Marta Stjepić, Sabina Bračko
University of Ljubljana, Faculty of Natural Sciences and Engineering, Aškerčeva 12, 1000 Ljubljana, Slovenia

Colour Memory Analysis for Selected Associative Colours
Analiza barvnega spomina za izbrane asociativne barve

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Corresponding author/*Korespondenčna avtorica:*
Assoc Prof dr. Sabina Bračko
Phone: +386 1 20 03 238
E-mail: sabina.bracko@ntf.uni-lj.si
ORCID ID: 0000-0002-3140-7263

Abstract
Colours are one of the most important factors in everyday life. The exact number of existing colours is not yet fully known. Nevertheless, people are known for having poor colour memory. The ability to remember colours depends both on the characteristics of an individual and the situation in which the colour needs to be recalled. The field of colour memory (perception and memory of unusual colours) has been very poorly researched. The aim of this study was to analyse long-term colour memory for selected associative colours, comparing it with short-term colour memory. The research approach was based on observation, with observers observing for a period of time a particular colour, image, or a descriptively given reference colour. Colour was treated separately from associations in the first part, and related to associations in the second and third parts. The first part contained all the reference colours shown independently of associations, the second part contained grayscale images of brands, and the third part comprised descriptively given colours. The result analysis showed that people remember colours very poorly. Observers generally performed better in testing short-term memory. Moreover, the way the template was presented had a noticeable effect on the long-term colour memory. When the image was given in grey, the results were better. The descriptive rendering of reference colours shown did not contribute to better results. The gender of observers did not significantly affect the results.
Keywords: associative colours, colour memory, colour perception, colour difference

Izvleček
Barve predstavljajo enega izmed najpomembnejših dejavnikov v vsakdanjem življenju. Točno število obstoječih barv še ni povsem znano. Znano pa je, da imajo ljudje slab barvni spomin. Sposobnost pomnjenja barv je odvisna tako od značilnosti posameznika kot tudi od situacije, v kateri nastopi potreba po priklicu barve. Področje barvnega spomina, zaznavanje in pomnjenje nevsakdanjih barv je zelo slabo raziskano. Namen dela je bila analiza dolgotrajnega barvnega spomina za izbrane asociativne barve in primerjava s kratkotrajnim barvnim spominom. Raziskovalni pristop je temeljil na opazovanju vzorčnih predlog. Opazovalci so določen čas opazovali izbrano barvo, podobo ali opisno podano referenčno barvo. Barva je bila v prvem delu obravnavana ločeno od asociacij, v drugem in tretjem delu pa se je navezovala na asociacije. Prvi del je vseboval vse referenčne barve, prikazane neodvisno od asociacij, drugi sivinske podobe blagovnih znamk, tretji pa opisno podane barve. Rezultati so pokazali, da si ljudje zelo slabo zapomnijo barve. Opazovalci so se v splošnem bolje odrezali pri testiranju kratkoročnega spomina. Način podajanja predloge je opazno vplival na dolgoročni spomin in barvne razlike. Ko je bila predloga podana kot sivinska podoba, so bile razlike manjše, opisno podajanje referenčnih barv pa ni pripomoglo k boljšim rezultatom. Spol opazovalcev ni opazno vplival na rezultate.
Ključne besede: asociativne barve, barvni spomin, zaznavanje barv, barvna razlika

1 Introduction

Human senses form the foundation of a person and their existence. Our smell, taste, touch, hearing and sight play a key role in our understanding of the world. We use our senses to receive information from the environment. In this way, we also obtain information about various brands and companies. In consequence, the so-called "Sensory marketing", i.e. effect on customer well-being, perception and behaviour, was invented. The aspect of vision proved to be the most decisive in this field. People start explaining visual impressions of surroundings at a very early age. Most consumers thus have complete confidence in their vision. It allows them to do almost everything, from performing everyday tasks to distinguishing between different packaging and brands in the store. Visual information is extremely influential and the most important visual element turned out to be colour. Colours carry meaning and communicate information. Scientists have found that colour arrangements affect attitude as well as feelings and mood [1]. Our age and gender significantly influence which colour patterns we prefer. Fakin et al. found that in general the most popular colours are blue and green, with blue prevailing among male observers. Brown and pink turned out to be the least popular colours. The results varied throughout different age periods. One of the more noticeable changes was the popularity of black, which has grown in recent years in the younger population and has become less popular in elder age groups [2].
People update and build their archives of colour impressions on a daily basis, facing new experiences. They can name these impressions; however, they cannot avoid making mistakes when trying to recall them from their long-term memory. A comparison of a colour in the current situation with the one from the past happens completely automatically, naturally, yet the choice and the results vary depending on the circumstances and colour shades [3]. The ways of testing colour memory are very different. Perez-Carpinell stated [4] that colour memory is successive colour matching after a certain time has elapsed from the observation. Comparing the colour from our long-term memory with the present is much more important as it may seem at first glance. People choose fresh fruits and vegetables based on their previous experience, which means freshness, ripeness. They usually select and buy clothes according to their colour preferences and they pick the colour that matches the rest of their outfit [5].
A simultaneous comparison of samples with the reference colour is usually very accurate. The results of the research confirmed as many as 96% correct results. In the case of the remaining 4%, the colour difference was minimal [6]. A successive comparison occurs when some time elapses between the observation of a given reference colour and the sample. In this case, the colour memory is used, which is more common in everyday life [4]. Research has also confirmed that the more we increase the pause time, the greater the colour differences; however, only to a certain extent. If increased over 15 min, no major differences are observed [7–10].
Bodrogi and Tarczali [11] studied how colour memory is affected by the surroundings of a colour pattern, when it is observed within a certain image or context. Prototype paints or associative colours, e.g. the colour of the sky, plants, and skin, were observed as a simple colour pattern shown in a photorealistic image. The results showed that the association could be influenced by the added image despite the longer time period having passed since remembering the colour stored in long-term memory.
The aim of our study was hence to examine how the method of recall from memory affects our long-term memory. To examine this, we used in addition to independent colour patterns two options, i.e. grayscale images of brands and a description of associative colours. A comparison of short-term and long-term memory was performed on the basis of calculated colour differences.

