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Analysis of Memory Colour Using Selected Foods As an Example

ABSTRACT

In the complex process of recalling a distinct colour, memory plays a crucial role. The accuracy of recall is particularly important in some cases, for example when recognising the colour of food, as it communicates information about its freshness, taste and ripeness. Food manufacturers establish their first contact with consumers through various forms of advertising. To attract attention and encourage purchase, the colour of food must be carefully selected and depicted. This process relies on memory colours for different groups of fruit and vegetables, i.e. the colours of well-known and frequently seen objects. In 2024, a new Preferred Memory Colour (PMC) chart was published, which contains the memory colours of selected objects and foods and enables accurate colour reproduction. The purpose of the present research was to investigate the influence of the mode of colour presentation on the observer's ability to recall a colour sample, namely the colour of fruit or vegetables. In the experiment, three different ways of presenting the colour were used. The experiment took place in a controlled environment under constant observation conditions. The colour vision of the observers was previously checked with the Farnsworth-Munsell 100 Hue test. The test charts were prepared based on the preferred colours of selected foods, and the results were numerically evaluated using the parameters of the CIELAB colour space. The results showed that the accuracy of colour recall is greatly improved with additional directed instruction, due to subconscious associations with a specific object. In addition, it emerged that some food colours are remembered more accurately than others.

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KEY WORDS
Colour perception, colour memory, memory colours, food colour, colour recall

1. Introduction

Colour is one of the key attributes of visual communication and influences most of our purchasing decisions (Martinez et al., 2021). It also affects our appetite and food choices, as it is a significant factor in our expectations regarding taste. For most food products, their properties, including colour, change over time through ripening or decay, as well as through processing methods such as baking and cooking (Hutchings, 2010). Every food has an acceptable colour range. If the colour of a particular food does not align with the observer's expectations, it signals that the food is not fresh or ripe, which may deter the consumer from purchasing it (Pathare, Opara & Al-Said, 2013). In everyday life, we often compare colour stimuli separated in time, attempting to match the colour currently being observed with the one held in our memory (Bodrogi & Tarczali, 2001). When buying fruit, for example, we select a product based on the image we hold in our memory. In this process, we must rely on our colour memory.

Food companies establish their first contact with consumers through advertisements, promotional catalogues and attractive packaging. To encourage purchase, the colour of products must be accurately represented, as this reflects their quality. In 2024, the new Preferred Memory Colour (PMC) chart was published, enabling an accurate assessment of colour reproduction quality and including 30 samples of associative colours, i.e. the colours of well-known and frequently seen objects (Luo, 2024). A memory colour is the colour of a well-known

and frequently seen object, a colour that becomes part of the memory representation of an object and constitutes an individual's standard for familiar objects (Granzier & Gegenfurtner, 2012). A specific associative colour, or our mental image of a colour, may influence the objective perception of that colour. The memory colour effect is based on the premise that an object is strongly associated with a typical colour and that the observer is well acquainted with the object (Valenti & Firestone, 2019).

Research on the influence of memory for the colour of familiar objects, primarily food, has shown that preferences for red, yellow, and green shades increase as colour samples approach a specific associative colour, whereas the effect is less pronounced for blue and purple samples (Liao & Yoshizawa, 2024). It has also been found that the accuracy of colour matching for familiar objects in long-term recall can vary among observers due to individual colour preferences and colour memory (Seliger, 2002). The purpose of the present research was to investigate the influence of the mode of colour presentation on observers' ability to recall a colour sample, specifically the colours of fruit and vegetables. The test charts were prepared based on the preferred colours of selected foods and the results were evaluaed using the parameters of the CIELAB colour space.

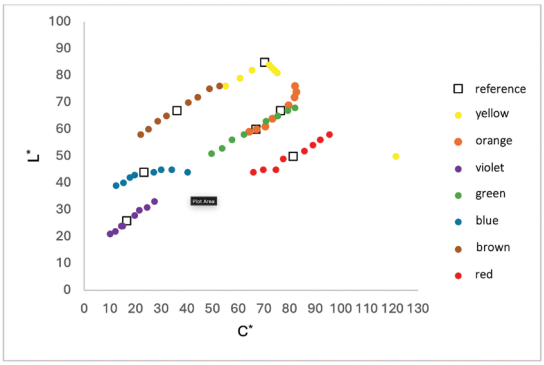
2. Methods

2.1. Preparation of reference colours and samples

Reference colours were obtained from seven food items (banana, pumpkin, aubergine, lime, blueberry, ginger, tomato) selected to cover a wide colour range. Photographs of each item were sourced from Adobe Stock and opened in Photoshop, where colour values (Hue, Saturation, Brightness) were extracted from five random points and used as the final reference colours (Figure 1).

