



Original Research Article

Evaluating the influence of ocular dominance and its effect on shade matching and perceiving colour with in dentist population- A cross sectional study

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Abstract

Aim: The aim of the study was to assess dominant eye's impact and efficacy in shade matching.

Introduction: Successful esthetic dentistry, essential for patient satisfaction and a positive impact on one's personality, depends on proper shade selection for both direct and indirect dental restorations.

Materials and Methods: The Ishihara test was used to evaluate 120 people for color blindness before they were enrolled. The Dolman's test was then used to determine ocular dominance and determine which eye was dominant. After taking the Farnsworth-Munsell Hue (FM Hue) test to assess color perception, participants were given a shade matching exercise using five distinct shades from the Vitapan shade guide. In order to gain insight into potential factors impacting clinical decision-making in restorative dentistry, the study aimed to determine whether ocular dominance influences the capacity to appropriately perceive and match dental shades.

Result: Dolman's test results showed that 31.6% were left-eye dominant and 68.4% were right-eye dominant. In shade matching, there was a statistically significant difference between the dominant and non-dominant eyes for every individual.

Conclusion: Shade matching is positively impacted by the dominant eye, and the more clinical experience one has the better one grows at matching shades.

Keywords: Ishihara test, Dolmans test, Eye dominance, Shade matching, FM hue test.

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1. Introduction

One important aesthetic characteristic that significantly increases a person's self-esteem and confidence is a grin. Dental aesthetics has changed dramatically as a result of several innovations and procedures that have improved the discipline. For patients to be satisfied with the cosmetic outcomes of dental procedures, a restoration's precise color is essential. Therefore, choosing a shade is an important part of regular dental procedures that applies to both working with resins and ceramic materials.¹ The significance of color selection in aesthetic dentistry is underscored by the increasing aesthetic demands of patients. Inadequate color matching causes many restorative attempts to fall short of expectations. Shade guides supplied by dental product manufacturers are frequently used to visually evaluate tooth color. The way the gums are shaded, the colors of the surrounding objects, and the lighting all affect how color is perceived by the human eye. The enamel and dentin layers

affect the overall color quality of teeth by absorbing, reflecting, diffusing, or rerouting incident light. Shade matching is an unavoidable and extremely difficult phase regardless of the process.¹ Despite the fact that most dentists are well-versed in appropriate shade choosing techniques, it is still difficult to assess the color and appearance of teeth.² The ability to precisely determine the tooth color to be copied and select the material that most nearly resembles it is the first step towards achieving a satisfactory clinical outcome in cosmetic dentistry. The eye's capacity to discriminate between various hues when exposed to light with different wavelengths is known as color perception. Rods and cones are the two kinds of photoreceptors found in the retina that are in charge of color perception. Cones work in bright light (photopic vision), whereas rods are mostly involved in low-light (scotopic) vision. Color perception is made possible by pigments found in both kinds of photoreceptors that absorb light. The middle of the retina,

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which is crucial for most color vision, contains the majority of the cones.¹ The main techniques used for shade matching are visual and/or musical. Both educational institutions and healthcare settings frequently use the visual approach. The tooth and its hue should be equally visible when employing the visual technique in uniform lighting. However, a variety of factors, including the practitioner's age, experience, color vision deficits, and the limits of the human eye, might induce bias and variability in the selection of visual shades. The patient's appearance, the color of their clothing, and their surroundings can all have an impact on clinical judgment.³ On the other hand, the instrumental shade matching approach is reproducible, objective, fast to achieve, and simple to assess. The faults frequently linked to the visual method are eliminated by these dependable and attractive qualities. The main disadvantage of instrumental shade selection, meanwhile, is the equipment's high cost, which many dentists may find unaffordable, especially in developing nations.^{Error!} Reference source not found. Colorimeters, spectrophotometers, digital color analyzers, digital cameras, and instruments that combine these technologies are among the current range of technology-based shade-matching devices. Although these tools provide objective methods for matching dental shades, their application is frequently constrained by the equipment's high cost and intricate functioning. Therefore, both experts and students need to be aware of how important it is to satisfy patients' aesthetic requirements and expectations, particularly when it comes to installing restorations.²

2. Materials and Methods

The Best Dental Science College in Madurai, Tamil Nadu, was the site of this investigation. For the study, a total of 120 participants were chosen. The Ishihara color blindness test was used to evaluate people with normal vision, faculty, postgraduate students, and undergraduates who met the inclusion requirements. Participants who had a history of ocular surgery, strabismus, retinal pathology, or who refused to participate in the study were not allowed to continue.

