

Exploring Cross-Modal Sensory Experiences in Flavour Perception

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1 Introduction

Cross-modal perception research shows that visual cues, such as the color of a cup, can shape how we experience taste—for instance, making a drink taste sweeter or more acidic. Most existing studies rely on simple stimuli (like flavored water solutions) and controlled laboratory settings, overlooking how these effects unfold in real-life contexts. Meanwhile, psychedelics are anecdotally associated with enhanced cross-modal experiences (synaesthesia), yet their impact on taste and flavor perception remains largely unexplored. In this study, we investigated whether the color of a coffee cup influences the perception of complex flavor notes in a naturalistic tasting task and whether this effect is amplified in individuals reporting psychedelic use.

2 Methods

Phase 1: Online Survey (Color-Flavor Associations)



Participants (n=143) selected from 19 available descriptors all flavors associated with each cup color (8) using a Choose-All-That-Apply (CATA) format.

Phase 2: Naturalistic Coffee Tasting Task (Flavor × Color Interaction)



Participants tasted 4 randomized samples (coffee × colour) and rated the coffee flavour using CATA (12 flavor descriptors). Psychedelic use (e.g., LSD, Psilocybin) was self-reported (n=27 reported use).

Study conducted at a music festival using opportunistic sampling (n=71). Within-subject, repeated-measures design



Semi-structured phenomenological interviews throughout guided tasting.

3 Results

Phase 1: Online Survey (Color-Flavor Associations)

