New Trends of Colour and Background Effect in Restorative Dentistry

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Abstract: Evaluation of the right colour is an important step in restorative dentistry. In history, clinicians started to take the colour with subjective methods. For instance, shade guides were used to compare the teeth with their colour tabs and choose the right one. However, this method presents some issues related to the clinician: everyone perceives colours in different ways, not only because humans differ from each other, but also because they can be affected by local, physiological, physical and psychologically uncontrolled factors, such as fatigue, aging, emotions and lighting conditions. All these factors together contribute to make the subjective method unpredictable. For this reason, new instruments need to be exploited by clinicians in order to describe teeth colour in a more accurate and objective manner, thus applying the objective method. The digital camera, the colorimeter and the spectrophotometer are some of the instruments that can be used to reach this purpose. In both the subjective and objective methods, during determination of the colour, the clinician often focuses on teeth and forgets what surrounds it, like the black background of the mouth or the environmental light. These elements may influence the perception of the colour and, mainly in clinicians with a low level of experience, they could lead to a wrong evaluation of right shades. In order to solve these issues, different strategies can be applied by clinicians, such as making their own shade guide, mixing the objective and subjective methods, or use new devices.

Keywords: Spectrophotometer, Background effect, Tooth colour, Shade guide, Colorimeter.

1. INTRODUCTION

Red, blue, green... these are some of the colours that we can attribute to objects without knowing whether they are the right ones: colour is an aspect that our visual system attributes to them. Many disciplines were interested in the phenomenon of colour. Dentistry also searched to identify it correctly, mainly, when clinicians try to replicate teeth using direct or indirect restorations.

Before going ahead, we have to identify and resume what is colour. It “was born” from the light ("lux" in Latin), it is the visible portion of the electromagnetic spectrum: visible light ranges from 380 nm to 760 nm, or in frequency from 790 THz to 435 THz. The light interacts with matter mainly by scattering and absorption, thus colour is born by this interaction: it is the portion of the scattering light reaching the observer [1], in other words, the human eye. Visible radiations coming to human eyes are processed by retina (rods and cones); they can convert a photon into an electrical signal. Then, the brain elaborates it and allows us to perceive colours [2]. Everyone perceives the colour in different ways, it is the subjective way; not only because humans differ from each other, but because colour perception can be affected by several factors: personal experience, aging, emotions, light condition and fatigue. Even the same person can perceive the same colour differently in different time of the day, depending on the attitude too [3]. This subjective perception of colours gave rise to debates and, indeed, there were several attempts to describe it objectively.

The artist Albert H. Munsell was one of the first scientist to describe the colour with three parameters [4]:

- hue: it describes the type of colour whereby we can recognise red from green, blue from yellow;
- chroma: it is the degree of colour saturation in the same hue;
- value: it is the lightness, the degree of luminosity of colour.

These parameters had some interpretation problems, and, in 1976, CIE (Commission international de l'Eclairage) established parameters to measure and communicate colour: three mathematical parameters were used to create absolute colour spaces, some of these spaces are CIELAB space and CIELCh space [5,6]. By means of these spaces and their mathematical parameters, it is objectively possible to describe all of colours. The colour space CIELAB is not a linear space and is determined by three coordinates L*, a*, b*:

- L* represents the lightness, it runs from 0, that is the absolute black, to 100, that is absolute white;
- a* represents the quantity of green or red, it ranges from –a (green) to +a (red);
- \( b^* \) represents the quantity of blue/yellow, it ranges from \(-b\) (blue) to \(+b\) (yellow).

On the other hand, the colour space CIELCh is a cylindrical shape space and is determined by three coordinates \( L^* \), \( C^* \) and \( h^* \):

- \( L^* \) is the same of CIELAB;
- \( C^* \) represents the chroma and it is linear measure;
- \( h^* \) represents the hue and it is an angle value.

In these colour spaces, it is possible by means of the coordinates to: locate the colour precisely in the space; recognize it accurately; make it transmittable [7] and evaluate the spatial and perceptive difference between two colours by using \( dE \). \( dE \) is the distance between two points (colours) in colour space and it is linked with eyes perception of colour: \( dE \) values more than 1.7 \( dE \) identify two visually different colours, if \( dE \) values is less than this value, no perceptive difference is noticed by human eye [8].