2.1. Methods

This investigation was carried out in a naturally illuminated room from 9:00 a.m. to 3:00 p.m. To match the color, each participant was told to utilize the shade guide that was set up on the table in front of the table. The laptop was kept fully charged during the Fransworth-Munsell (FM) 100 hue test, the screen brightness was set to 70%, and each participant's distance from the screen was kept at 45 cm.

2.2. Color blindness test using ishihara test

The Ishihara color book, which had 38 plates, was used to administer the Ishihara test for color blindness to the participants. Every participant had five seconds to figure out the plate's number. (Figure 1)

The participants were subsequently separated into three groups according to the number of years they had received clinical training or practice. Third and fourth BDS and interns make up Group I; postgraduates make up Group II; and professors and senior residents make up Group III.

These participants underwent a shade guide test, a color perception test, and a dominance test, as explained below.

Grouping

The participants will be further divided into 3 groups based on their clinical practice/training.

Group-1: house surgeons - 40

Group-2: postgraduates - 40

Group-3: faculties – 40

These individuals will be put through a shade guide test, a color perception test, and an eye dominance test, as explained below.

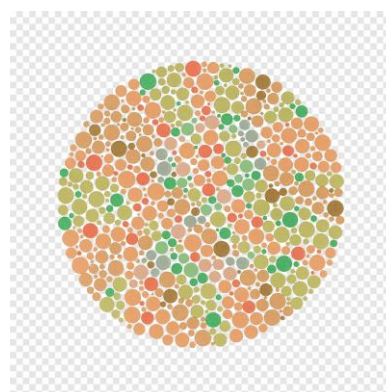


Figure 1: Ishihara test for color blindness

2.3. Dominant eye assesement using dolman's test

The Dolman's test was required of every participant. Each participant was told to hold a card in both hands, keep both eyes open, and look through a hole in the middle of the card to a target that was six meters away. To identify the dominant viewing eye, they were instructed to close each eye alternately. (Figure 2)

The eye that saw the dot was the dominant eye.



Figure 2: Identify the dominant viewing eye

2.4. Color perception assessment by FM 100 hue test

The www.colorlitelens.com website was used to conduct the FM 100 hue color perception test online. There are four rows of different color combinations in this examination. The first and last boxes of each color are fixed in each row. Participants will be told to arrange the boxes in each row according to Chroma, value, and color. (**Figure 3**)

The dominant eye will be used for the test, and the non-dominant eye will be closed. The dominant eye was closed, thus the non-dominant eye was used again.

A total error score is automatically generated by the system after the test is finished. The capacity to sense color was inversely correlated with the score that was achieved, with zero representing the perfect score.

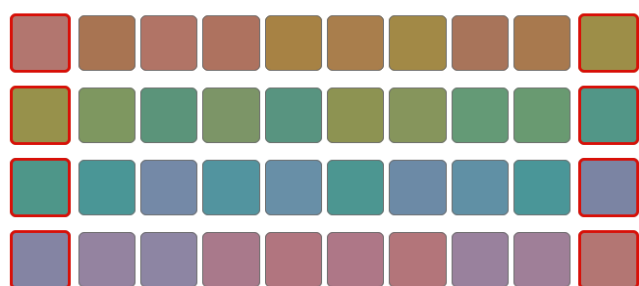


Figure 3: Chroma, value, and color

2.5. Shade guide test using Vitapan classical shade guide

Five tabs (A2, A3.5, B1, C2, and D3) from the Vitapan (VITA Zahnfabrik) traditional shade guide have the shade codes hidden on them. (**Figure 4**)

The participants were given instructions to match a second full set of the Vitapan classical shade guide with the hidden tabs.

