University of Zurich[UZH]

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Reliability of smartphone-cameras for color-mixing chewing-gum test for masticatory efficiency

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Objective

This study assessed the reliability of smartphone-cameras for acquiring chewing gum photos to be used in the evaluation of chewing efficiency (CE).

Methods

A healthy, fully dentate, subject produced five test specimens of varying degrees of color mixture according to a visual Subjective Analysis of CE (SA: SA1–SA5) using a validated two-colored chewing gum (Hue-check Gum®). The gums were flattened to a thickness of 1 mm in a transparent cellophane pouch. Both sides of the wafer were scanned using a flatbed scanner (control group). The wafers were photographed (both sides) with 8 different smartphones under standardized light and focus conditions (test groups: i5s, i6, i7, i8, iX, SS6, SS7, SS8). Each degree of CE was photographed by each smartphone, 20 times. The images from the control and test groups were edited so as to acquire both faces of the gums into a single image, for each specimen. This image was then analyzed for the variance of hue (VOH) using a software (ViewGum©) – lower VOH values mean higher mixture of the chewed gum. Mean and standard deviation were used to assess inter-group differences and intra-group variability. Pearson's correlation, one-way ANOVA and descriptive statistics were applied for data analyses (α=0.05).

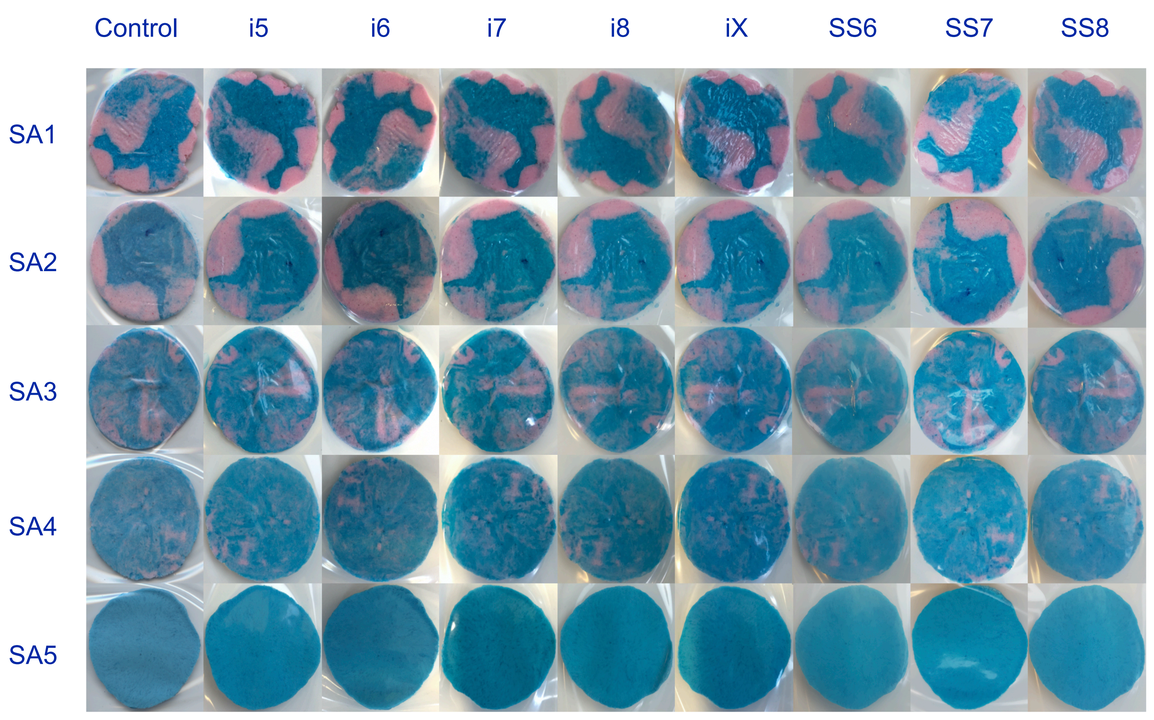

Fig.1: Two-colored chewing gum SA1 to SA5 control and test groups

Results

The mean overall VOH values decreased from SA1 to SA5, and were correlated with the degrees of CE (>-0.96; p<0.001). The comparisons of VOH between the control and smartphone groups were statistically significant for all degrees of CE (p<0.001). Nevertheless, the overall paired differences between control and smartphones was low, ranging from -0.02 (iX) to 0.06 (i6) for smartphones, and from 0.005 (SA4) to 0.044 (SA2) for SA degrees. Similarly, within-group variability was low (<1%) for all devices from SA1–SA3. Conversely, the control group presented lower variability (SA4=2.5%; SA5=0.79%) compared to the mean variation of smartphones (SA4=5.57%; SA5=8.76%).

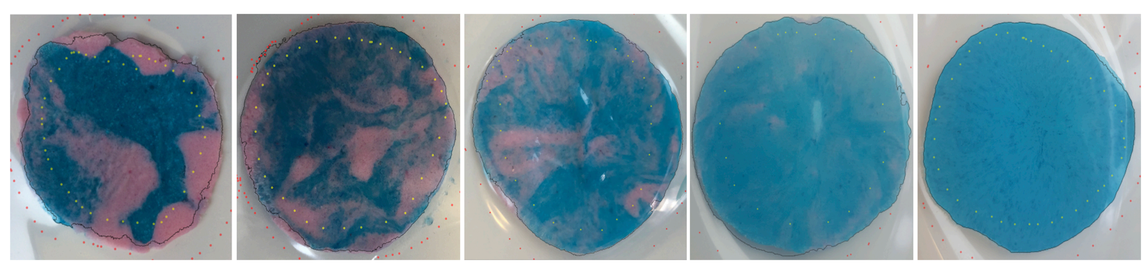

Fig 2: Examples of the analysis of the chewing gums (i5s with SA1, i6 with SA2, i8 with SA3, SS6 with SA4, SS8 with SA5)

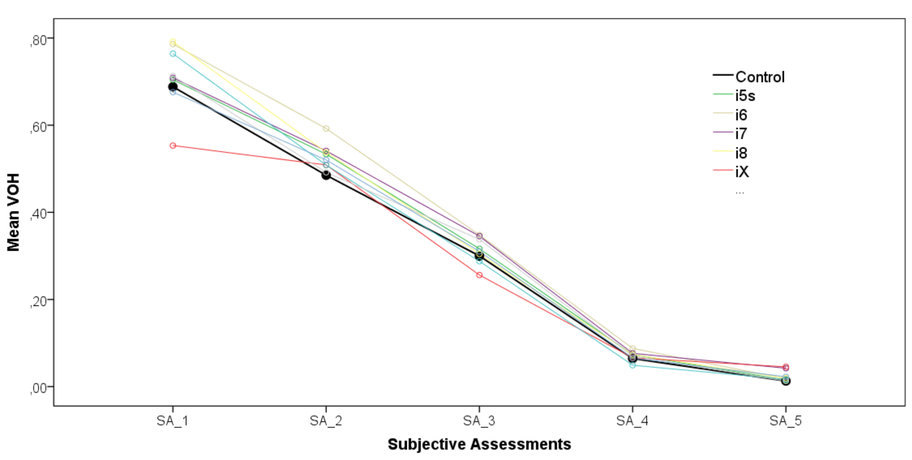

Fig 3: VOH obtained from various smartphone images in relation to degree of color mixture (SA)

