The impact of colour on Website appeal and users’ cognitive processes

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\textbf{A B S T R A C T}

One of the challenges today in human–computer interaction is to design systems that are not only usable but also appealing to users. In order to contribute to meet this challenge, our general objective in the present study was to enhance current understanding of the perceptual features that favour users’ interactions with Websites. This is a particularly important issue, as users’ first impressions when they land on a site determine whether or not they stay on it. We conducted two experimental studies, focusing on one specific perceptual feature: Website colour. The first study investigated designers’ and users’ preferred colours for a Web homepage. Although researchers generally flag up differences between designers and users, we found that the latter also had several favourite colours in common. On the basis of these initial results, three colours were selected for a second study exploring colour in relation to an entire Website. The main originality of this second study lies in the fact that we used both subjective and objective measurements to gauge the impact of colour, analyzing not only users’ judgments but also their Website navigation and the items of information they memorized. Results of this second study showed that colours were a determining factor in the way that users interacted with the Website. Their influence was also observed afterwards, when users were asked to exploit the information they had gleaned from the Website. As such, these findings will have a practical value for Website designers.

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1. Introduction

The importance of visual perception in human–computer interaction (HCI) has long been acknowledged (e.g., [1]). In the past, authors generally advocated a user-centred approach, putting forward ergonomic recommendations, or “golden rules” [1,2]. These recommendations tended to focus on users’ cognitive and perceptual-motor abilities, rather than on what they felt when interacting with a system. Now, however, humans and their interactions with systems are increasingly being studied at three different levels: knowing, doing and feeling [3]. In recent years, the “feeling” level has become a popular research topic in cognitive science and the science of design, with advances in our understanding of feelings, affects and emotions [4,5] having implications for the latter [6–8]. When developing products or systems, designers have to come up with design solutions that are both novel and adapted to their future users [9,10]. This adaptation to future users must encompass several complementary aspects. Usability is no longer the ultimate goal for designers. New systems must also have an aesthetic value and inject a little fun and pleasure into people’s lives [7,11]. In addition to their functional characteristics, interactive systems must be regarded as conveying feelings through visual sensory modalities.

In the present study, we sought to enhance current understanding of one perceptual feature, namely colour, in a type of interactive system where aesthetics and attractiveness constitute a particular challenge: the Website. Here, users’ initial feelings are crucial, as it is during the first few seconds of interaction that users or “visitors” decide whether or not to continue navigating the Website [12–14]. Lindgaard et al. [15] showed that users’ first impressions are constructed in about 50 ms and appear to be stable over time. They allow users to develop an aesthetic impression of the Web page, which influences their subsequent navigation. Since visitors’ preferences are based on the Website’s aesthetic features [16,17], our objective was to analyze one particular perceptual feature that contributes considerably to first impressions: Website colour. Colours have the potential to affect our perceptions, emotional reactions and behavioural intentions [18]. However, little research has been done on the impact of colours in Internet-based environments and only a handful of researchers have conducted studies on this topic in recent years e.g., [19,20]. With a view to filling this gap, the aim of our study was twofold:
– identifying colours that Website designers and users find appealing;
– determining whether some colours favour Website visitors’ navigation and cognitive processes.

To this end, we carried out two experimental studies. The first one investigated the preferences expressed by designers and users when they were shown Website homepages in 23 different colours. The second one analyzed how the use of three different colours (selected on the basis of the results from the first study) in Website design influenced interactions between visitors and three different versions of the same Website. We argued that the role of colours is essential not only when accessing a site and navigating it, but also after the actual interaction has come to an end and users exploit the information they have just obtained from the site. Before describing these studies, we present their theoretical framework, in order to underline both the importance of perceptual and aesthetic features (e.g., colours) in terms of the affects or emotions they convey, and their influence on users’ interactions with systems.

2. Emotions, aesthetics and colours

For years, researchers showed little or no interest in the possible links between emotion and cognition, and between usability and users’ emotions and aesthetic feelings. Only recently have they sought to draw these different threads together. We therefore begin by briefly characterizing emotions and their relationship with cognition, as well as their implications for product design (§2.1). We then point out the relationships between aesthetic feelings and users’ judgments (§2.2), as well as between one aesthetic feature in particular (product colour) and users’ preferences (§2.3).

