

Comparison of Tooth Shade Assessments Made by Tooth Colour Comparator and Visual Method

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Abstract

Tooth shade selected by the instrument method needs visual validation (hybrid method). Many studies have compared tooth shades selected by different instruments with the visual method, but no information exists on the agreement between shades selected by the Tooth Colour Comparator (Model YS-TCC-A) and the visual method. This study aimed to determine whether the shade selected by TCC substantially agrees with the visual method. This cross-sectional study included 150 indigenous people from the Ogoni ethnic group in Rivers State, Nigeria. We screened out individuals with poor oral hygiene or any anomaly that could affect tooth shade selection, and we used TCC to determine each participant's tooth shade on the mid-labial surface of the upper right central incisor. The tooth shade assessors were three experienced dentists with a satisfactory record of providing aesthetic dental services and they were purposively selected. At least two of the assessors must agree on the shade selected, and it should be satisfactory to the participant. The Vita 3D-Master shade guide was used for both digital and visual methods, following standard protocol. Cohen's Kappa statistic was used to analyse the data. The kappa value was 0.23, suggesting fair agreement (0.21-0.40), and the p-value was statistically significant, indicating the estimated kappa was not due to chance. This study found fair, not substantial, agreement in selected shades between TCC and the visual method.

Keywords: Shade guide, Tooth Colour Comparator, tooth shade selection, visual method.

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INTRODUCTION

Aesthetics constitutes a major requirement of what restorative dental patients expect from their dental restorations (Alsahafi R *et al.*, 2024). According to Kalantari MH *et al.*, (2017) as high as 80% of dental patients did not consider their restorations to be aesthetically pleasing; rejection of dental restoration may require a repeat procedure with attendant financial loss, loss of time, and wasted efforts on the part of all the stakeholders (Culic C, *et al.*, (2018). The patient may also lose confidence in the dentist. Tooth shade selection is a challenging procedure (Jouhar, R., *et al.*, 2022), and dentists have been encouraged to improve their shade selection skills (Shah P *et al.*, 2020). Evaluation of tooth shade is usually performed using the subjective (visual) or objective (instrument) method (Pérez *et al.*, 2019; Udiljak *et al.*, 2018). The visual method entails comparing the colour of a natural tooth with a colour

standard called a shade guide, and it is the most widely used method worldwide. Shade selection using a shade guide is useful, though inadequate, given the subjectivity involved (Udiljak *et al.*, 2018). It is common to encounter intra- and inter-examiner errors (Udiljak *et al.*, 2018). The errors could come from the observer (clinician), the light source, and the environment (Pérez *et al.*, 2019; Udiljak *et al.*, 2018). It could also come from the shade guide (Kalantari MH, *et al.*,) in that the full spectrum of natural tooth shades is not fully represented in the Vitapan Classical shade guide, for example, and the available shades are not distributed logically (Kim-Pusateri *et al.*, (2009). Sometimes, the same type of shade guides may have non-uniform colour (Alnusayri *et al.*, 2022). These are sources of error during the shade selection procedure.

Colour-matching instruments include colourimeters, spectrophotometers, digital cameras,

filter colourimeters, and spectroradiometers. The tooth colour matching capability of these instruments tends to be generally superior to the visual technique (Smitha & Savitha, 2017), but their accuracy and reliability are variable and far apart. In Abu-Hossin *et al.*'s (2023) study, the visual method showed only slight agreement with Trios 3 (Cohen's κ : 0.198) and Cerec Omnicam (Cohen's κ : 0.115) while Lehmann *et al.*, (2017) reported 72.5% accuracy for the visual method and 98.9% accuracy with the digital method. The advantages of these instruments include eliminating subjectivity and the influence of the surrounding environment, less chair time involved, and the shade of the final restoration is verifiable (Smitha & Savitha, 2017). In light of these advantages, the use of instrument methods is increasingly becoming popular among dental practitioners (Abu -Hossin S, *et al.*, 2023). However, the instruments are not all dependable (Abdulsamee & Nagi, 2020), and they are not without peculiar limitations. Apart from cost, instruments like spectrophotometers is limited to reading one point at a time, and there may be incorrect shade assessment arising from loss of a fraction of light entering the tooth when used on curved tooth surfaces, edge-loss error (Miyajiwalwa *et al.*, 2017). Because of the limitations associated with the instrument method, many authors have suggested that the visual method should be used to validate the assessment made by the instrument method in order to achieve the desired results (Ustin *et al.*, 2025; Adavikatla S, *et al.*, 2026). Several investigators have examined the agreement between the visual and instrument methods, but there is scant information on the agreement between the Tooth Colour Comparator (YS-TCC-A) and the visual method. This study aimed to determine whether the shade selected by TCC substantially agrees with the visual method.

