REVIEW ARTICLE

# Teeth Shade Selection: Minimize the Factors Effecting It

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**ABSTRACT**
*Natural teeth vary in their shape and shade in every individual and that gives a picture of the personality and appearance of our patients. Selecting shade for patients is a subjective thing and is very important step in treatment of prosthodontics. That is why the aesthetics of the prosthesis fails because of wrong colour reproduction. There are many factors which can affect the shade selection procedure which if controlled can give the result which are required. This article aims in collecting all the factors which may affect the shade selection procedure. This information with not help only the students and rese-archers but the clinicians as well.*

**KEYWORDS:** *Shade selection, Teeth, Crowns, Prosthodontics.*

## INTRODUCTION

Precision during the procedure of shade selection is the most important step during the restoration or replacement of natural tooth. Nowadays is the era of aesthetics dentistry and appearance matters a lot for every patient. 50% of the patients who complain about the appearance with their new restorations or replacements are because of mismatching of the shade with that of the natural teeth.[1]

This causes more time, cost and energy loss both for the patient and dentist. Additionally, it also becomes a psychological trauma both for the patient and the clinicians. To satisfy the needs and demands of the patients, we need to explore in depth the procedure of shade selection to avoid the distress situations.[3]

In aesthetics restorative dentistry, after the morphology and occlusal adjustments, shade matching is the final step, which is the most critical step. This final step if not matched properly can affect the acceptance of the other aspects of the restoration.[4]

Shade selection is an art and there is always something new that is to be learned to avoid the frustration and discouragement of everyone, a suitable plan to be made for the shade matching procedure.

This article explores a number of factors that may hinder the selection of a proper color match for prosthetic neoforalines.

## DISCUSSION

Colour is multidimensional thing but not everybody knows about this. Unfortunately, majority of the dentist are not taught about these dimensions and neither do they know about its scale of measurement. That is why they cannot deal with the situations when there is some problem in a colour mismatch.[5]

The science, physiology and scale for measurement of the shade are aspects which the dentist is mostly ignorant of. Colour is not only just a science but it has the most important aspect of the art as well. There are different methods of shades selection as conventional or digital means for it, but every method has its own limitations and flaws in it. Apart from the clinics, the important thing is the laboratory personnel. They should be trained equally about the colour science and arts as they are the one who have to interpret and incorporate the selected shade in the restoration. In modern era, many advances have been done to make the shade selection easy, through digital systems but operating that equipment also need skills to be learned.[6]

There are number of factors which makes the perception of shade selection difficult, some of which are:

### Light

When the light source affects the colour of an object, it is known as “colour rendition”.[7] there are multiple light sources available, every one of which affects the colour of the object that is to be recorded. The shade selection procedure is very much affected and even modified by these light sources in clinical practice.[7] This changes the overall shade scenario of the restorative and give false colours than expected[8]. Major light sources that are mostly used in dental clinical practice are incandescence, fluorescent and day light.[7] The prominent colour in the fluorescent light are blue-orange and red-yellow in incandescent light source[9].

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Although daylight is considered to be the most variable in nature, still it is considered to be the most appropriate light source during the procedure of shade selection[10] but the selecting the daylight source is very difficult because every patient cannot be appointed in the day light time during the day and also the day light quality changes at different times and may not be the same throughout the day.[10] The suggested timings for the perfect day light source are 3 hours later the sunrise and 3 hours before the sun is set. This is because all the 5 wavelengths of light that are visible, are available at these timings.[10] However, natural light can vary due to time, geographical location, meteorological factors, entry of light, its orientation and all that stands between the patient and sunlight.[11] office lighting should, ideally, be a combination of natural daylight and color-corrected fluorescent lighting. Natural light should be indirect and the fluorescent bulbs optimally should be 5500 kelvin color temperature, 1600-2100 lux intensity, and have a color rendering index of 90 or grea-ter.[12] Using a variety of light sources can lessen the problem of metamerism, (change in appearance of an object under various light sources).[13]

**Dentist and Patient Position**

The shade selection procedure was found to be more accurate when the patient position is upright one with turned off dental unit light. When the patient is in supine position, a more accurate shade matching is achieved when the dental chair light was turned on.[13,14] This phenomena can be explained by the fact that when the patient is in supine position, the amount of light received by the object is less due to of the shadow of the ob-server, and hence overall decreasing the rendering of colour.[14] The accuracy is again affected when shade matching is done with the patient in supine position with the dental chair light turned off. Here comes the effect of distance between the observer and the object because of the supine position of the object, which affect the shade selection procedure. As the distance bet-ween the patient and dentist is increased, it leads to less light reception from the object and hence causes problem in the shade of the object. The shade selection is found to be more and more accurate when the up-right position for the patient is adopted using the same conditions of lighting, because the colour-sensitive pa-rt of human retina acts stimulated.[14] The dentist's eyes should be on the level of the patient's tooth.[15]regarding shade matching distance, visual acuity for near vision (close inspection) is tested in ophthalmology at the standard reading distance of 25 or 33 cm.[16] The suggest minimum standard of visual acuity for dental practitioners is 6/7.5 at 33 cm.[17]