2.1. Emotions, cognition and product design

The numerous papers on the subject of emotions offer divergent points of view about emotional phenomena e.g., [21,5,22]. Scherer [22] suggested distinguishing between various affective states and, in particular, contrasting utilitarian emotions and aesthetic emotions. These two kinds of emotion result from an appraisal of environmental or proprioceptive information, but have different functions. Utilitarian emotions, such as anger and fear, allow us to adapt to events that may have major consequences for us as individuals. These adaptive functions may consist in the preparatory actions (such as confrontation or escape) or the recuperation and reorientation of work. In contrast, aesthetic emotions are unrelated to the need to satisfy vital and mandatory needs. For instance, a person can be impressed, admiring or fascinated. These diffuse sensations differ considerably from utilitarian emotions with regard to felt arousal and behaviour orientation.

Although emotion is not understood as well as cognition, both of them can be regarded as information processing systems [23], but with different functions and operating parameters. Cognition allows us to interpret the world and make sense of it, whereas emotions are more judgmental, assigning positive and negative valences to the environment [6,7,5]. Advances in our understanding of cognition and emotion suggest that each impacts the other. Thus, several studies have shown that emotions and affects have an impact on the cognitive functioning of individuals engaged in complex tasks [24,21,25]. According to Norman [7] and Csikszentmihalyi [26], emotions can even make us smart. For instance, positive affects broaden our thought processes and seem to enhance our creativity in finding design solutions [9]. Unlike negative affects, positive affects make difficult tasks easier to perform and make people more flexible and more tolerant of minor difficulties [6].

These approaches have implications for the design of products and interactive systems. In the field of HCI, a cognitive–affective model of organizational communication has been developed by Te’eni [27]. This author posits the notion that the communication process, which comprises the communication medium (a Website in the case of our study) and the message form (e.g., differences in the colours used for a Website), has an impact on the user and on whether the latter judges the communication to be appropriate. In line with this model, Norman [7] claims that the image which products present to the user, their attractiveness and the user’s behaviour, all need to be considered. As such, the design of products or interactive systems should take three levels of processing into account:

– visceral design, which refers primarily to the initial impact of products and systems due to their appearance;
– behavioural design, which is about the experience of using a product or system (the “look and feel”) and which contributes to its usability;
– reflective design, which is about the user’s subsequent opinion and what the latter has to say about the product or system (e.g., how it makes him or her feel, the image it portrays or the message it conveys).

Put in a slightly different way, we need to think about three dimensions when designing products: (1) their attractiveness (or appeal), which depends on visceral design, (2) their functional and usable properties, which result from behavioural design, and (3) their “prestige”, which is related to reflective design. Nowadays, therefore, the aim of designers is to come up with products or systems that are not only useful and usable, but which are also thought to convey positive emotions and feelings through their aesthetic features.

2.2. Aesthetics and users’ judgments

Many years ago, social scientists demonstrated the importance of aesthetics in everyday life. For instance, a person’s physical appearance influences other aspects of social interaction [28]. Similarly, products’ aesthetic qualities are deemed to play an important role in marketing strategies and the retail environment [29].

Only recently, however, has the relationship between system aesthetics and users’ judgments been analyzed in the area of HCI e.g., [30,31]. In particular, close correlations have been observed between judgments of aesthetic quality and a priori perceptions of usability, that is, perceptions formed before the system is actually used [32,31]. Tractinsky and colleagues [31] claimed that “what is beautiful is usable”. For Hassenzahl [33], it is the “goodness” of a system that is the main issue, not its “beauty”. According to this author, goodness is judged on the basis of a combination of impressions – hedonic identification, pragmatic values (e.g., perceived usability) and mental effort (resulting from actual usability), whereas beauty is determined solely by hedonic feelings. According to Norman [6,7,34], attractive systems work better. They are perceived as functioning better and lead to better user performances.

In the context of Websites, Shenkman and Jönsson [17] examined visitors’ first impressions and found that the best predictor of overall judgments by typical Website users was the impression of beauty. For their part, Lavie and Tractinsky [35] analyzed users’ perception of Website aesthetics. They identified two main dimensions: “classical aesthetics” and “expressive aesthetics”. The classical aesthetics dimension emphasizes orderly and clear design, and is closely related to certain of the design rules advocated by
usability experts. The expressive aesthetics dimension corresponds to designers’ creativeness and originality, and to their ability to break design conventions.