2. DISCUSSION

In dentistry, one of the attempts to establish the colour of teeth was to compare them with samples of difference shades. The first attempts were Vitapan Classical and Vitapan 3D Master shade guides. Nowadays, shade guides are used and the clinician can compare their colour tabs with the teeth and choose the colour. Therefore, it is a subjective method and the main issue is the colour perception among clinicians [9], which can be affected by local, physiological, physical and psychologically uncontrolled factors, such as fatigue, aging, emotions, lighting conditions [10] and metamerism [11]. All these factors are variable, thus making the subjective method unpredictable.

As a short-sighted person needs glasses to see better, so the clinician can use new instruments to describe faster, more correctly and more objectively (objective method) the tooth colour.

2.1. Digital Camera

Digital cameras take pictures using three sensors, which measure red, blue and green wavelength. The photograph picture is based on RGB colour model, in which these three colours are added together in different ways to reproduce all colour range. The digital picture can be used by clinician to obtain important information about the shape of teeth and its character-
2.4. Background Effect

Sometimes the clinician only focuses on teeth during determination of tooth colour and he forgets what surrounds it, like the black background of the mouth, or the environmental light. It is important not to forget that anterior teeth have a thin thickness, with some translucent areas, and so they can be influenced by environment: the cervical area by gum, middle and incisal area by the black background of the mouth. We can see "the background effect" in colour evaluation in both subjective methods and instrumental methods and it is of paramount importance to determine the background of intra-oral situation, also to mimic the oral environment in the laboratory [20].

In the subjective method, the clinician often put the sample-shades of the shade guide near the mouth, and then he determines the colour. This step could bring clinicians in a wrong shades taking (mainly if they have little experience), because they compared two different materials which, in addition, have different degree of translucency and so they are influenced by background in different ways. The background affects also instrumental evaluation, but, it is less crucial than in visual method, because the spectrophotometer works with ideal condition, like 5500 k° illumination [21], and can describe objectively the colour using three parameters, moreover, they can evaluate even only one area of the tooth or define the background. On the other hand, the influence of background on colour is still a controversial issue and there is not a consensus in the scientific literature about the ideal background to use by clinicians or technicians [20].

3. CONCLUSION

"Pares cum paribus facililime congregantur" [22], literally translated from latin: "equals with equals are very easily associate (themselves)". In both subjective and objective methods, we use samples of shade guides with different properties than teeth, like translucency and opacity. It makes difficult to catch the right colour of the teeth, mainly if the clinician has a low level of experience.

Making personalised shade guide using their own materials of reconstruction (like resin-based composites) could be the right solution, even because nowadays dental composites have the same properties of dental hard tissues [23]. Indeed:

1) clinicians could create discs, shells or tooth shape samples of different thickness and types (dentin, enamel or body composites). They could be mixed and superimposed near the tooth which should be reconstructed, so that both shade guide samples and tooth have the same background; 2) the custom-made shade guides, with a variable thickness width could help the clinician to better understand the material’s behaviour, the correspondence between thickness and colour [23]. The laboratory material also could be used with the same custom-made shade guide, improving the communication between clinician and technician.

Another reason to use custom made shade guide, is that, even though many manufactures already have shade guides of their composites, the clinician should carefully use them because of the mismatch between their colour and VITA correspondence: the manufacturers decide the composite colour with different backgrounds (black or white) which can influence the colour itself. Regarding the instrumental evaluation, using personalised shade guides could help the clinician to compare it directly with the image of a tooth by software, in order to delete the problems of subjective methods. Clinically, trusting in instrumental evaluation of colours with personalised composite shade guides could be useful to solve the colour problem and safely increasing their own experience. The new potential trend, still not available on the market, is to use the mobile phone itself to choose the colour. The clinician could compare directly on mobile phone the tooth with most of different trends of composite at different thickness, catch the right shade and use the right composite thickness. Therefore, clinicians could use their own composite and its thickness, to make the right "recipe". Indeed, it would be a portable and easy way to evaluate and shear the teeth colours. Although these new tools and trends could help the clinician to catch and achieve the right colour, there are not ideal materials: best aesthetic materials can give bad results if they are used incorrectly, so as worst aesthetic materials can give good results in good hands.

CONFLICT-OF-INTEREST STATEMENT

The authors declare no conflict of interest related to this publication.

REFERENCES