Table 1: Dominant eye assessment using Dolman's test

Dominant eye	Group 1	Group 2	Group 3	Overall
Right	26	24	24	74
Left	11	13	12	36

Table 2: Difference between Dominant and Non – Dominant F.Muller test score among three groups

Groups	Subcategory	Mean $\pm$ SD	Mean rank	Z Value	P Value
Group 1	F.Muller Dominant	3.87 $\pm$ 1.72	41.63	-1.476	0.140
	F. Muller Non -Dominant	4.49 $\pm$ 2.05	49.37		
Group 2	F.Muller Dominant	3.87 $\pm$ 1.72	41.30	-1.603	0.109
	F. Muller Non -Dominant	4.53 $\pm$ 2.01	49.70		
Group 3	F.Muller Dominant	3.60 $\pm$ 1.51	38.60	-2.600	0.009*
	F. Muller Non -Dominant	5.07 $\pm$ 2.85	52.40		

Mann Whitney - U Test, $p < 0.05$ statistically significant

Table 3: Difference between Dominant and Non – Dominant Shade test score among three groups

Groups	Subcategory	Mean $\pm$ SD	Mean rank	Z Value	P Value
Group 1	Shade Dominant	3.07 $\pm$ 1.19	50.03	-1.699	0.089

The dominant eye (the non-dominant eye was closed) was used for the test, and it was then repeated with the non-dominant eye (the dominant eye was closed). The score was determined using the percentage.

A higher percentage meant that more tabs were correctly matched by the participants.



Figure 4: Vitapan (VITA Zahnfabrik) traditional shade guide

3. Result

Ten people were eliminated from further testing after taking longer than the allowed amount of time to identify the image in the Ishihara test. (**Table 1**)

36 people had left eye dominance, while 74 persons had right eye dominance, according to Dolman's test. The FM Hue test was used to get the average color perception value. (**Table 2**) (**Figure 5**)

Results of the Shade Guide Test: The dominant eye's mean rank for color perception was 43.45 ± 15.73 , while the non-dominant eye's was 25.58 ± 20.75 . (**Table 3**) (**Figure 6**)

The dominant and non-dominant eyes in Groups I and II did not differ statistically significantly in any test; however, Group III and all participants showed a statistically significant difference ($p = 0.05$).

	Shade Non -Dominant	2.88± 1.36	40.97		
Group 2	Shade Dominant	3.07 ± 0.86	49.17	-1.395	0.163
	Shade Non -Dominant	2.80 ± 1.08	41.83		
Group 3	Shade Dominant	3.20 ± 0.84	53.00	-2.862	0.004*
	Shade Non Dominant	2.21 ± 1.02	38.00		

