RESEARCH SUMMARY

Colour science in dentistry

Colour in relation to dentistry. Fundamentals of colour science

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The past decade or so has witnessed a marked increase in consumer awareness in virtually every aspect of modern life. The concomitant rise in consumer expectations has extended, of course, to dentistry and, in particular, to the more aesthetic aspects of the discipline, namely shade matching and tooth whiteness. As a consequence, various instrumental methods of shade matching have been launched commercially in recent years; in addition, considerable, commercial research effort is currently being focused on instrumental methods of assessing tooth 'whitening'. Such interest in 'aesthetic dentistry' has, in turn, resulted in the author's laboratories having received myriad enquiries from dental researchers in relation to colour perception, colour theory and instrumental colour measurement. Despite the importance of colour in relation to dentistry and the current, very high level of research interest in the subject, remarkably few, if any, references have appeared that concern the application of colour theory to dentistry; furthermore, the colorimetric aspects of shade matching and tooth whitening have received virtually no discussion in relevant journals. The high level of interest in colour in dentistry coupled with the paucity of publications in this particular area, prompted the research work presented here.

This paper concerns both dental shade matching and tooth whitening. The first part of the paper deals with the basics of colour perception, colour theory and instrumental colour measurement, in terms of three key elements, namely light source, object and observer. The fundamental aspects of light sources, how they interact with objects and the manner in which these interactions are interpreted through human colour vision are discussed. The principles of colorimetry are then considered and the functioning of instrumental colour measuring instruments are discussed.

Subsequent papers will review the various approaches that have been used for shade matching, including methods that have been devised for visual shade matching and the various systems that use instrumental methods of shade matching. Research findings will be presented that identify the variables (eg lighting, shade guides) which can influence the accuracy of visual shade matching. The concept of instrumental shade matching will be explained in relation to the principles of colour perception, colour theory and instrumental colour measurement. Finally, the subject of tooth whitening will be discussed, from a colorimetric viewpoint.

IN BRIEF

- The principles of colour perception, explained in terms of the interactions between a light source, an object and an observer.
- Fundamental aspects of light sources.
- The ways in which an object modifies the light reflected from it.
- Characteristics of the observer and principles of human colour vision
- The essentials of colorimetry and instrumental colour measurement.

COMMENT

The aim of the author was to provide a review of the fundamentals of colour science and this he has accomplished in a manner that is both informative and readable.

The paper begins with a classic description of the dependency of colour perception on three elements: the light source, the object that interacts with this light source, and the observer. This perspective ignores the colour perception that occurs when we view light sources directly, such as when we look up at the sun, but is an excellent starting point to begin a discussion of what needs to be taken into account in order to begin to measure or specify surfaces colour. The author dwells on the complexity of the use of colour in our language. Rightly so, in my opinion, since familiarity with words such as 'colour' which we use everyday in a non-technical sense can present a barrier when we attempt to understand colour in a more scientific way. We might, for example, refer to a certain object as being red which leads to the common misconception that colour is the property of objects in the same way that mass is a property of objects. It is well-known, however, that objects that appear red in typical daylight may appear black under light that contains energy only at the short wavelengths in the visible spectrum.

The real meat of the paper is concerned with the specification of colour and the international system of colorimetry that has been with us since 1931. The CIE (Commission Internationale de l'éclairage) system allows a colour percept to be specified by the amounts of three primaries that would match the stimulus if used together in an additive mixture in such a way that the properties of the illuminant, the surface and the observer are taken into account. The amounts of the primaries that are used are referred to as tristimulus values and although a great number of colour spaces, metrics and equations have subsequently been introduced (more than 100 equations have been produced for measuring whiteness alone) the basis of colorimetry remains the tristimulus values and these have served the colour industry well for over 70 years.

Readers in any field with an interest in colour would find Burkinshaw's review interesting and informative. Subsequent parts of the paper promise to inform us about colour matching and the colorimetry of tooth whitening but this part provides a solid basis from which to begin the discussions of these more practical topics.

Stephen Westland, Reader in Colour Imaging, at the Colour and Imaging Institute, Derby University
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