2 Experimental

The experimental part was based on an observation experiment, which was divided into three parts. In the first part, observers were exposed to a single colour for 5 s, then after a 10 s pause, they used a circular template to select the colour they thought was the reference. The set of colours used in the first part was then repeated in the second and third part. The first part thus contained 16 colours, and the second and third contained 8 colours each. The second part contained grey images of certain brands, and the third part included descriptions of associative well-known colours. In addition to short-term memory, we also tested long-term memory. In the first part of the study, colours were considered independently of associations, and in the second and third part, they were considered in conjunction with corresponding associations.

2.1 Preparation of reference colours and patterns

Reference colours were divided into two groups, each containing 8 colours. The first group (cf. Table 1) contained associative colours that are tied to everyday experiences, i.e. cinnamon brown, grass green, sky blue, cyan, lemon yellow, colour of an orange, purple red and magenta. The second group (cf. Table 2) consisted of associative colours related to brands and companies, i.e. Starbucks green, blue colour of the European Union, Facebook blue, Milka purple, yellow colour of the Post office Slovenia, Mueller orange, red colour from the University of Ljubljana and red-pink colour of the Mercator store.

We checked the representative colours of companies online and in collections. Those related to descriptive naming were selected according to the colour values that were reported most often. Colour values were presented in the *CIELAB* colour space using $L^*a^*b^*$ coordinates [12].

All reference colours and associated patterns were prepared with Photoshop. The entire template was made in InDesign to ease the reading of the results. The method of selection and the conditions taken into account are described below.

Selection of samples according to each reference colour

For each reference colour, we prepared 8 different visually similar colour samples, which were selected according to three basic colour properties, i.e. hue, lightness and saturation (cf. Figure 1). Samples were

Table 1: Reference colours with CIE $L^*a^*b^*$ coordinates; Group 1: colours of well-known objects

Reference colour	Sample	L^*	a^*	b^*
1-I		56	38	56
1-II		48	–23	25
1-III		79	–18	–22
1-IV		91	–51	–15
1-V		95	–10	76
1-VI		68	45	74
1-VII		56	76	69
1-VIII		60	93	–61

Table 2: Reference colours with CIE $L^*a^*b^*$ coordinates; Group 2: colours of brands and logos

Reference colour	Sample	L^*	a^*	b^*
2-I		37	–36	19
2-II		15	46	–77
2-III		38	4	–39
2-IV		39	25	–43
2-V		84	9	83
2-VI		61	52	62
2-VII		48	66	53
2-VIII		48	72	26

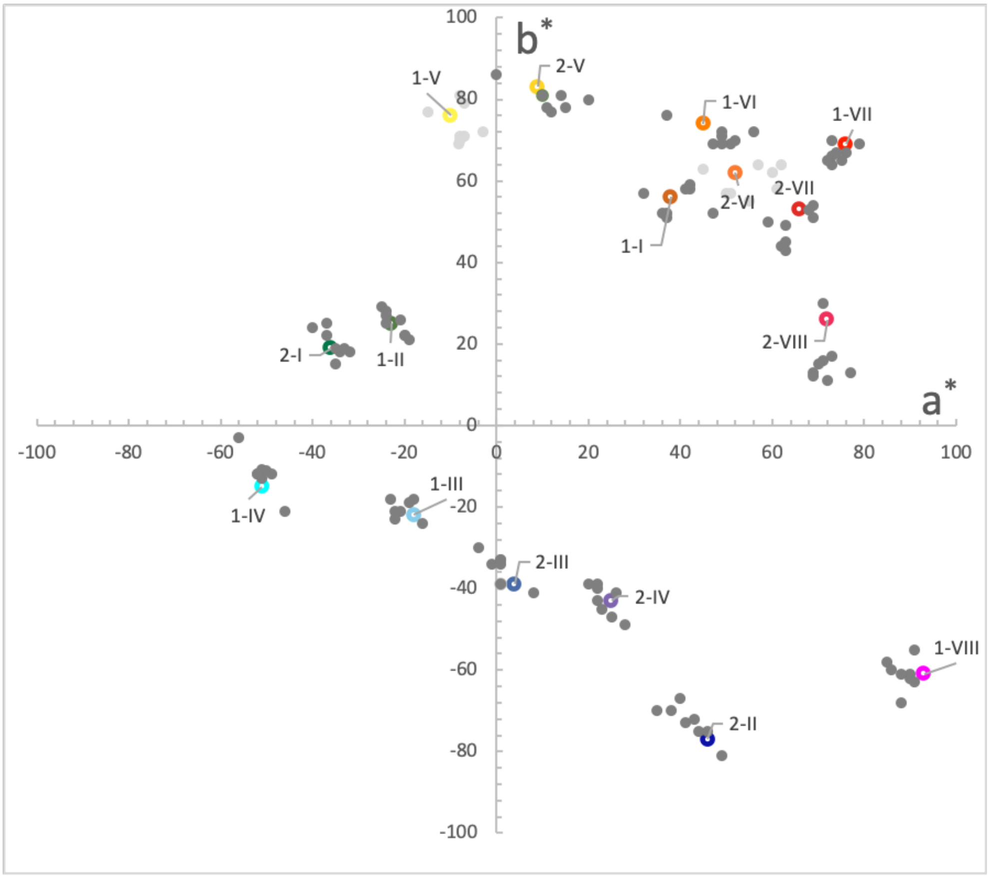


*Figure 1: Reference colours with appropriate samples in a*b* plane of CIELAB colour space*