Mann Whitney - U Test, p < 0.05 statistically significant

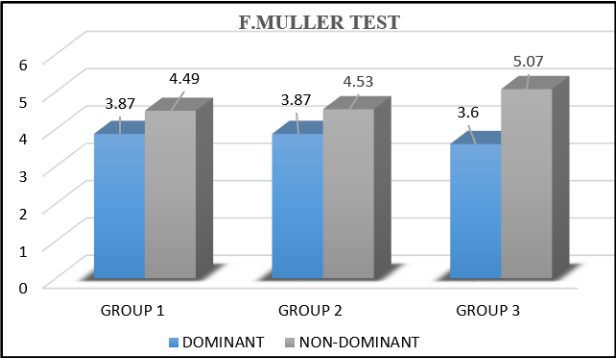


Figure 5: Average color perception value

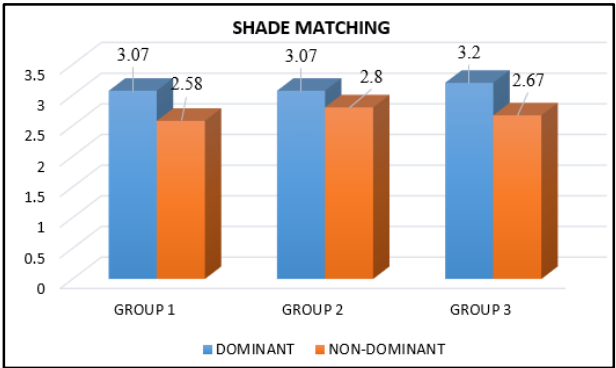


Figure 6: Results of the Shade Guide Test

4. Discussion

Since eye dominance was found to have a considerable impact on color perception and shade matching, the null hypothesis that it had no influence on color perception was accepted.

The process of choosing the right shade is complicated by a number of elements, including the observer's physiological characteristics, age, gender, clinical experience, and lighting circumstances. Color perception is affected by age-related changes in the lenses, cones, and pupil size. Furthermore, color perception is greatly influenced by optical characteristics such as metamerism, opalescence, fluorescence, and translucency.

Another important component influencing shade matching is color blindness. Congenital color deficits can be quickly diagnosed with the Ishihara test, which is commonly considered the gold standard.⁴

Dolman's approach, Mile's test, the Porta test, the Pinhole test, and the Ring test are some of the ways to identify

the dominant eye. Dolman's test was used for this investigation because of its ease of use and repeatability.

Shade-matching accuracy is positively influenced by clinical expertise, which is frequently regarded as a trustworthy factor.⁵ Some research suggests that clinical expertise enhances one's ability to match colors, whereas other studies found no connection between the two. Because of their years of clinical practice, the group with more than six years of experience (Group III) in our study demonstrated higher shade matching accuracy.⁶ Furthermore, studies show that educational training improves color-matching abilities.

Since the FM 100 hue test is the most sensitive instrument, we employed it in our investigation to evaluate color perception.³ Both a manual kit and online software are available for the exam. We chose the free, easy-to-use online version (found at www.colorlitelens.com) for accessibility and ease. In addition to being highly precise and reproducible, this procedure takes less time than the manual test. Using the FM 100 hue test, Elghorab et al.³ discovered that male participants' color perception was greatly impacted by eye dominance. However, when^{Error! Reference source not found.} performed visual shade matching, they found that clinical expertise had no discernible effect on the outcomes, even if shade matching was more accurate with the dominant eye. According to our research, there is no statistically significant relationship between eye dominance and the FM 100 hue test.⁹ Furthermore, the dominant eye performed marginally better in the first two groups and noticeably better in the third group when shade matching was taken into account. The dominant and non-dominant eyes do not significantly differ in color discrimination, according to other studies.⁸

The Vitapan Classical shade guide, which has 16 tabs organized by chroma or value, was employed in this investigation. Clinical dentistry most commonly uses the chosen five shade tabs (A2, A3.5, B1, C2, and D3).⁶ Similar findings were found in a comparison study that used the Vita Classical shade guide on a different group of participants. It showed that women and participants with a lower Total Error Score were better at matching shades but could not distinguish between values.⁷

Pupil size and color perception gradually decrease at age 30 as a result of a shift in the ocular apparatus's ability to absorb light, but this does not become apparent until the sixth decade of life.¹⁰ The physiological effects of age might be missed if a study were conducted on an older dental

professional population because of years of experience matching dental shades.

It has long been believed that women are better at matching colors and shades than men. However, research has not found that gender significantly affects shade matching, and men and women seem to have comparable abilities to distinguish between different tooth hues.¹¹

One possible drawback of the study was the unequal distribution of ages and genders. Additionally, a different set of shade tabs was used in place of real teeth. In order to match the color of natural teeth, more research can be done using the shade tabs. Furthermore, a comparison between the instrumental and visual shade guiding systems needs more investigation.^{12,13,14,15,16}

5. Conclusion

The importance of eye dominance in shade matching for restorative dentistry is shown by this study. The findings indicate that eye dominance has a significant impact on how accurately shade selection is perceived, which may have an impact on the results of aesthetic restoration operations, including crowns. A more individualized and successful clinical practice may result from an understanding of the connection between eye dominance and shade matching, which would enhance patient satisfaction and treatment results overall.