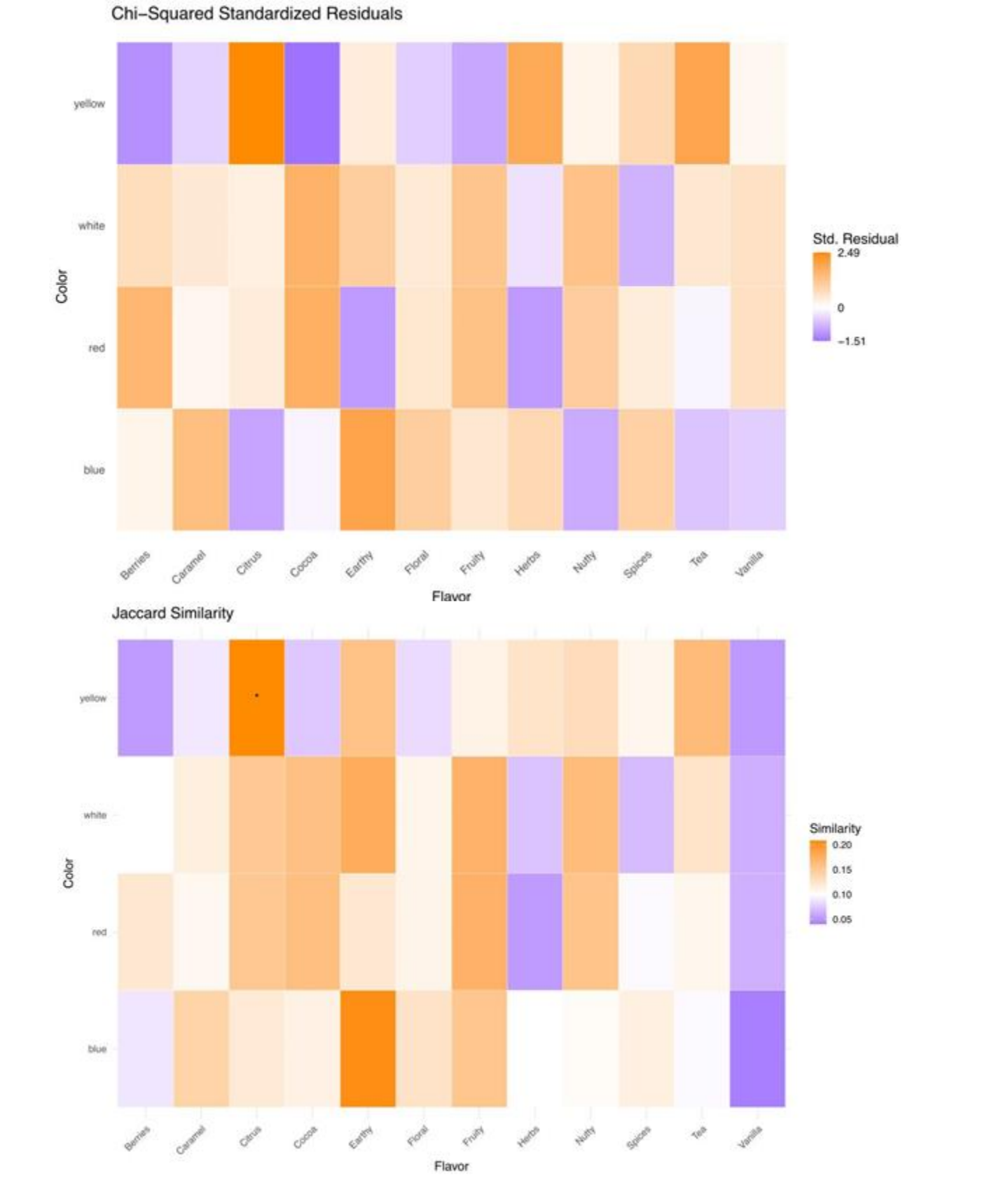