2.2. Selection and adjustment of samples

For each reference colour, eight samples were created by adjusting hue (±2 units), saturation and brightness (±3 units). Additional fine adjustments (1–3 units) were made when samples appeared visually inconsistent with the colour set. In Photoshop, colour-adjusted images for the experiment were produced using masked selections and Solid Colour layers set to Colour blending mode.



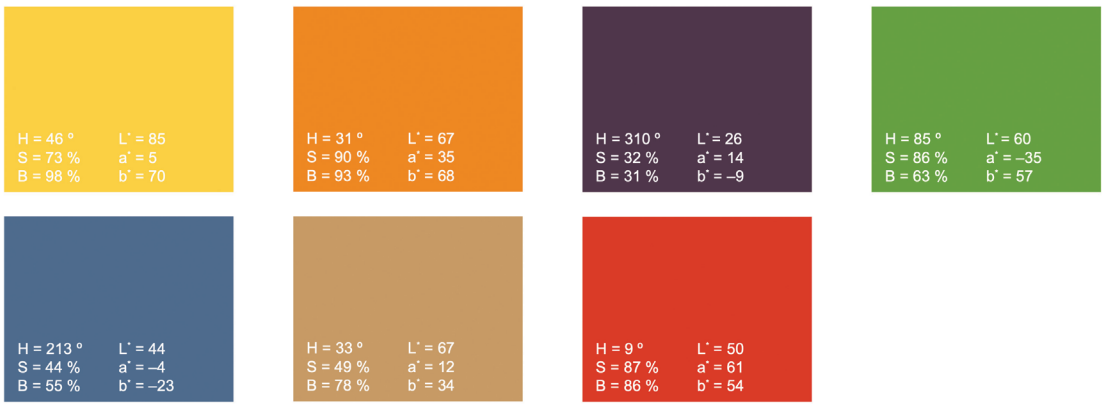
» **Figure 2:** *Selected reference colours and samples in C*L*plane of CIELAB colour space*

2.3. Participants

Seventeen observers (students aged 19–24, 16 female and 1 male) took part in the study. All participants completed the Farnsworth–Munsell 100 Hue Test beforehand. For the experimental part, only those participants with a maximum of four misplacements (0–16 error score) were included. The study was approved by the ethical committee of the University of Ljubljana, Faculty of Natural Sciences and Engineering.

2.4. Viewing conditions

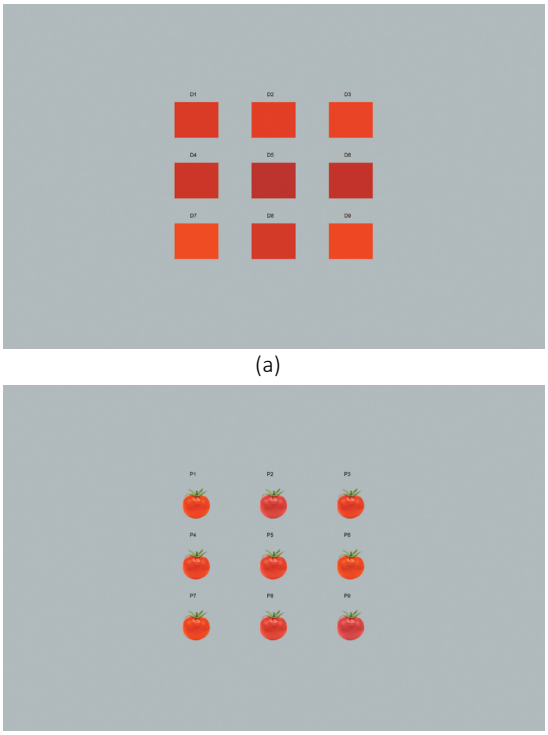
The experiment was conducted in a controlled, as the light source. Observers were seated 77 cm from the screen, positioned perpendicular to it.



» **Figure 1:** *Reference colours with HSB and CIELAB colour values*

2.5. Presentation of Colour Charts

A total of 42 colour charts were prepared, six charts per colour. Each chart included one reference and eight samples, arranged centrally on a neutral grey background (L* = 75, a* = –3, b* = –2). Charts differed in using either rectangular colour patches or colour-adjusted photographs (Figure 3).



(a)

(b)

» **Figure 3:** *Colour charts used in the experimental Part 1, 2 (a) and Part 3 (b)*

2.6. Experimental Procedure

Participants first adapted to a neutral grey screen for 5 s, followed by written instructions. They then viewed a colour chart and selected one sample according to the task. Each trial concluded with a 5-second grey-screen interval.

- Part 1 used non-specific instructions (e.g., “Select the basic red colour”).
- Parts 2 and 3 used directed instructions (e.g., “Select the tomato red colour”).

Each colour was tested in six repeated trials.

