Good practice of colour masking in sensory research

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Introduction

Research background

Standard sensory testing with trained and expert assessors requires assessors with normal vision, reproducible lighting conditions and reproducible visual inspection conditions (ISO 11037:2011). Normally sighted assessors shall be in good general health and shall not have any deficiencies that could affect their perception or the reliability of their assessments. The assessor's vision is basically determined by three factors: visual acuity, contrast sensitivity and color vision. These factors need to be tested to select judges with normal vision for sensory testing. Methods and testing protocols for these factors have been developed (Sipos et al. 2020; ISO 8586:2012). Reproducible illumination conditions are determined by the photometric and spectral nature of the light source, the photometric and spectral nature of the sample environment, and the adaptation state of the visual system. The reproducible ophthalmic exposure conditions are determined by the relative positions of the light source, the specimen, and the eye, i.e., the test geometry. For sensory testing of colored products, it is recommended to implement a testing environment where color differences between products do not influence the assessors' judgement of other sensory parameters (taste, smell, texture) (ISO 11037:2011). Many methods have been used for colour masking in international practice, but all of them are subject to varying degrees of error: product colouring, eye-binding, black test glasses, spectrally fixed colour illuminations, colour filtering lenses.

Objective

In our research, we demonstrate good practices of color masking through examples of product groups with spectrally controllable light booths using the new approach.

Materials and Methods

Examined product groups

Tea leaves, tea drinks, milk chocolates, dark chocolates, syrups, white wines, red wines, rosés, biscuits, paprikas.

Sensory tests

Selection of assessors. The requirements of the relevant international standards (ISO 8586:2012; ISO 11037:2011) were used as the guideline for testing the assessors' vision. Accordingly, in the first step, an **instrumented color vision test** (based on Rayleigh equation) was performed by an OCULUS 47700 Heidelberg MultiColor anomaloscope.

Sensory tests were conducted at Sensory Laboratory which meets **standard requirements** (ISO 8589:2007). Assessors had to rank samples on their hue under different colored illuminations. Due to reliability of the test, chocolate samples were first evaluated under validated D65 illumination simulating artificial sunlight in a PANTONE Color Viewing Light Booth (3-light Unit) (ISO 11037:2011). Then, evaluations focused on the correctness of the made sequence and duration of decision making in different lighting environments. Sensory tests were performed under four different monochromatic illumination environment (Red, Green, Blue, Amber).

Spectrally controllable lighting booth

The light booth was built at the Department of Mechatronics, Optics, and Mechanical Engineering Informatics, University of Technology and Economics, Budapest. The installation has enclosing dimensions of 1.5 x 1 x 1 meters, in which there are 5-5 different types of LED groups (red, green, blue, white and amber) mounted on 4 fixed panels (Fig. 1.).

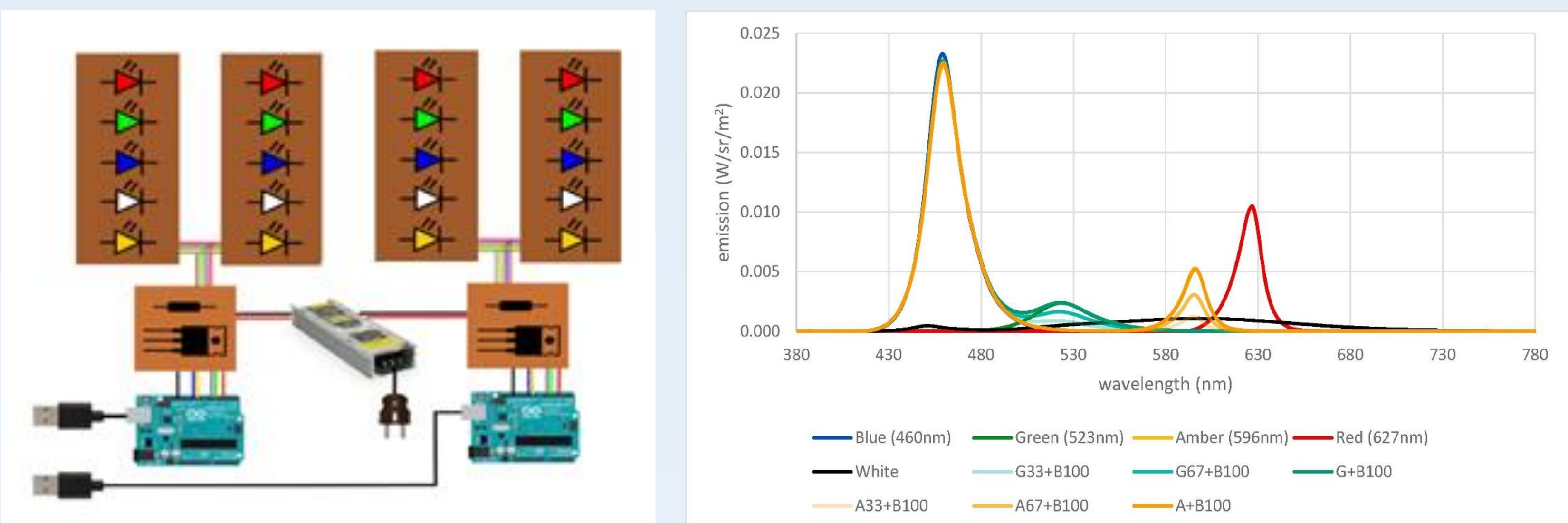

Fig. 1. Schematic structure of a spectrally controllable lighting booth (Nyitrai et al., 2022)

Colour and spectral measurements

The colors of the **products were measured by a tristimulus colorimeter** (*X-rite RM200QC*). The instrument specifies the color as the L*, a*, b* color coordinates of the CIE Lab color system. The measurements were made in ten different places on each sample, and arithmetic mean was calculated. From the obtained color coordinate values, chroma, hue and color differences (ΔE_{ab*}) between samples were determined (CIE, 2004). Spectral measurements were also performed to design the appropriate masking illumination. The **spectral reflectance was measured** three times on each product flat surface by an AvaSpec Spectrophotometer in the range of 380–780 nm with a resolution of 10 nm.