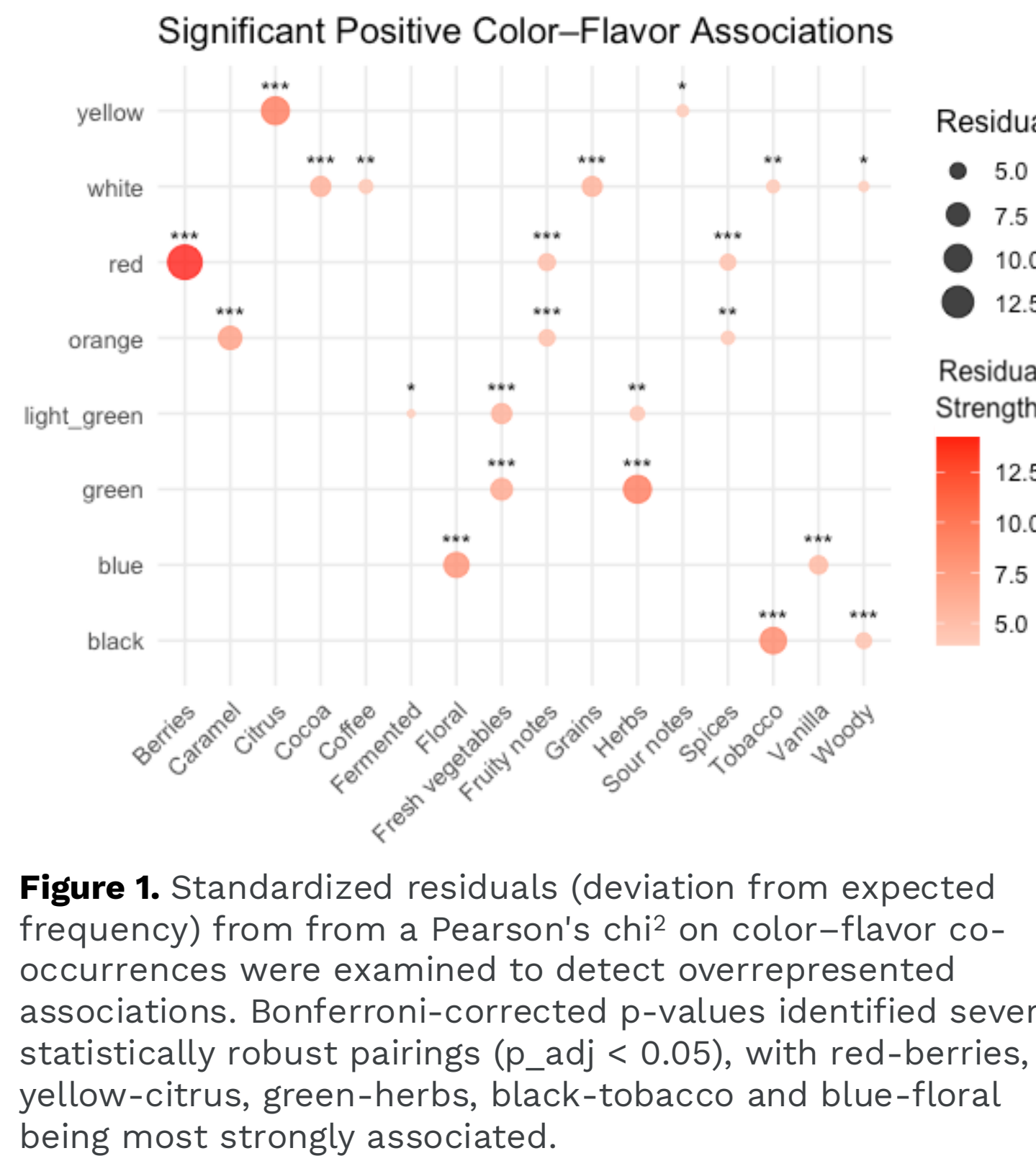