3. Results and discussion

3.1. Recall of basic colours

In the first part, observers were asked to select, from nine colour samples, the one they perceived as representing a basic colour. The average colour differences regarding the reference colour are presented in Table 1. The calculated CIELAB (Bračko & Blaznik, 2022) colour difference (ΔE*) showed a relatively high deviation. This result was expected due to the use of non-directed instructions and inherent inter-observer variability, as individuals conceptualise “basic colours” differently.

Yellow showed the highest recall accuracy (ΔE* = 2.19), corresponding to a small colour difference. In contrast, blue exhibited the poorest recall (ΔE* = 8.59), representing a very large deviation. Higher variability was also observed for violet, green, orange, and brown, consistent with their classification as secondary or tertiary colours.

Table 1

Recall of basic colours: colour differences (ΔL*, Δa*, Δb*, ΔC*, ΔE*)

Colour	ΔL*	Δa*	Δb*	ΔC*	ΔE*
Yellow	-1.32	-3.03	1.56	4.20	2.19
Orange	3.50	-2.41	4.91	3.50	5.17
Violet	5.47	8.47	-1.68	8.26	7.65
Green	3.12	-5.32	2.85	5.37	4.92
Blue	0.26	6.47	-13.79	13.60	8.59
Brown	-6.38	-0.59	-10.97	-10.28	7.91
Red	3.15	2.03	5.15	5.08	4.98

Analysis of colour attributes showed systematic shifts. Lightness (L*) varied most for brown (ΔL* = –6.38), which observers consistently recalled as significantly darker, likely due to strong real-world associations (e.g. soil, wood, chocolate). Violet (ΔL* = 5.47) was perceived as lighter, while other colours showed smaller deviations (up to 3 units). Blue showed minimal lightness deviation (ΔL* = 0.26). Hue shifts (Δa*, Δb*) revealed clear perceptual biases:

- Violet, blue and red were recalled as more reddish,
- yellow, orange, green and brown as more greenish.

On the b* axes, warm colours (yellow, orange, green, red) shifted towards more yellow tones, while cool colours (violet, blue, brown) shifted towards more blue tones. Observers generally selected more saturated colours, with two notable exceptions:

- blue was significantly oversaturated (ΔC* = 13.60),
- brown was recalled as less saturated (ΔC* = –10.97).

3.2. Recall of colours with verbal association

In the second part, colour samples were presented with a verbal association to specific food items, introducing a semantic context. Observers again selected the most appropriate colour from nine samples.

The results are presented in Table 2. Overall accuracy improved, with an average colour difference of ΔE* = 4.21, indicating a moderate but reduced deviation compared with the first part. This suggests that verbal association enhances colour recall, although the improvement was smaller than expected, likely because colour perception from flat patches lacks the visual richness of real objects.

Yellow remained the most accurately recalled colour (ΔE* = 2.38). In contrast, blue showed the weakest performance (ΔE* = 5.82). Several observers explicitly reported that none of the samples matched their perception of blueberry colour, highlighting the importance of surface texture and material appearance, which cannot be conveyed by simple colour patches.

Table 2

Recall of colours with verbal association: colour differences (ΔL*, Δa*, Δb*, ΔC*, ΔE*)

Colour	ΔL*	Δa*	Δb*	ΔC*	ΔE*
Yellow	–1.88	–0.09	–1.88	4.40	2.38
Orange	1.76	–1.41	2.41	1.68	4.22
Violet	1.00	2.09	–0.29	1.99	4.26
Green	–1.91	3.38	–3.06	–4.28	4.47
Blue	–1.62	1.03	0.53	–0.21	5.82
Brown	1.79	–1.15	3.29	2.92	4.49
Red	1.47	1.00	1.79	2.07	3.83

Deviations in lightness (L*) were minimal (within ±1 unit), indicating relatively stable brightness perception. However, systematic shifts were still observed:

- Orange, violet, brown and red were recalled as lighter,
- yellow, green and blue as darker.

Hue shifts (Δa*, Δb*) revealed consistent perceptual tendencies:

- Violet, green, blue and red shifted towards more reddish tones,
- yellow, orange and brown towards more greenish tones.
- Along the b* axis, orange, violet, brown and red shifted towards more yellowish tones, while yellow and green shifted towards less yellow (more bluish) tones.

In terms of chroma, most colours were recalled as more saturated, with:

- Yellow showing the highest increase in saturation (ΔC* = 4.40),
- green and blue being recalled as less saturated (ΔC* = –4.28) for green.

3.3. Recall of colours from food images

In Part 3, observers selected the most appropriate colour of a food item based on colour-modified photographs, introducing the highest level of visual realism.

This condition produced the highest overall accuracy, with an average colour difference of ΔE* = 3.77, (Table 3) confirming that realistic visual context significantly improves colour recall. Nevertheless, the deviation remained higher than expected, likely due to individual colour preferences and personal interpretations of food appearance.