EXPERIMENTAL SECTION/ MATERIALS AND METHODS

This was a cross-sectional study conducted among 150 indigenous people of Ogoni living in Port Harcourt, Rivers State, Nigeria. Inclusion criteria were individuals aged 16-30 years who had no stain or plaque, dental anomaly, restoration, xerostomia, or periodontal disease and who were not undergoing orthodontic treatment. Individuals who did not want to remove their jewellery or bright make-up were excluded from the study. The University of Port Harcourt Research Ethics Committee approved the study (UPH/R&D/EXEC/242). TCC was used for tooth shade selection. To start with, the charge level of the instrument was checked to ensure it would not run low during the exercise. To prevent cross-infection, the probe tip was inserted into the anti-infection barrier cover, and the paper barrier was then removed. The anti-infection barrier cover was kept flat and held tight with the anti-infection cover hold ring. The machine was then switched on, and the calibration-required icon automatically appeared. The calibration block's surface was cleaned with a dry cloth. The tip of

the probe was then placed vertically on the magnetic surface of the calibration block, and this was followed by pressing of the start button. A three-beep sound and probe tip light confirmed the calibration was successful.

Vita 3D-Master shade guide and the one-point measurement mode were selected and used for the study. For tooth shade matching, the probe tip was kept vertical and flush with the centre of the labial surface area of the upper right central incisor of each participant. After placing the probe tip on the tooth surface properly and steadily, the start button was pressed. A short beep indicated that the measurement was successful, and the shade tab closest to the shade of the reference tooth appeared on the screen.

Three experienced dental surgeons, who were not aware of the tooth shade selected by TCC, and one of whom was a lady, were purposively selected as tooth shade assessors because they had satisfactory records of providing aesthetic dental restorations in the Restorative Dental Clinic of the University of Port Harcourt Teaching Hospital. The tooth shade selected by two or all three assessors is taken as the shade of the subject. The shade must be satisfactory to the participants. Vita 3D-Master shade guide was used for the visual shade selection. The value (brightness) of the shade was selected first by squinting. The shade tab with M hue was used to select the chroma. The hue was selected afterwards. The standard protocol for visual tooth shade selection was followed.

The null hypothesis is that there is no substantial agreement between the tooth shades selected by TCC and the visual method. IBM SPSS Statistics software version 20.0 (Armonk, NY: IBM Corp). Cohen's kappa statistic was used to assess agreement between the shade selected by TCC and the visual method.

Kappa coefficients and their interpretations (Abu-Hossin S *et al.*, 2023) are as follows:

0	=	No agreement
0.01-0.20	=	Slight agreement
0.21-0.40	=	Fair agreement
0.41-0.60	=	Moderate agreement
0.61-0.80	=	Substantial agreement
0.81-0.99	=	Strong agreement
1.0	=	Perfect agreement

RESULTS AND DISCUSSION

A total of one hundred and fifty young adults aged 16-30 years, of whom 52 (34.7%) were male and 98 (65.3%) were female, participated in the study. The mean age was 21.2 ± 4.2 years. The kappa statistic (Table 1) was used to assess the agreement between the tooth shades determined by the TCC (objective method) and those determined by the visual (subjective method). The kappa value is 0.23, suggesting that the level of agreement was fair (0.21-0.40), and the p-value is statistically significant, implying that the estimated

kappa is not due to chance. The data therefore fail to reject the null hypothesis, stating that there is no

substantial agreement between the tooth shades selected by the objective and subjective methods.