To supplement these results, Su-e et al. [36] analyzed the “high-level” design elements used by professional designers to convey different feelings to visitors and flagged up the importance of colours, shapes and images. In a recent study, Cyr [19] found that good visual design of a Website, which includes colours, resulted in trust, loyalty and satisfaction.

In line with these observations, we argue that controlling the aesthetic aspects of interactive systems, especially their colour, serves other purposes apart from purely subjective ones: these aspects may have an impact on users’ activities and on the types of information they memorize whilst interacting with a system. In the present study, we focused on one of the aesthetic aspects highlighted in the research by Su-e et al. [36] and Cyr [19]: the colour of products or interactive systems, such as Websites.

2.3. Colours and users’ reactions

Although research on the psychology of colour is still in its infancy, several studies have pointed to a relationship between colours and emotions [37–41,18]. Especially, the choice of colours can impact user feelings and reactions. Research conducted by Walters, Apter, and Svebak [42] suggested that there are two levels of felt and preferred arousal: high and low. More specifically, some colours serve to arouse and excite an individual, while other colours elicit relaxation. Despite the fact that there is no precise theoretical rationale for explaining exactly how a colour might affect feelings, evidence exists to indicate that colours do indeed influence individuals' feelings, attention, judgments and decisions - such as shopping intentions or perceived usability [43–47]. For instance, Soldat et al. [40] showed that the colour of answer sheets given to university students sitting an exam affected the quality of their productions: students who were provided with blue sheets of paper scored higher marks than those who were provided with red ones.

Cooler colours, such as blue, are generally viewed more favourably than warmer colours, such as red or yellow [48–50]. Several findings support the premise that blue elicits relaxed feeling states [51–53,18]. In contrast, yellow has been found to give rise to less relaxed feeling states [54]. In accordance with these findings, Jacobs and Hustmyer [53] used measures of galvanic skin responses to show that blue is a more relaxing colour than red or yellow. Similarly, using rating-scale measures of feelings, Gorn et al. [55] showed that red elicits more excitement, and blue more relaxation. Colour has also been described as having an influence on behavioural intention, with blue producing stronger buying intentions than red [44].

In certain guidelines (or “design basics”) for designing user interfaces, a few recommendations are related to appropriate colour combinations, or “colour harmonies” [56,57]. However, such recommendations are usually restricted to readability issues or to specific aspects of the interfaces, such as text background [58,59]. In visual terms, harmony corresponds to a pleasing arrangement of parts; to something that is pleasing to the eye. In the context of Websites, users feel a sense of equilibrium when balance is achieved within each page [56], and users’ preferences seem to be based on a combination of Web page balance and colour [60]. Bynum et al. [61] recently asked American students to look at a computer screen on which successive colours were displayed and to express their feelings about these colours. Red was associated with nervousness and yellow with satisfaction. Gorn et al. [51] also investigated the effect of background screen colour, while a Web page was being downloaded, on the perceived rapidity of the download. These authors found that colours which induced more relaxed feeling states led to faster perceived speed. Moreover, they observed that colour had consequences on users' judgments of the Website and on the likelihood of their recommending it to others. More recently, Cyr et al. [50] analyzed relationships between Website colours and users’ culture (Canadian, German or Japanese). These authors identified a colour that was disliked by all participants (yellow), as well as colours that were preferred by certain groups (e.g., blue for Germans and grey for Canadians). These kinds of results have a practical value if Web marketers and interface designers wish to use colour as a catalyst in Website development: if the colour of a Website arouses a user’s satisfaction, that user can be expected to return to the Website.

In line with these views, we argue that colours constitute a crucial feature of Websites, insofar as they not only contribute to the users’ first impressions and feelings about a Website, but also influence users’ navigation behaviour and subsequent performance. We therefore conducted two experimental studies in order to meet the following complementary objectives:

- testing 23 Web homepage colours to find the ones that are judged to be most appealing by Website designers and users;
- analyzing the impact of three separate Website colours (selected on the basis of the findings of the first study) on users’ behaviour, judgments and subsequent performance.