6. Informed consent Statement

Informed consent was obtained from all subjects involved in the study.

7. Data availability statement

The data presented in this study will be available on request from the corresponding author.

8. Source of Funding

None.

9. Conflict of Interest

None.

References

1. Kalyani P, Subiksha K, Jena A, Shashirekha G, Mohanty S, Sharma G. Effects of eye dominance on shade matching and color perception among the dentist population. *Restor Dent Endod*. 2023;48(4):e40.
2. Chu SJ, Devigus A, Paravina RD, Mieleszko A. Fundamentals of color: shade matching and communication in esthetic dentistry. 2nd ed. Chicago: Quintessence publications; 2004. p. 20-40.
3. Elghorab HF, Hammad IA, Azer A, Nassif MA. The effect of eye dominance in color perception among dental students with normal color vision. *Alex Dent J*. 2021;46(2):127-31.
4. Hidajat RR, Hidayat JR, McLay JL, Elder MJ, Goode DH, Pointon RC. A fast system for reporting the Farnsworth-Munsell 100-hue colour vision test. *Doc Ophthalmol*. 2004;109(2):109-14.
5. Sikri VK. Color: implications in dentistry. *J Conserv Dent*. 2010;13(4):249-55. doi: 10.4103/0972-0707.73381.
6. Oishi A, Tobimatsu S, Arakawa K, Taniwaki T, Kira JI. Ocular dominance in conjugate eye movements at reading distance. *Neurosci Res*. 2005;52(3):263-8.
7. Samra AP, Moro MG, Mazur RF, Vieira S, De Souza EM, Freire A, et al. Performance of dental students in shade matching: impact of training. *J Esthet Restor Dent*. 2017;29(2):E24-32. doi: 10.1111/jerd.12287.
8. Van der Burgt TP, Ten Bosch JJ, Borsboom PCF, Kortsmit WJ. A comparison of new and conventional methods for quantification of tooth color. *J Prosthet Dent*. 1990;63(2):155-62.
9. Shinomori K. Ageing effects on colour vision—changed and unchanged perceptions. *J Int Color Assoc*. 2005;8:7-12.
10. Ragain JC. A review of color science in dentistry: colorimetry and color space. *J Dent Oral Disord Ther*. 2016;4(1):1-5.
11. Vadher R, Parmar G, Kanodia S, Chaudhary A, Kaur M, Savadhariya T. Basics of color in dentistry: a review. *IOSR J Dent Med Sci*. 2014;13(9):78-85.
12. Adebayo GE, Gbadebo OS, Ajayi MD. The tooth shade matching ability among dental professionals: A comparative study. *Ann Ib Postgrad Med*. 2022;20(1):65-71.
13. Hardan L, Bourgi R, Cuevas-Suárez CE, Monika LS, Monjarás-Ávila AJ, Zarow M et al. Novel trends in dental color match using different shade selection methods: A systematic review and meta-analysis. *Materials (Basel)*. 2022;15(2):468.
14. Floriani F, Jurado CA, Abuhamoud S, Vargas M, Fischer NG, Rojas-Rueda S et al. A comparative study of shade-matching reproducibility using an intraoral scanner and a spectrophotometer. *Dent J (Basel)*. 2024;12(3):62.
15. Jouhar R, Ahmed MA, Heboyana A, Faheemuddin M, Mosaddad SA, Ahmed N. Analysis of shade-matching ability in dental students: a comparative study under clinical and correcting light conditions. *BMC Med Educ*. 2024;24(1):169.
16. Ahmed MA. Assessing the shade matching accuracy among dental students through visual and instrumental methods. *Pak J Med Sci*. 2024;40(8):1770-5.

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