obtained by changing the *CIELAB* hue difference, ΔH^*_{ab}, by 2 units, *CIELAB* lightness difference, ΔL^*, by 3 units, and saturation, i.e. *CIELAB* chroma difference, ΔC^*_{ab}, by 3 units. An exception was the blue colour of the European Union, where the samples did not differ enough from each other for the observer to be able to distinguish among them; therefore, we changed them by 5 units (–5, –10 and –15).

2.2 Test preparation

Test group

The test group consisted of 12 observers, 8 female and 4 male. The age range was 15–30 years, since people are most sensitive to perception in this period [11, 13]. The oldest observer was 24 years old and the youngest was 16 years old, for at younger observers deviations could occur [8]. In accordance with recommendations [9], all participants previously performed the Farnsworth-Munsell hue colour vision test to demonstrate their ability to distinguish colours and assure their normal colour vision. Observers had different educations in different fields of study. Some also had poorer eyesight and used glasses; however, this did not affect the test results.

Observation conditions

The conditions of observation were the same for all observers, ensuring comparable results and excluding the influence of possible external factors. A 25-inch Dell U2518D monitor with the resolution of 1920 × 1080 and brightness of 350 cd/m^2 was used. Brightness was set to maximum value. The testing was performed in a dark room, the only light source being the screen.

The observer was positioned 50 cm away from the screen, sitting at a 90° angle to the screen. Before each test, we checked the screen brightness and the display resolution of the screen image.

Presentation of colour templates

For each reference colour, four different templates were prepared (cf. Figure 2). The first colour template contained only the reference colour shown in the shape of a square measuring 6 × 6 cm. The other two templates contained a reference colour and 8 associated samples. The templates differed from each other

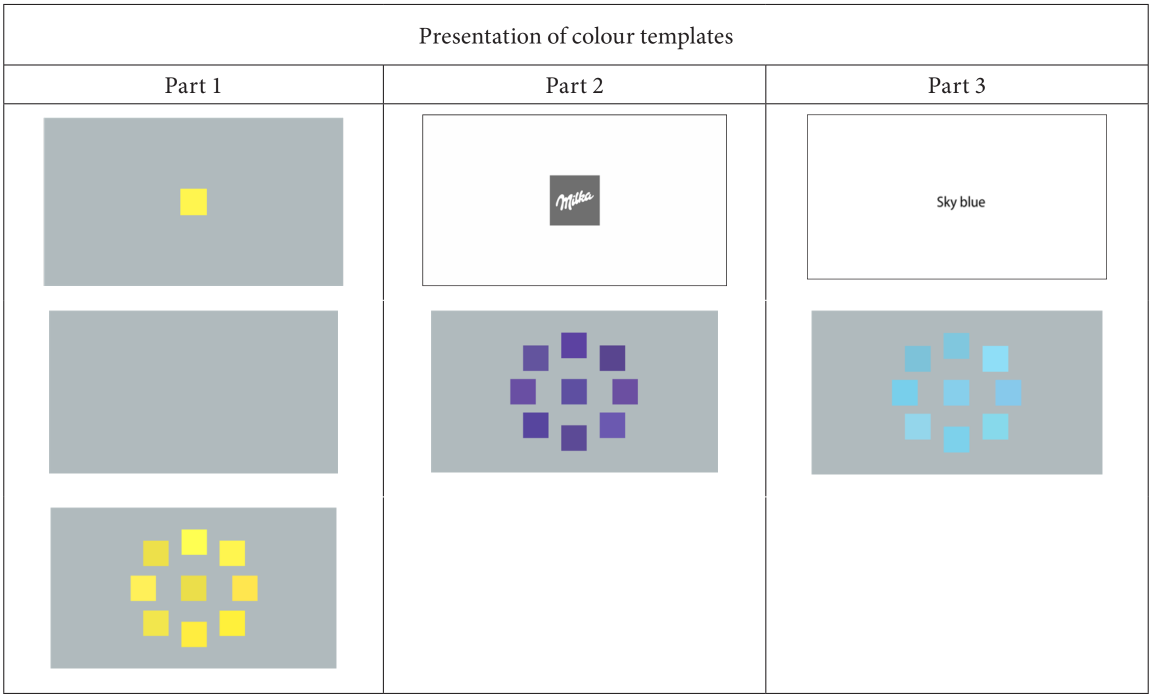


Figure 2: Presentation of colour templates when testing colour memory

in the arrangement of colour patterns. Each sample was shown in the form of a 6 × 6 cm square as well. The squares were arranged in a circle in the middle of the template. To ease the observing and reduce eye fatigue, the background colour was neutral grey ($L^* = 75$, $a^* = -3$, $b^* = -2$). The third template depended on the group the colour was from. In Group 1, i.e. tied to colour names, the template only contained a description of the colour on white background. The typography used was an 87-point Myriad Pro. In Group 2, i.e. colour tied to the brand, the image of the brand was shown in a 6 × 6 cm square in grey tones on white background. A neutral grey background was displayed for 10 s between each reference colour template and the sample template (cf. Figure 2).