Figure 2. Top: Standardized residuals from a Pearson's χ^2 test on the aggregated flavor × color contingency table revealed no statistically significant associations after Bonferroni correction ($\chi^2(33) = 24.48$, $p = 0.858$), suggesting no deviation from independence.

Bottom: A Jaccard similarity analysis—more sensitive to binary and sparse data—revealed a significant co-reporting association between citrus and yellow (Jaccard = 0.2, $p = 0.036$), permutation test on hypothesis color-flavor associations).

Phase 2: Coffee Tasting (Flavor × Color Interaction)

Data were modeled using a generalized linear mixed model (GLMM) with binomial family structure, predicting color-flavor co-occurrences, while accounting for repeated measures per subject. A Type III Wald Chi-Square test - used to assess the contribution of each term in the model - revealed a significant Flavor × Color interaction ($\chi^2(4) = 9.69$, $p = 0.04598$), demonstrating that the reported flavor notes varied significantly based on cup color. Yellow cup effect: Significantly enhanced reports of citrus flavor ($z=0.49, p=.019$). Blue cup effect: Significantly reduced reports of citrus flavor ($z=-0.48, p=.023$).

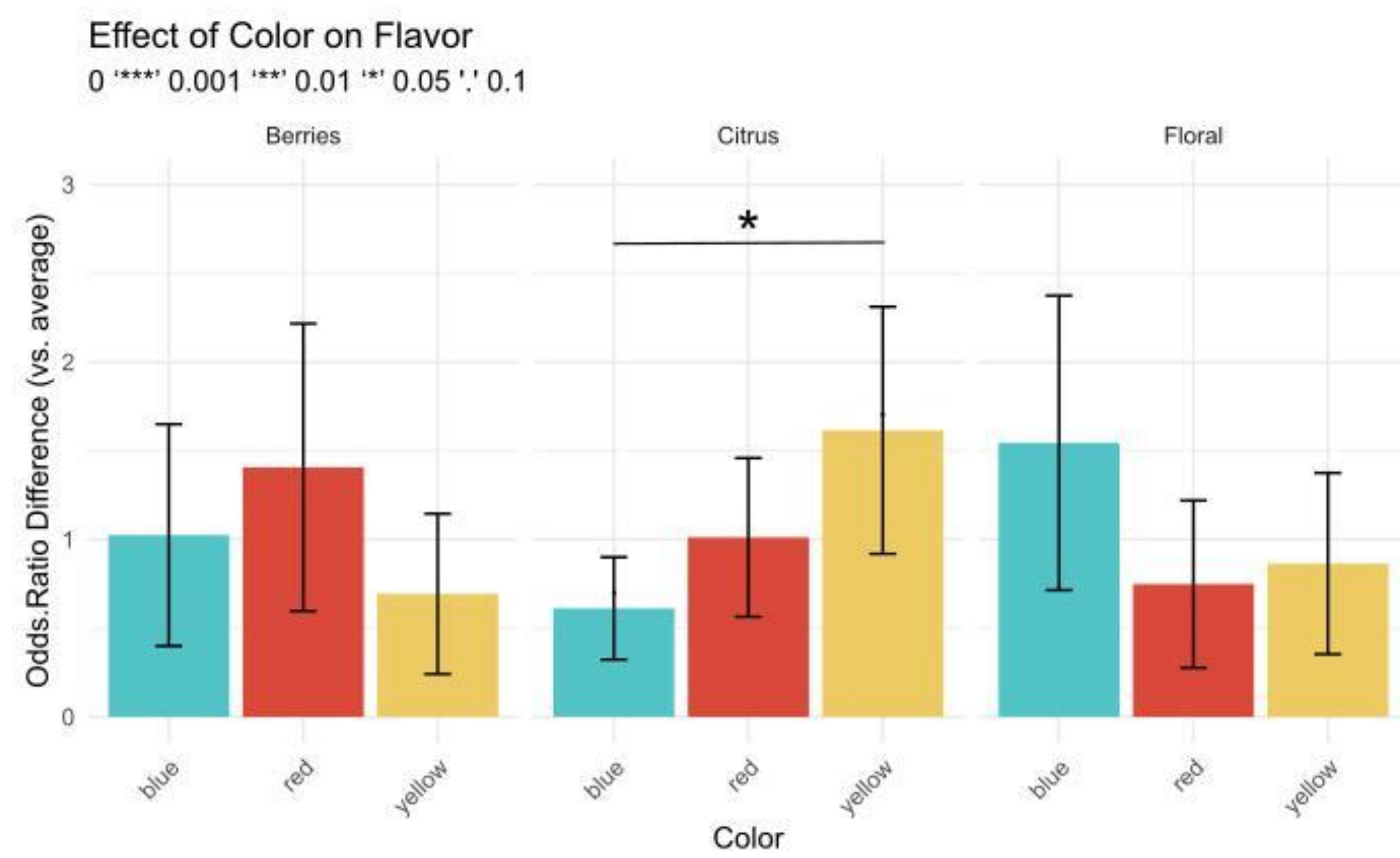


Figure 3. Estimated marginal means (EMMs) and their effect contrasts were computed to perform pairwise color comparisons within the citrus flavor group. Yellow cups significantly increased citrus flavor reports compared to blue ($p = .042$), with no other color effects observed.