3. Study 1: colour appeal for Website users and designers

3.1. Objectives and hypotheses

We first conducted an exploratory study in the context of Websites in order to determine whether the users and designers of Websites judge the same colours to be appealing or unappealing. Colour appeal is defined as the degree to which colours used in Websites are perceived as pleasing, appealing and appropriate [50].

In our study, participants were provided with the homepage of an informational Website. Instead of forming precise hypotheses about the appeal of specific colours, we chose to develop numerous versions of the same homepage in order to expose participants to 23 different colours across a broad spectrum (see §3.2 “Experimental material”). As the 23 resulting versions of this homepage differed only in respect of colour, there was no confounding influence of Webpage structure or balance.

In addition, we wished to determine whether the status of participants had an impact on the colours they judged to be appealing. We therefore distinguished between two kinds of participants: Website users and designers. According to Norman [1], the designer’s model and the user’s model are broadly dissimilar due to differences in background and experience. These differences help to explain the difficulties encountered by users when they try to use a newly designed system. However, in the case of judgments about colours, it is surely possible to argue that preferences mainly depend on the feelings that colours convey, and these may be similar regardless of the participants’ status. However, although we expected some of the preferences expressed by Website designers and users to be consensual, the former might also regard colours conveying an “ambiance” of novelty as appealing, as designers try to come up with products that are creative and therefore different from existing ones [9,62]. In contrast, users would favour external consistency and would thus prefer colours that matched the ones they were used to seeing in the Websites they visited. Therefore, it should be possible to identify colours that were preferred by both designers and users, as well as colours that were preferred solely by designers or by users.

3.2. Experimental material

In order to identify participants’ preferences across a broad spectrum of colours, 23 versions of the same Web homepage were
developed by using Photoshop software (see examples in Fig. 1). This homepage was the first page of an informational site called “Psych-Aix”, which is intended to provide information about university courses and leisure activities to prospective students applying to a French university (cf. study 2 for details).

When designing the different versions of the homepage, we took into account the fact that colours can be defined with regard to three dimensions: hue, value and chroma (see Fig. 2). As our study was about colour preferences, value and chroma were controlled, and only hue differed from one homepage to another.

To select the colours of our homepages, we created pages with a constant physical difference in hue of 20°. This allowed us to define 18 values for hue (i.e., 18 colours), to which we added white, black and three nuances of grey (see Fig. 3). In this way, we were able to create 23 homepages.

Participants accessed these pages by logging onto the experimental site, which provided them with the homepages and allowed them to answer questions (see §3.4 “Procedure”). This experimental site was created with Dreamweaver MX 2004 and developed in html and php.

3.3. Participants

Eighty participants took part in this first study:

– fifty Website “users” or visitors (25 men and 25 women, with a mean age of 32.8 years), from a variety of backgrounds (university students, teachers, professionals carrying out administrative functions, etc.).

– thirty Website designers (20 men and 10 women, with a mean age of 34.5 years). This group was smaller than the user one, due to the lack of availability of professional designers. They, too, came from different backgrounds (e.g., qualifications in computer science, design engineering or applied arts), but all of them had been in a job for between 2 and 35 years in which they were regularly called upon to create Websites.

All these participants were French and none of them was colour-blind.

3.4. Procedure

Participants were given a password to access the experimental site. When they logged onto it, they were all given the same instructions (see Appendix A), and the same 23 homepages were presented in random order.

For each homepage, they had to indicate how much they liked it on a 7-point Likert scale, ranging from “not at all” (point 1) to “a
lot" (point 7), without intermediate labels associated to points going from 2 to 6.

At this point, the process varied slightly, according to the participants’ status. They all had to answer four questions relating to general information: their gender, age, the average time they spent on the Internet each day, and their background. In addition, the Web designers had to answer supplementary questions about the colour they would have chosen for this homepage, the reasons for their choice, the role of colour in Websites and any training they had received about Website colours.

Finally, all the participants read the last page of the Website, which signalled the end of the experimental task. This page provided information about contacting the experimenters and terminated their access to the experimental site, so that they could only perform the experiment once.