2.3 Performance of testing

We first explained the course of the research in detail to each observer to have time to adjust to a dark space. The first part of the study contained all 16 reference colours from both the first and the second group, the observers not being aware of this. A template with a reference colour was displayed for 5 s, which was followed by a 10-second pause with a neutral grey background to calm the eyes and prevent the glow of colours. Studies [14] have confirmed that memorising is best in the first 5 s, prolonging the time not having any major effect on the results. The observer then selected a sample for which they considered it is the same as the reference. The time for sample selection was not limited, since this has not been shown as necessary in previous studies [14, 15]. A new template with a reference colour followed. In the second part, the observer observed grey images of well-known companies and brands. The attachment was displayed for 5 s, then they chose the colour sample for which they thought it belonged to the company. At this stage, we checked long-term memory bound to associative colours.

In the third part of the research, associative colours were given descriptively. The same as in the previous parts, the template was shown for 5 s. Based on the experience, the observer selected a colour sample that they associated with the description.

2.4 Evaluation of colour differences

The reference colours and the selected colour samples were defined by the coordinates of the *CIELAB* colour space and the colour differences, ΔE^*_{ab}, were calculated using the basic *CIELAB* equation [12]. Moreover, the contributions of *CIELAB* lightness difference, ΔL^*, saturation, i.e. *CIELAB* chroma difference, ΔC^*_{ab}, and *CIELAB* hue difference, ΔH^*_{ab}, were calculated, describing the differences between the observed reference colour and memorised colour represented by the selected sample [16].

3 Results with discussion

3.1 Overview of colour differences

In the first part of the study, where short-term colour memory was tested, male observers (ΔE^*_{ab} = 5.09) performed slightly better than female (ΔE^*_{ab} = 5.26). *CIELAB* lightness differences were minimal (ΔL^* = 0.04), similarly observed in previous studies [17]. The differences in saturation were also small (ΔC^*_{ab} = 0.29). According to the results of our study, hue was remembered the least accurately (ΔH^*_{ab} = 4.95), which contradicts with the findings of some other studies [6]. In this case, male observers performed better (ΔH^*_{ab} = 4.69) than female (ΔH^*_{ab} = 5.21) (cf. Table 3).

In the second part of the study, which was based on brand recognition, female observers (ΔE^*_{ab} = 4.99) performed better than male (ΔE^*_{ab} = 5.21), which might be due to women being more often in contact with brands and companies. Again, the *CIELAB* lightness differences were very small (ΔL^*= 0.07), the average difference in saturation being slightly larger (ΔC^*_{ab} = 1.40). The largest difference was observed as *CIELAB* hue difference (ΔH^*_{ab} = 5.00), where larger deviations were detected by male observers (ΔH^*_{ab} = 5.21) compared to females (ΔH^*_{ab} = 4.79).

In the last part, related to the conceptual representation of associative colours, the average colour difference was the highest (ΔE^*_{ab} = 5.33), which can be attributed to poor colour memory, especially unreliable long-term memory. The *CIELAB* lightness difference for selected samples was approximately one unit (ΔL^*= 1.09) and no major deviations in saturation were observed (ΔC^*_{ab} = 0.86). The largest contribution to the *CIELAB* colour difference was detected as the *CIELAB* hue difference (ΔH^*_{ab} = 5.13). The latter is unusual and in contradiction to some previous research [6], as it would be expected that this property is remembered most accurately as basic colour information. *CIELAB* lightness differences are expected to be small, although most studies show that observers remember light reference patterns as even lighter and dark as darker [7, 13] (cf. Table 3).

3.2 Comparison of long-term and short-term memory

Reference colours Group 1: well-known objects

The first group contained associative reference colours that relate to familiar concepts and objects. The results (cf. Figure 3) showed that the average colour difference for Group 1 of the reference colours was greater in Part 3 of the study (ΔE^*_{ab} = 5.27) than in Part 1 (ΔE^*_{ab} = 4.40). The first part was based on short-term memory and the third part on long-term memory. Observers had to recall only what they thought was most appropriate colour and then select a sample. Given that all observers successfully passed the colour vision test, the reason for errors was primarily their poor long-term memory for colours. The total value of the colour difference was mostly due to the *CIELAB* hue difference, which was also larger in Part 3 (ΔH^*_{ab} = 4.16) than in Part 1 (ΔH^*_{ab} = 3.70). There were no major lightness differences (Part 1: ΔL^*= 1.04 and Part 3: ΔL^*= 1.11) nor chroma differences (Part 1: ΔC^*_{ab} = 1.83 and Part 3: ΔC^*_{ab} = 1.47). On average, observers chose darker and less saturated samples. In general, we can say that the differences are greater when dealing with long-term colour memory. For most reference colours, a larger colour difference was found in Part 3 and a smaller one in Part 1.