**Number of Observers**

Everyone has his own perception of colour and the difference in perception of every individual can make the colour matching procedure more and more complex, leading to inaccuracy and variations in the shade selection.[18]

The procedure of shade selection should not be performed by only one individual, but rather a team should be made by the restorative dentist to select the shade for the restoration. Increasing the number of observers decreases the bias and discrimination in the accuracy of shade selection procedure. The accuracy can also be affected by the number of times the readings are taken.[19]

**Vision**

Individuals vary in their ability to select colour matches.[20] Culpepper found disagreements between dentists in shade matching the same tooth and he demonstrated the inability of individuals to duplicate their shade selection on different days.[21] Not all dental personnel are lucky to have a perfect color vision. All those dentists who have some defect in their vision may not know of their situation and hence can enhance many problems in colour perception as compared to the normal dentists. The word "colour blindness" usually makes one misguided as there will be only small population of people who cannot see all the colours. Hence the term may be replaced by color vision def-ect.[22] Research has also has demonstrated that dental personnel who have impaired color vision make significantly more errors in the process of shade match-ing.[23] A study conducted by Mollon, stated that the perception of colour is more accurate in females as compared to males, and hence females can be more accurate during the shade selection procedure than males. This may be because more deficiencies in color vision are recorded for men than for women.[24] Dentists should be screened for color defective vision and referred to the ophthalmologist for more accurate investigations. Alternate means of shade selection/matching be advised for color defective personnel. Defective color vision personnel should be advised to take assistance in the shade selection procedure.[22]

**Training and Skills**

Among all the various factors that influence ideal reproduction of tooth color, education in color science and clinical experience play a significant role in the visual color shade matching ability of a clinician.[10]

Most clinicians are not comfortable with visual shading investigation as compared to the technician? and are maybe unfit to sufficiently depict hue to the technician present in the laboratory.[25] When clinicians are unable to discuss hue, chroma, and value with the technician, they are unable to supply the information

necessary to create anesthetic restoration that harmonizes with the patient's remaining natural teeth.[25]

Although the colour matching ability of dentist is strongly dependent on individual perceptual ability, clinical experience and knowledge of color science in dentistry can lead to better performance in a clinical setting, especially with complex color matching.[26]

**Effect of Medications**

During the procedure of shade selection, both eyes should be kept open. Shade selection with one eye may affect the procedure as there can be difference in the perception of both eyes. If the clinician has some defect in the vision, he should choose alternative method of shade selection, for example, assigning the estimation of shading to staff, who have no defect in their vis-ion for the time being at least, or the easiest method is not to take any substance that can affect the perception of colour in individual. Different substance intake has different effect on the colour perception like in case caffeine, it has dark effect on colours which are warm while lighter effect on the colours which are cold. Viagra® has its effects by the modifying the perception of colour, and making the blue colour prominent. Peo-ple who takes contraceptives, have difficulty in per-ceiving the colours blue yellow or red green. Morphine and alcohol have opposite effect than that of the caff-eine. It changes the perception by giving dark effects on the colours which are colder and lighter effect on colours which warm.[27]

**Shade Guides**

Most of the dentist identifies many problems in shades of the ceramic restorations, by selecting its shade through available shade guides.[28] There are many prob-lems with the shade guides as their arrangement is first of all not logical or scientific and sometime it does not even match the tooth shade.[29-31] The shade guides also have metal bases which effects its perception, changing the colour of the guide.[32] The thickness of porcelain which greatly effects the shade of the restoration is different in shade guides than the restorations that are made.[33] Different shade guides from the same manufacturer also varies from each other and one cannot rely on them.[34] If the shade guide is made of a material like resins, it changes its colour with time or when put in sterilizing solution, especially those solutions which contains chlorine. The shade guide manufacturers and the ceramic manufacturers both need to look into this great variable and find a way to control the compounding factors.[34]

The shade guides that are used worldwide in hospitals or clinics are:

- Custom or specific Chroma and value guide.
- Vita system 3d-master.
- Chroma scope.
- Vita classic.

It is known to everyone that the colour varies greatly of the same tab of the shade in different available shade guides. It is therefore very important the clinician/observer who is selecting the shade has the same shade guide as the laboratory technician may have with him.[35]

The available shade guides have the problem that it cannot compensate for different variations that are present in the structure and anatomy of the tooth like the enamel or dentine thickness, transparency or translucency of the teeth, luminescence, texture, amount of mineralization etc. which can greatly change the perception of colour of the tooth.[37]

**Time**

Timings can great effect the shade selection percept-ion. Hydrated teeth tend to have different shade perception than the dehydrated ones. As during the procedure of tooth preparation, the teeth can become dry, it can change the perception of the colour and so the sha-de selection should be done at the start of the procedure before any preparation of tooth. Taking longer time for selection of shade can fatigue the eyes which may also change the perception of shade, and hence it should be done as quickly as possible. Recommended time is 5 seconds. The longer the time taken in the sha-de selection, the more will be the inaccuracy of the shade[37], as the eyes perception changes specially to yellow and red colours. The vision staring at a tooth for more than five seconds can cause incorrect perception of the color because the eyes become accommodated to colours red and yellow.[38] Wagenaar and Smit have discovered the shading vision capacity of the eyes to diminish when a tooth is seen for longer than 10 seconds.[39]