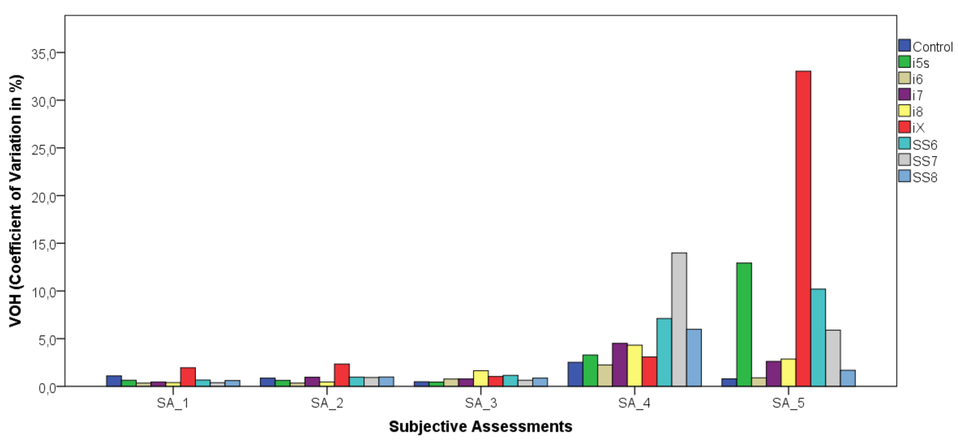

Fig 5: Coefficient of variation [(SD / mean)*100) for all devices

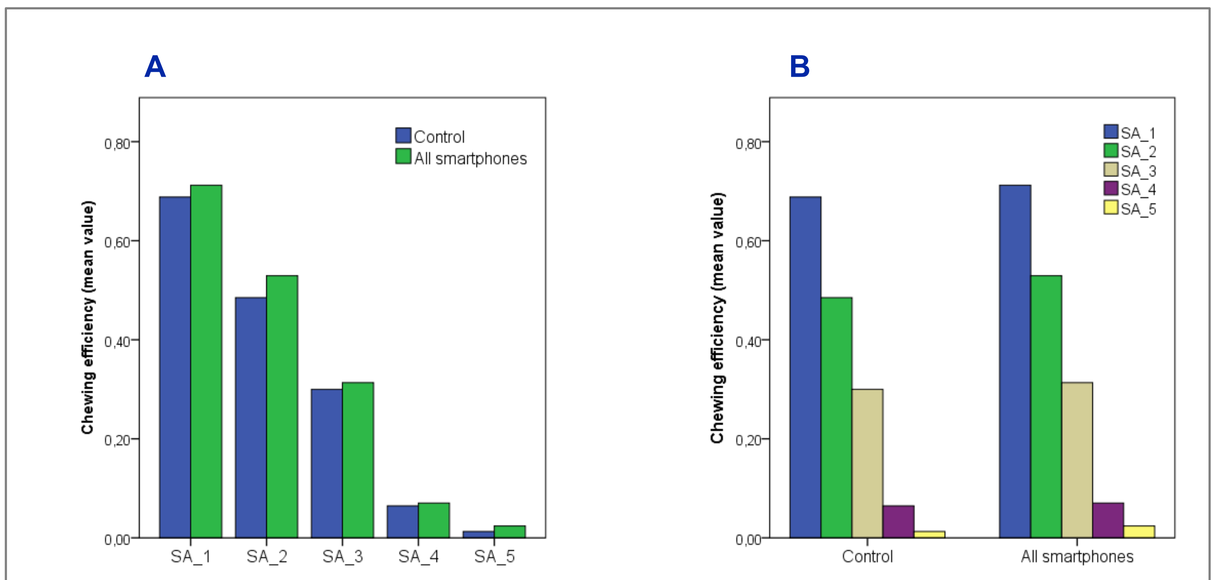

Fig 4: Comparison of chewing efficiency between control (flatbed scanner) and grouped mean of all smartphones. (A) comparison of devices according to SA; (B) comparison of SA according to devices.

Conclusion

Smartphone-camera images can capture the changes in CE similar to the images from a conventional flatbed scanner. However, for well-mixed gums, the smartphone-camera seems less reliable than the scanner, but this finding needs to be tested for its clinical significance with further studies.

Conflicts of interests: None. (email: nicolas.fankhauser@zzm.uzh.ch)