The results showed that the best recognised reference colour was in Part 1 of the study colour 1-IV (cyan) with the smallest overall colour difference (ΔE^*_{ab} = 1.89). The reason can be attributed to the uniqueness and unnaturalness of the colour. A much larger colour difference was observed in Part 3 of the study (ΔE^*_{ab} = 6.43), when observers had to recall the

Table 3: Average colour differences in Part 1 (short-term memory), Part 2 (long-term memory using grayscale image) and Part 3 (long-term memory using description of colour)

Part	Part 1			Part 2			Part 3		
Gender	Female	Male	All	Female	Male	All	Female	Male	All
$\lvert\Delta H^*_{ab}\rvert$	5.21	4.69	4.95	4.79	5.21	5.00	5.05	5.21	5.13
$\lvert\Delta C^*_{ab}\rvert$	0.62	1.96	0.29	1.33	1.48	1.40	0.86	0.85	0.86
$\lvert\Delta L^*\rvert$	0.34	0.27	0.04	0.43	0.28	0.07	0.72	1.47	1.09
$\lvert\Delta E^*_{ab}\rvert$	5.26	5.09	5.18	4.99	5.42	5.21	5.17	5.48	5.33

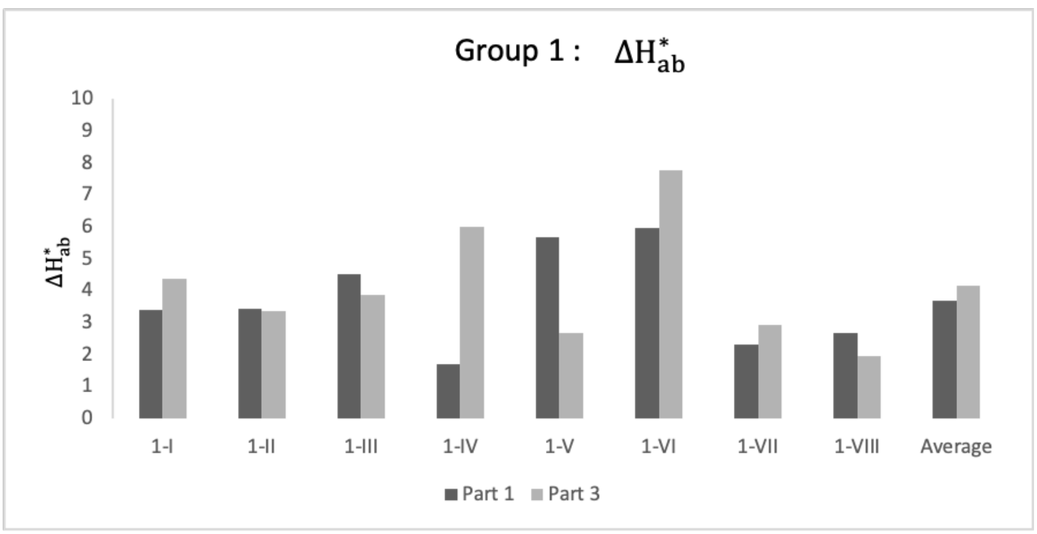
same colour from memory and select the correct pattern. Let us mention that most of the observers were full-time students in the field of graphic arts, this colour hence being well known to them. Similarly, it is worth mentioning the reference colour 1-VIII (magenta), which was also well recognised by the observers, especially in Part 3 of the study ($\Delta E^*_{ab} = 2.61$). The worst recognised reference colours were 1-V (lemon yellow) and 1-VI (orange fruit). In both cases, the average colour differences were high, which can be attributed to the fact that both yellow and orange have a smaller number of light levels and the differences increase rapidly. We attribute the large discrepancies to our perceptions of the colour of an orange and our experience of it. A similar study was performed using a monochromatic light source that also displayed a lemon yellow colour. Otherwise, this colour is supposed to have the highest accuracy, with the wavelength peak at 570 nm (in addition to blue with the peak at 494 nm). The observers recognised it best and the results had the smallest deviations from the reference colour in a given case. Improvement followed by using the association with a lemon [14].

The biggest contribution to the total *CIELAB* colour difference was due to the *CIELAB* hue difference which in some cases almost equalled the total colour difference. All reference colours that achieved a larger total *CIELAB* colour difference in Part 3 than in Part 1 of the study also exhibited a larger *CIELAB* hue difference in Part 3 than in Part 1: 1-I (cinnamon brown), 1-II (grass green), 1-IV (cyan), 1-VI (orange fruit) and 1-VII (purple-red). Due to the predominant influence of the *CIELAB* hue difference on the total colour difference, the reverse also applies to all other reference colours.

The deviations in *CIELAB* lightness were relatively small, with the exception of the reference colours 1-I (cinnamon brown, Part 3: $\Delta L^* = -2.42$), 1-III (sky blue, Part 1: $\Delta L^* = 2.83$ and Part 3: $\Delta L^* = 2.42$), 1-VI (orange fruit, Part 1: $\Delta L^* = -3.58$) and the reference colour 1-VII (purple red, Part 3: $\Delta L^* = -4.67$). Even when there was a larger deviation, observers chose darker samples than the reference. An exception was found only for the reference colour 1-III (sky blue), for which lighter samples were chosen.

We also detected similarly small differences in saturation when recalling colours from memory. Observers selected less saturated samples in most cases. Major deviations were only in the case of the reference colours 1-I (cinnamon brown, Part 3: $\Delta C^*_{ab} = 3.79$), 1-VII (purple red, Part 1: $\Delta C^*_{ab} = -2.84$ and Part 3: $\Delta C^*_{ab} = -3.98$) and the reference colour 1-VIII (magenta, Part 1: $\Delta C^*_{ab} = -2.84$).