**Communication to Laboratory**

When impressions are made for restorations or replacements, the casts along with shade selected is sent to the dental laboratory. The shade selected should be communicated to the laboratory in a way that the exact selected shade may be incorporated by the dental laboratory. These means of communication are very important that need to be learned. When a definite way of communication is learned then even a complex shade selected can be incorporated by the laboratory like shade of hypo plastic enamel, fluorosis crack lines etc. These shades can be incorporated in the laboratory if the correct shade is selected under colour corrected lighting conditions and exactly same shade is sent to the laboratory, or else it can lead to disastrous situation.[19]

Problems arise mostly during the communication to the laboratory, because the dentist demands a shade

but may not state and communicate it clearly to the laboratory. The laboratory personnel have not seen the original teeth and they can only incorporate a shade which has been communicated to them. Unfortunately, the selected shade is lost in air because of faulty communication to the dental laboratory.[34] The shade selected can be communicated to the laboratory by various conventional and digital methods, like in the form of diagrams, graphs, slides or pictures. Diagrams can be used by drawing the facial surface representing the location of shades and the diagram of proximal surface denoting the layers of porcelain body and enamel.[4] The photographs taken along with the shade guide can be very good means of communication to the laboratory specially when one wants to sow the laboratory technician the various characterizations in the toot and morphology. Although the photograph may not record the exact shade of the tooth because of the light and resolution of the camera, but it may help a lot to give the basic idea to the dental technician. There are some objective problems in communication between dental practice and laboratory.[41,42] Before starting the tooth preparation for restoration, the photographs should be taken and again along with the shade guide when the teeth are prepared. Every aspect from various angles should be recorded in the photograph. This will help the dental laboratory technician to have an idea about the morphology, size, contours and texture of the tooth. The photographs should also record the lip line at rest, active lipline, smile line to incorporate the exact aesthetic demands of the patient.[43]

**Surroundings and Environment**

The perception of colour can be greatly affected by the environment and surroundings of the object. The tissues adjacent to the tooth can change the perception of the colour either making it more prominent or dull. Colour of the soft tissue mucosa, surrounding teeth, dress of the patient and shade of the lips can greatly influence the colour perception, and should be taken into consideration.[38,40,44]

The colour of the walls of the clinic can also confound the perception of the tooth shade selection procedure. The texture of the walls and its brightness can be a big variable in the procedure of shade selection, as it may change the reflection of the clinic room and ultimately changing the perception of colour of the object.[43]

It is recommended to communicate to the patient not to wear bright colour dress during the procedure or the patient should be covered with additional apron. Any dark coloured lipstick may further elevate the whiteness of the teeth because of its contrasting colour and so the lipstick if phase it should be wiped off. The colour of the rubber dam can also affect the colour perception and light colour rubber dam is recommended. Some clinicians wear black gloves or apply black rubber dam which may severely affect the existing colour perception of the teeth.[45,46]

The walls of the clinic room should be grey or off white in colour. Any other colour may cause eye fatigue to that specific colour, and ultimately changing the perception of the colour of the tooth. The texture of the walls and cabinets should not cause glaring.[44.47]

The colour of the teeth is not the same for all the teeth inside the mouth and it varies according to their position intraorally in the same patient. For example, the anterior teeth may be whiter in shade while canine may be darker. There may also be great difference in the colour between the premolars and molars.[48]If incisor teeth are prepared; the colour of the canine may greatly influence its shade selection. This deceives even the most experienced dentist and should be taken into account. That is why shade selection before the tooth preparation is recommended.[49] The shade can also be taken of the contralateral same tooth of the arch if the existing shade of the working tooth is compromised.[49,50]

The soft tissues like mucosa cheeks can have great effect on the colour perception. The skin shade mostly effects the perception of colour and the teeth may be perceived as whiter in dark coloured skin patients. Usually a bit darker shades are selected for patients with dark colour skin or else it may not give life like appearance to the restoration or replacement.[51,52]

**CONCLUSION**

It is concluded that selection of the teeth shade is not a simple procedure, rather it is influenced by many factors. Different light sources can give different results in the procedure. The operator experience, number of operators, any medication used by the operator and operator position also influence the perception of colour. The timing of shade selection also influences the perception, as fatigued eyes can give false perceptions. Digital machines can also make the procedure easy. The surrounding environment should be grey in col-our, for eyes not to be fatigued for one specific colour. Finally, the shade guide used and communicating all the details to the laboratory is last but not the least step in the shade incorporation step in the restoration. Whatever recorded if not communicated prosay to the laboratory is useless. No matter how well the shape is given; wrong shade can give wrong perception. Every factor mentioned above, can affect the shade and to give patient, life-like appearance, all the factors mentioned should be considered and controlled.

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**SH:** Substantial contributions to conception and design, acquisition of data and analysis and interpretation of data.

**NY:** Drafting the article, revising it critically for important intellectual content and final approval of the version to be published.

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None to declare.

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