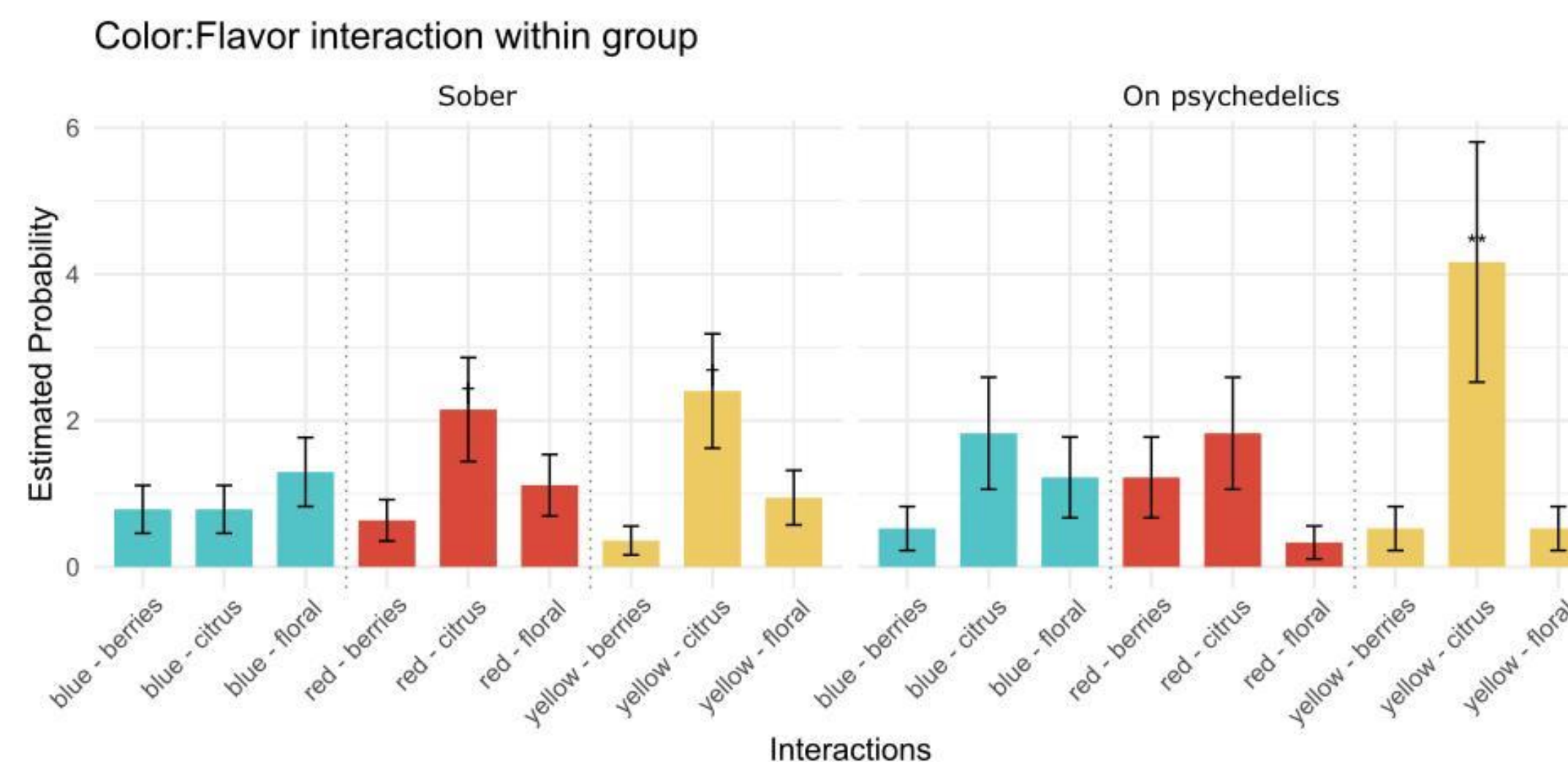


Figure 4. Estimated marginal means (EMMs) and their effect contrasts were grouped by drug state. Under psychedelics, the citrus-yellow combination significantly increased positive outcome likelihood (OR = 4.17, $p = .0026$), while no other flavor-color effects were significant in either condition after correction.

Stimulus

Single-origin arabica (Burundi, Bourbon, Washed): (1) Gahahe washing station, Kayanza, Burundi, 1805 masl; (2) Gaharo Long Miles, Muramvya, Burundi, 1700-2100 masl;

Profile: (1) floral - lime - maple syrup; (2) floral - lemon - brown sugar;

Target flavor descriptors: *Berries, Citrus, Floral*



Brewing method:
Filter (pour-over) coffee prepared using the Hario V60 02 Kit at a concentration of 60 g/L-1 using mineral water at 94 °C, t = 2:30 min



Cups:
Ceramic ionEgg (80 ml, 77gr), selected based on the strongest associations (Phase 1)

4 Conclusions

The study provides evidence that cup color affects perception of coffee flavor with yellow cups amplifying reports of citrus notes specifically under psychedelics, extending our understanding of cross-modal sensory perception in ecologically relevant contexts and diverse subjective states.

The results hold practical relevance for the specialty coffee industry, where intentional color design—such as using yellow cups—could reliably influence consumer flavor perception.

References

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