The comparison of Parts 1 and 3 of the research agrees with our assumptions that the differences will be greater in Part 3, which is tied to long-term memory, and this is also in agreement with previous investigations [8, 9]. Regardless of the fact that the observers had the reference colours descriptively given, this did not affect their final decision. Each one of us has a different idea of objects; therefore, we choose different colour patterns depending on our memory. The evocation of associations by means of a verbal description of colour did thus not affect the improvement of long-term memory. The only exception may be the reference colour 1-VIII (magenta), which achieved noticeably better results when given descriptively. This colour is well known by its name and the descriptive rendering in this case led to mi-



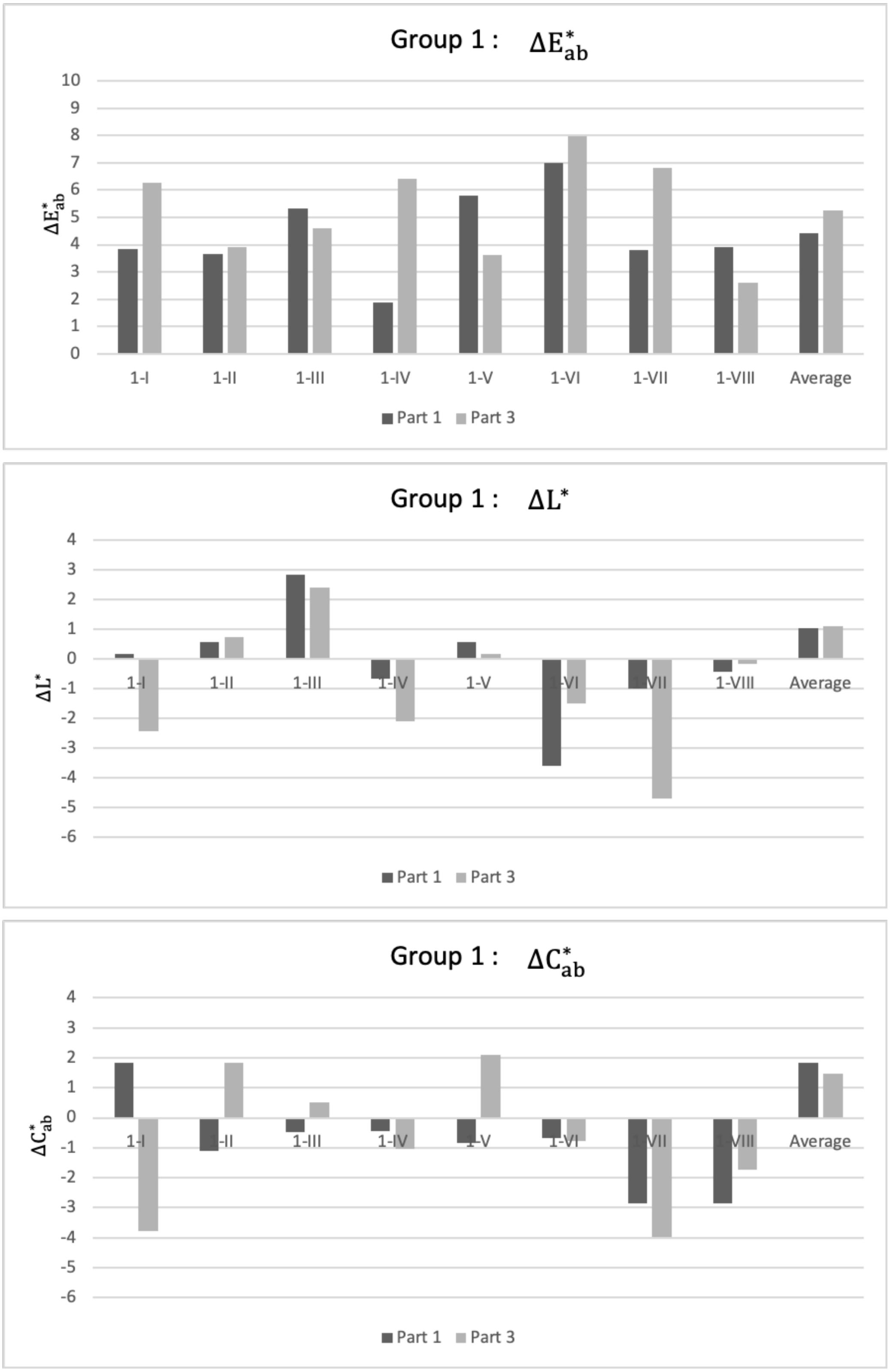


Figure 3: Comparison of Part 1 (short-term memory) and Part 3 (long-term memory using description of colour) for samples 1-I–1-VIII: CIELAB colour difference (ΔE^*_{ab}), CIELAB hue difference (ΔH^*_{ab}), CIELAB chroma difference (C^*_{ab}) and CIELAB lightness difference (ΔL^*)

