deaf and hearing people in terms of color perception. The findings support the general hypothesis that there are more similarities than differences in color perception between these two groups; thus, confirming the contribution of deaf culture to the social environment of the hearing community as a whole.

Keywords: color perception, deaf, hearing, Farnsworth-Munsell 100 hue test

1. Introduction

There has always been a fascination with color vision and its evolution. There are several schools of thought about the difference in perception between deaf and hearing people, in addition to numerous color perception theories. One of which is that a deficiency in one sensory system influences the development and structure of the other sensory system [1].

Sensory deprivation was expected to have an evident influence on the functional and anatomical architecture of the affected system, and auditory impairment, whereby deaf and others with varying degrees of hearing impairment should lead to improved visual perceptual performance. However, Ostroga et al [2] claimed that there were no differences in color perception between deaf and hearing people.

Wiig and Neurman [3] employed a “match-to-sample” technique and discovered no difference in color dimension selection between deaf and hearing people. Although unclear, the results suggested otherwise.

Many important behavioral tasks, such as material identification and object recognition, rely on color cues. The behavioral applications of color, as well as the known perceptual and physiological aspects of color vision, are significant, and it is generally accepted that a preference for colored things generates a desire for color itself. The underlying universality in patterns of human color preference, such as love for blue, distaste for yellow, and yellow-green, lends credence to the idea of evolved emotional reactions to color. It should be emphasized that differences in preference show that the ability to form emotional associations with color is established in human nature [4].

When complementary hues, like red and green, are displayed simultaneously, there is a maximum input transmitted to the projection-decoding regions of the brain, indicating both activation and inhibition of both red and green color receptors. In the inferior temporal cortex of monkeys, neurons have been discovered that indicate the presence of a fundamental color recognition system in the monkey brain [5]. This might be difficult for the brain to accept, leading to sensory overload or information overload, resulting in emotions of "tension" or "dislike."

Although previous studies apparently utilized a visual perceptual test to examine deaf visual perception, none of the hypotheses may be universally supported by deaf cognitive functioning. This implies that further testing for deaf color perception should be theoretically and methodically constructed. Although the use of color in instructional materials is increasing, there is limited research interest in color perception.

If the most essential component of the experimental investigation is the therapy, the instrument of measurement is also crucial. Heider and Heider [6] compared deaf and hearing people, and determine if there were any variations in their reactions to color. They conducted a study on deaf color perception in which participants were asked to pick from a variety of colors. It was carried out to see if the hearing impaired and hearing children matched the conventional selection. When compared to hearing children, the results indicated that hearing challenged children were not aphasics, but they consistently chose a broader variety of colors than hearing children.

The present study focused on color perception and the human visual system. There were aspects of color in the red, green, and blue (RGB) scheme that detected and interpreted information from visible light to build a representation of the surrounding environment. Here, the subjects were examined separately and instructed to sort the color caps by hue vividness one by one. The color paper was matched to the Munsell Hue Value/Chroma Chart and the Munsell Color Cascade for all colors. The T-test was performed to see if there was a significant difference in the Total Error Score (TES) obtained by hearing and deaf individuals.

3. Materials and methods

The Munsell Color system is designed as a numerical scale with visually uniform steps for each of the three-color attributes - hue, saturation, and brightness. Each color has a logical and visual link to all other colors in Munsell color notation.

The Farnsworth-Munsell 100 hue test is one of the most well-known color vision exams. It is a type of color discrimination test, often known as an arrangement test. This instrument is popular for eliciting color words by using standardized stimuli from various color chips [7]. The test score is well correlated with the anomaloscope and wavelength difference measurement necessary for an observer to detect chromatic variations [8].

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Figure 1 shows the experimental research consisting of 12 deaf girls (E1) and the 15 hearing girls (C) subjected to the Farnsworth-Munsell 100 hue test. The results were compared by using an independent sample T-test.

E1 ------------- □ X 1 ------------- O1

C ------------- □ X 1 ------------- O2

Figure 1. Research design.

This research used a pre-experimental research design. It is a research method that involves observing a group after a treatment has been administered to determine if the therapy has the potential to produce change. Two groups of subjects (N=27 each, 12 deaf and 15 hearing) were from Setsatian School and Kasetsart University Laboratory School Center for Educational Research and Development.

Figure 2 shows the experimental research. The subjects needed to sort colored caps correctly under an incandescent with 270 lux and 5,600 degrees Kelvin within two minutes.

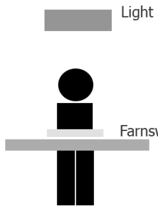

Figure 2. Schematic representation of Farnsworth-Munsell 100 hue test.

4. Results and discussion

Table 1 depicts deaf people's color vision. The color vision test results in 12 participants revealed that the greatest TES score was 136 points, the lowest TES score was 44, with an average of 90.33 and a standard deviation of 33.92. The maximum TES score of color vision test among 15 participants was 236 points, the lowest TES score was 20, with an average of 74.93 and a standard deviation of 52.58.

Table 1. Mean and standard deviation of the deaf and hearing groups.

Participant	Number of participants	TES Max	TES Min	Mean	SD
Deaf	12	136	44	90.33	33.92
Hearing	15	236	20	74.93	52.58

Because the t - value was 0.87 and the 2-tailed sig. was 0.389 (Table 2), it was determined that the deaf have some degree of color vision, which did not differ from the color vision of the hearing. This disproved the idea that the deaf are unable to distinguish between the many colors experienced by hearing persons. The outcome appears comparable because human eyes between deaf and hearing are of the same mechanism [4,9]. The result is similar to color-shape associations indicating the same semantic sensory correspondence between colors and shapes in both the hearing and deaf which is the common semantic information underlying properties of sensory features [10].

The visual perception of colors of deaf girls was found to be similar to that of hearing girls in this study contrary to previous reports demonstrating that the deaf are better at color discrimination than hearing individuals. A hypothesis argues that observation and modeling play a significant role in learning. This might explain the rejection of complimentary colors being used or worn together, as this is not a typical habit in our culture.

We frequently "learn" to blend colors or patterns by seeing how others react. Our future decisions may be influenced by experiences that we may not recollect consciously. Vicarious learning would be available to both deaf and hearing people. Because the deaf individual lacks one of his perceptual channels, his acquisition of verbal color associations is limited. Some learning processes may occur as a result of observation.

5. Conclusion

The study revealed that the deaf's visual color perception is not inferior to that of hearing individuals. It clearly demonstrated the potential contribution of deaf people to the social environment of the hearing population in general. Our findings back with previous reports that the deaf people prefer the same color perception as the hearing individuals.

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Table 2. Means comparison of total error score (TES) between the hearing and the deaf participants.

Participant	Mean difference	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Deaf Hearing	15.40	-20.75	51.55	0.87	25	0.389

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