Table 1: Agreement between the Objective and Subjective Tooth Shade Selection Methods (Cohen's Kappa)

Measure of Agreement	Kappa	Standardized Error	95% C.I	p-value
Objective vs. Subjective Shade Selection	0.227	0.036	0.156-0.299	< .001

This study investigated the agreement between the tooth shades selected by TCC and the visual method. The instrument method was created to eliminate the errors associated with the subjective visual shade selection method (Ustin *et al.*, 2025). Even though these instruments have already proved to be promising, the accuracy varies remarkably, and none of them has attained 100% accuracy (Sirintawat N *et al.*, 2021). This has led to the emergence of the hybrid method (Adavikatla S, *et al.*, 2026; Ebeid K *et al.*, 2021). According to Gotfredsen *et al.*, (2015), validation of instruments for shade determination should include comparative evaluation of their performance against that of the visual method.

The findings from this study show a fair level of agreement between the tooth shade assessment made by TCC and the visual method, and the data failed to reject the null hypothesis. This result aligns with Ozturk *et al.*'s (2025) study, which reported weak or no agreement between visually and objectively selected tooth shades when the vital classical and vital 3D-Master shade guides were used, respectively. The present study also corroborated the study by Abu-Hossin *et al.*, (2023), who compared the level of agreement between the subjective tooth shade selection method and two intraoral scanners, Trios 3 and Cerec Omnicam, where Cohen's κ statistical test showed a slight agreement, 0.198, between the visual and Trios 3 shade assessment instrument. The results are also consistent with the results reported by Homsy FR *et al.*, (2014; Anthony JK *et al.*, 2021; Brandt J *et al.*, (2017), where poor agreement was observed between the visual shade selection and the instrumental method.

The finding in the present study, however, contradicts that of Lehmann *et al.*, (2017) where the visual method had 72.5% accuracy and the digital method recorded 98.9% accuracy. Furthermore, the agreement recorded by Miyajiwala *et al.*, (2017) between visual and digital methods was high (66.0%). The reasons for the differences recorded in studies comparing the performance of objective and subjective tooth shade assessment methods may be due to differences in the repeatability and accuracy of the digital method and the non-uniform methodology adopted in the studies. Validation of a new instrument for tooth shade determination in vivo requires that the shade assessment made by the instrument be compared with that of the visual method. This has been stated by many authors (Sirintawat N *et al.*, 2021; Brandt J *et al.*, 2017; Gotfredsen *et al.*, 2015). It is also a standard protocol, and it is part of the assessment that will enable experts to decide whether the instrument is better than the visual

method or vice versa. The visual method performs better when the digital method has been used to narrow the choice of best shade to one, unlike when the eyes have to select from a pack of 16 or 26 tooth shade options. According to Gotfredsen K *et al.*, (2015), the human eye is efficient at detecting small variations in the colour of two objects, and despite the subjectivity of visual assessment, it is regarded as important and relevant for determining the best tooth shade match (Paul *et al.*, 2002).

The tooth shade assessors were not sent for a colour vision test before the commencement of this study; rather, a judgemental sampling was used to recruit them. Dental practitioners who are into aesthetic dentistry rely on the protocol for shade selection, which has been formulated to limit the errors that could come from the clinician, the surrounding environment and the source of light, if it is followed strictly. Besides, the assessors worked independently at first before coming together as a group. The ability to visually match tooth shade has been described as both a technical skill and an art (Gupta & Saluja, 2023). It requires input from others. Apart from two assessors agreeing on a shade, the tooth shade selected must be satisfactory to the participant, and a lady was included among the assessors in line with the protocol for shade selection because about 8% of males and 2% of females have genetically determined colour-vision defects (Awchat *et al.*, 2023). Ladies are therefore less likely to have the defect.

CONCLUSION

Within the limitations of this study, the results show fair agreement and not substantial agreement between the shade selected by TCC and the visual shade selection method. TCC will require further evaluation.

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