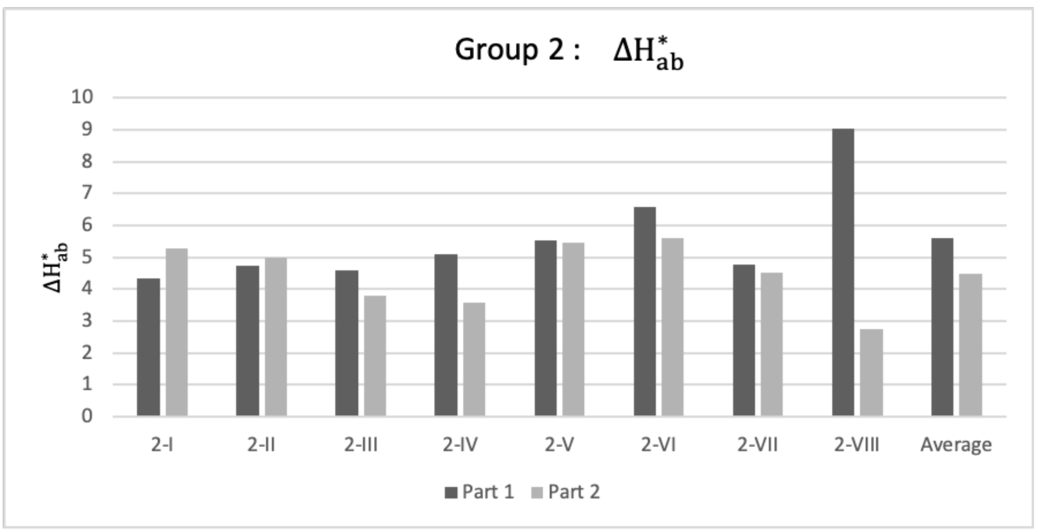
nor colour differences. The explanation for better recognition could also lie within the Weber's law [18], as its initial stimulus intensity is higher due to its chromaticity, grey background and dark room.

Reference colours Group 2: brand colours

The second group contained associative reference colours that relate to companies and brands. The results are shown in Figure 4. The average colour difference in Part 1 of the study was ΔE^*_{ab} = 6.01 and in Part 2 ΔE^*_{ab} = 5.13. Contrary to our expectations, the results were better in Part 2, when observers selected samples based on long-term memory. The reason can be found in the fact that most observers are often in contact with the colours of the brands that were presented as a reference. Whenever there is a connection between a colour and an object or an image from our memory, there are differences in selected patterns and thus in research results. An improvement and a smaller deviation of the overall colour difference was observed compared to the situation where there were no associations [15, 19].

The results for the reference colours 2-III (Facebook blue), 2-IV (Milka purple), 2-VI (Mueller store orange) and 2-VIII (red-pink colour of the Mercator store) were consistent with the findings of a smaller colour difference in Part 2. The reference colour 2-VIII achieved the largest colour difference within Part 1 (ΔE^*_{ab} = 9.42) and the smallest colour difference within Part 2 (ΔE^*_{ab} = 2.75) as it was best recognised. All observers recognised this brand very successfully. The reference colour 2-VI (Mueller store orange) was less recognisable (Part 1: ΔE^*_{ab} = 6.68 and Part 2: ΔE^*_{ab} = 5.62), perhaps due to less frequent encounters with it, or just a human tendency to remember bright colours less well. In the case of the reference colour 2-III (Facebook blue), the differences (Part 1: ΔE^*_{ab} = 5.87 and Part 2: ΔE^*_{ab} = 5.00) occurred most likely due to different screen renderings of the application of the mentioned social network and the previously changed representative colour of the application. The reference colour 2-IV (Milka purple) was very well recognised by most observers (Part 1: ΔE^*_{ab} = 5.35 and Part 2: ΔE^*_{ab} = 3.86). In fact, they had bigger problems in Part 1, when they had to imprint the colour in their memory and recognise it after 10 seconds.

Interestingly, the reference colour 2-VII (red colour of the University of Ljubljana, Part 1: ΔE^*_{ab} = 5.53 and Part 2: ΔE^*_{ab} = 5.69) achieved very similar colour differences in both parts of the research. Due to the fact that all observers are in frequent contact with this colour, such results differ from expectations in the case of long-term memory and can be explained by a variety of representations, as the problems are mainly a consequence of inconsistent rendering and rendering of colours; the overall graphic image of the University of Ljubljana uses a darker colour than the website. The reason for the deviation of the reference colour 2-I (Starbucks green) is probably that its recognition depends on the frequency of encountering the brand. The observers who are not very familiar with it consequently did not recognise it well in Part 2 of the study. The reference colour 2-II (blue colour of the European Union) made greater differences (Part 1: ΔE^*_{ab} = 4.95 and Part 2: ΔE^*_{ab} = 6.19), most likely due to the inconsistency in its representations (flags, screens, application, TV etc.). Each participant has thus a completely different idea of this colour.