Statistical analysis

Ranking times and correctness were investigated by ANOVA after checking the condition tests – normality and standard deviation homogeneity. In the case of difference Duncan post hoc test in pairs was performed. Kaplan-Meier survival analysis was used to compare the curves generated by combining the ranking time and correctness. Post hoc tests: *Log-rank* and *Wilcoxon* method. A significance level of $\alpha \leq 0.05$ was determined for statistical analyzes (Addinsoft, XLSTAT).

Results

Compared to D65 (White), all other lighting environments increased decision times and errors. In summary, all used colored illuminations have some masking ability compared to D65 (White), but they differ in the effectiveness of masking. Kaplan-Meier survival analysis and post hoc tests revealed that there were three significantly different groups: 1. blue, 2. red, green, amber, 3. white (D65).

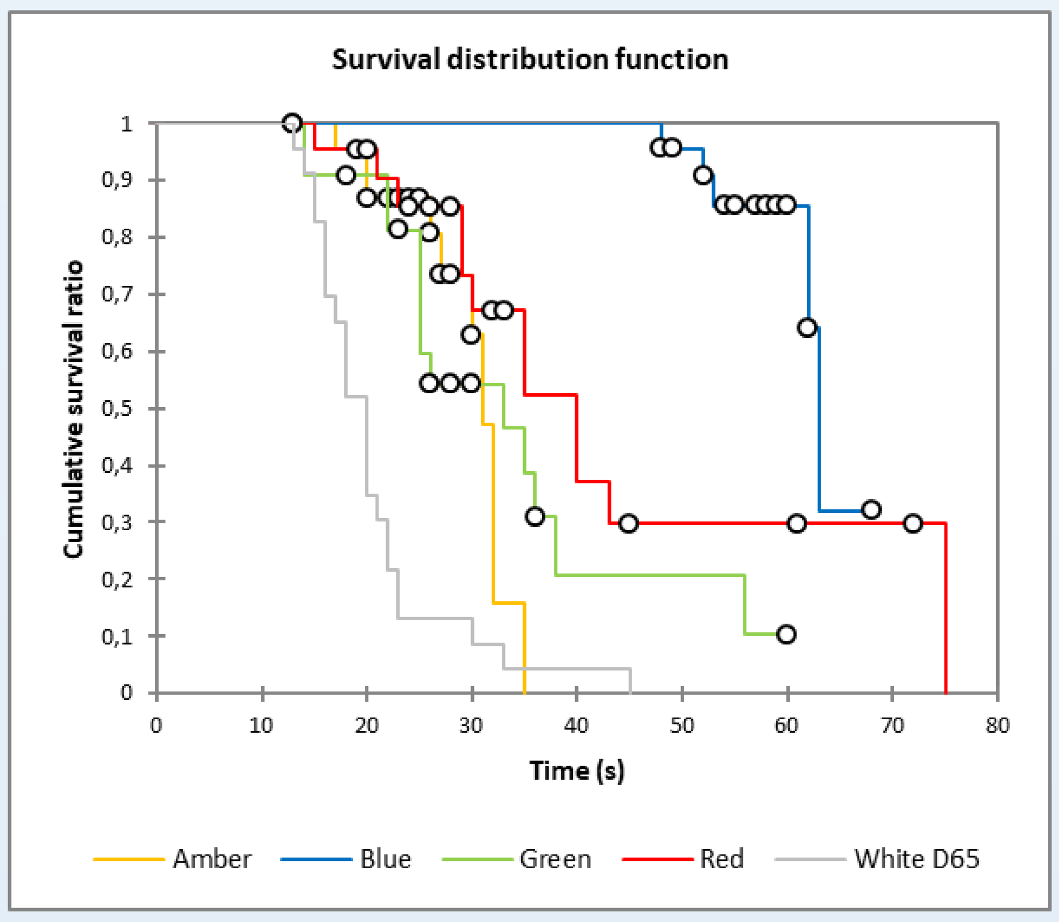

Fig. 2. Survival curves based on Kaplan-Meier analysis (paprika)

Conclusions

The five pillars of good practice of colour masking:

1. Standard international sensory methods and testing environment.
2. Spectrally controllable testing environment.
3. Instrumental characterization of sensory assessor.
4. Instrumental characterization of products.
5. Instrumental characterization of the test environment.

References

ISO 11037:2011 Sensory analysis — Guidelines for sensory assessment of the colour of products

ISO 8586:2012 Sensory analysis — General guidelines for the selection, training and monitoring of selected assessors and expert sensory assessors

Commission Internationale de l'Éclairage (2004) Colorimetry: technical report. Central Bureau of the CIE, pp 12–18.

Nyitrai, Á., Urbin, Á., Nagy, B. V., & Sipos, L. (2022). Novel approach in sensory color masking: Effects of colored environments on chocolates with different cocoa content. *Food Quality and Preference*, *95*, 104363.

Sipos, L., Nyitrai, Á., Szabó, D., Urbin, Á., & Nagy, B. V. (2021). Former and potential developments in sensory color masking–Review. *Trends in Food Science & Technology*, *111*, 1-11.

Acknowledgements

The authors acknowledge the Hungarian University of Agriculture and Life Sciences's Doctoral School of Food Science for the support in this study.