Yellow once again demonstrated the highest recall accuracy (ΔE* = 2.17), reinforcing its perceptual stability. In contrast, green showed the poorest performance (ΔE* = 7.33), contrary to expectations.

Table 3

Recall of colour from food images – colour differences (ΔL*, Δa*, Δb*, ΔC*, ΔE*)

Colour	ΔL*	Δa*	Δb*	ΔC*	ΔE*
Yellow	–1.82	1.03	–3.09	4.08	2.17
Orange	–2.5	0.74	–3.47	–2.63	4.04
Violet	–2.29	–2.41	1.06	–2.58	3.51
Green	–6.24	10.06	–8.29	–12.13	7.33
Blue	–1.35	–0.26	2.76	–2.50	3.28
Brown	–0.62	–0.65	–1.38	–1.43	3.45
Red	1.71	1.32	3.00	3.04	2.60

Clear and consistent biases were observed across all colour attributes. Lightness (L*) showed the largest deviation for green (ΔL* = –6.24), which was consistently recalled as significantly darker. This result is notable, as such ambiguity would be more typical in abstract conditions, suggesting that even realistic images do not fully resolve interpretative uncertainty (e.g., lime peel vs. interior). Most other colours were also recalled as darker, with the exception of red, which was perceived as lighter. The smallest deviation was observed for brown (ΔL* = –0.62). Hue (a*, b*) shifts confirmed systematic biases:

- Yellow, orange, green and red shifted towards more reddish (less green) tones.
- Violet, blue and brown shifted towards more greenish tones.

- Along the b* axis, violet, blue and red appeared more yellowish (less blue), while yellow, orange, green and brown shifted towards more bluish tones (less yellowish).

Chroma (C*) revealed a different trend compared with parts 1 and 2:

- Most colours were recalled as less saturated,
- green showed the strongest desaturation (ΔC* = –12.13),
- while yellow (ΔC* = 4.08) and red were remebered as more saturated again.

3.4. Best and Worst Recalled Colours

Across all three experimental conditions, yellow was consistently the most accurately recalled colour, supporting the hypothesis that certain colours are inherently easier to remember. Colour differences remained low throughout the experiment (ΔE* = 2.17–2.38), indicating highly stable colour memory. Although yellow was generally recalled with increased saturation (ΔC* = 4.08–4.40), deviations in hue and lightness remained small, suggesting a robust and consistent memory representation.

The least accurately recalled colours varied between experimental conditions. In Parts 1 and 2, blue showed the largest deviations (ΔE* = 8.59 and 5.82, respectively), primarily due to errors in hue and saturation. Observers tended to recall blue as more saturated and shifted in hue relative to the reference colour. This finding may be related to the complex visual appearance of blueberries, where texture and surface characteristics substantially contribute to colour perception.

In Part 3, when realistic food photographs were presented, green was the least accurately recalled colour (ΔE* = 7.33). The largest contribution to the overall colour difference came from a substantial reduction in saturation (ΔC* = –12.13), accompanied by lower lightness (ΔL* = –6.24) and noticeable hue shifts (ΔH* = 4.77). Observers therefore remembered the green food image as both darker and less saturated than the reference.

4. Conclusions

This study investigated how colour memory influences the recall of food colours under different presentation conditions. The results showed that both the presentation format and the type of instruction significantly affect colour recall accuracy.

Observers achieved more accurate colour recall when given directed instructions. Colour memory therefore benefits from semantic context, enabling observers to associate colours with specific food items rather than relying solely on abstract colour categories.

The most accurate recall occurred when colours were presented within realistic food photographs. Compared with abstract colour samples, photographic representations provided additional visual cues that enhanced memory retrieval and reduced overall colour differences.

The findings also show that some food colours are recalled more accurately than others. Yellow was consistently the best-recognised colour across all three experimental conditions, exhibiting the smallest colour differences and the most stable memory representation. In contrast, blue and green showed the largest deviations, indicating that these colours are more susceptible to memory distortions, particularly in hue and saturation.

Although realistic imagery improved performance, colour recall was not perfectly accurate. Observers tended to remember food colours as darker and less saturated than the reference values, while systematic shifts in hue remained evident. These biases suggest that colour memory is influenced not only by visual information but also by personal experience, colour preferences and learned associations with familiar foods.

Overall, the results demonstrate that food colour memory is highly context-dependent rather than purely perceptual. Providing meaningful visual and semantic cues significantly improves recall accuracy, while the stability of yellow compared with blue and green highlights the unequal memorability of different food colours. These findings contribute to a better understanding of memory colours and may support the evaluation and optimisation of colour reproduction in food packaging, advertising and quality control.

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