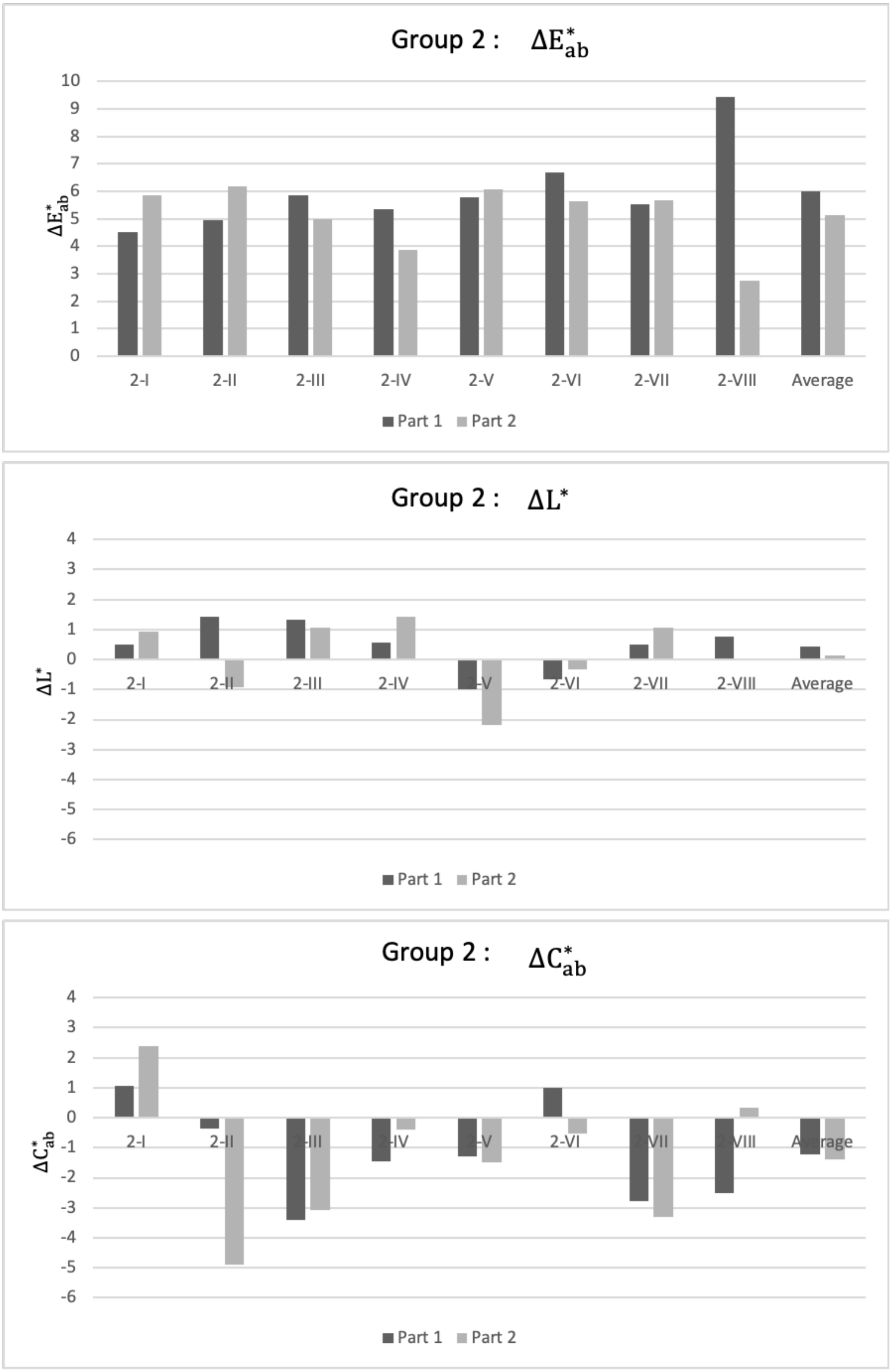


Figure 4: Comparison of Part 1 (short-term memory) and Part 2 (long-term memory using grayscale image) for samples 2-I–2-VIII: CIELAB colour difference (ΔE^*_{ab}), CIELAB hue difference (ΔH^*_{ab}), CIELAB chroma difference (C^*_{ab}) and CIELAB lightness difference (ΔL^*)

The average *CIELAB* lightness differences were very small in both Part 1 and 2 of the study (Part 1: ΔL^* = 0.43 and Part 2: ΔL^* = 0.14). Generally, observers chose lighter samples than the reference colour.
The average *CIELAB* chroma differences were slightly larger (Part 1: ΔC^*_{ab} = –1.21 and Part 2: ΔC^*_{ab} = –1.37). Observers mostly chose less saturated samples.
The colour differences were predominantly displayed as the *CIELAB* hue difference (Part 1: ΔH^*_{ab} = 5.59 and Part 2: ΔH^*_{ab} = 4.49), which again had the greatest impact on the total colour difference. Consistent with the total *CIELAB* colour difference, the *CIELAB* hue difference was greater in Part 1 than in Part 2 for the majority of Group 2 reference colours.
The comparison of Parts 1 and 2 of the research does not match our assumptions that the differences will be greater in Part 2, which depended on long-term memory. The differences were smaller in Part 2, where observers selected samples according to the grey image of the brand. Evidently, the way the suggestions were made was crucial for minor colour differences and had an impact on better long-term memory results. Similar results were found in a research when observers used a black and white photography of a reference coloured object [20]. According to the results, observers performed better in Part 2 of the study when observing grayscale brand suggestions, with some exceptions that were either not well known among observers or differed in the ways in which they were depicted and the applications they encountered: 2-I (Starbucks green), 2-II (blue colour of the European Union), 2-V (yellow colour of the Post office Slovenia) and 2-VII (red colour of the University of Ljubljana). According to the Weber-Fechner law, the perceived magnitude of a stimulus, in this case colour, is proportional to the logarithm of the physical stimulus intensity [21]. Consequently, such results could reflect the inability of the human visual system to distinguish relatively small colour differences in case of highly saturated colours.

4 Conclusion

The result analysis confirmed that people have a deficient memory for colours. Observers performed much worse in the part of the study that was tied to long-term memory. We can therefore confirm that our long-term memory is not as accurate as short-term. Although an unreliable colour memory can lead to unpleasant surprises when selecting a certain hue, e.g. when buying clothes, this can be improved by offering suitable support or association. The results showed that the way colour suggestions are made has a significant impact on colour differences when testing colour memory. When the suggestions were given only with the help of verbal descriptions of reference colours, the results were worse, consequently confirming our hypothesis that deviations are greater with long-term memory. In the case of grayscale brand proposals, however, observers achieved better results. Here, the association with the help of a grayscale template had a strong impact on improving long-term memory. The results showed that our memory for lightness is relatively accurate. In general, the colours in our memory are slightly more saturated than they really are. The largest share of the total colour difference was exhibited as the hue difference, which is in contradiction to some previous research. Female observers remembered the colours slightly better than male, the differences between the two genders not being substantial.

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