4. Results

The data analysis was performed in two stages. The first analysis served to identify and select the colours that both the users and the designers preferred. The second analysis compared the users’ and designers’ preferences.

First, the subgroups of colours were identified and selected on the basis of a hierarchical cluster analysis, using the squared Euclidean distance (Ward’s method). Linkage distance is reported as \( D_{\text{link}}/D_{\text{max}} \), which represents the quotient between the linkage distance for a particular case divided by the maximal linkage distance. The quotient was multiplied by 100 for standardize the age distances for a particular case divided by the maximal linkage distance. The mean scores given to homepage colours by the professional designers were lower than those given by the users for the green (Mann–Whitney test, \( U = 473.5, p < .01 \)), the blue (\( U = 470.5, p < .01 \)), and the magenta (\( U = 343.5, p < .001 \)), and higher for the yellow (\( U = 466.0, p < .01 \)). The difference was not significant for the orange (\( U = 683, p > .10 \)).

The analysis of user data revealed a main effect of colour, Friedman chi2(4) = 50.16, \( p < .001 \). Blue was preferred to all other colours (all \( z < .001 \)). By contrast, grey was significantly less appreciated than all the other colours (all \( z < .01 \), except for green (marginal significance; \( z = .054 \)). Orange appeared to be an intermediate colour, as it was appreciated more than green (\( z < .05 \)) but did not differ significantly from magenta. Lastly, green was not significantly preferred to magenta.
The analysis of Website designer data also revealed a main effect of colour, Friedman chi²(4) = 55.62, p < .001. Grey, blue and orange were preferred to green and magenta (all p < .001). The differences between grey, blue and orange, and between green and magenta were not significant.

In short, the homepages that obtained the highest scores (or the least low scores), whatever the participants’ status, were the ones presented in blue and in orange. Contrary to users, professional designers also gave similar scores to homepages presented in grey.
5. Discussion

First, the professional designers appeared to be more critical of the Webpages than the users. However, blue and orange were regarded as the most appealing colours by all participants, whatever their status. Website designers also liked (or at least did not dislike) grey, unlike the users.

The choice of these three colours can partly be explained by the reported associations between these colours and emotions [43,47,41,18]. The result for blue, in particular, was in accordance with previous research, insofar as blue is frequently regarded as users’ favourite colour, whatever their age and cultural context, e.g., [63–66]. Findings for orange contrasted with previous results suggesting that cooler colours are viewed more favourably than hotter ones. However, the warm effect conveyed by the orange homepage may have explained its high score. Finally, although grey is a neutral colour, it may also be regarded, to some extent, as an innovative feature by Web designers, allowing such Websites to be perceived as trendy. This relatively discreet colour may also have enhanced the way in which the information was set out on the homepage, thereby generating a semantic effect (accessibility of information structure) rather than an aesthetic one.

To take our research one step further, a second, complementary experiment was conducted in order to determine the impact of these three colours (blue, orange and grey) on users’ behaviours and cognitive processes.

6. Study 2: impact of colours on users’ behaviours and cognitive processes

6.1. Hypotheses

Our general hypothesis was that Website users would react differently according to the colour of the site they were exploring. For this experiment, three versions of the same site, corresponding to the different colours for which participants in the previous study had expressed a preference, were shown to new participants. In line with results of the first study, we expected that the three selected colours (blue, orange and grey) would have an impact on the users’ judgements. Moreover, we hypothesized that these Website colours would also exert an influence on users’ behaviours and cognitive processes. More precisely, we expected that these colours would have an impact on both the users’ searches for information and the way they memorized it.

Therefore, the main originality of this experiment lays in the fact that the impact of the colours was analyzed with regard to both objective and subjective measurements. Three types of data were analyzed: (1) data relating to Website navigation for the purpose of gathering specific information, (2) the information that users memorized and retrieved (i.e., in order to inform another person in writing about the content and usefulness of the site), and (3) users’ judgments. We expected that these Website colours would influence all three successive tasks the participants had to perform, namely:

- exploring the Website,
- writing a text in which they had to introduce information they had gleaned from the site and memorized,
- answering a questionnaire about their individual judgments about the site they had just visited.

In order to make the navigation experience more realistic, we developed a large Website comprising 19-pages (including the homepage). The information provided on this site was also chosen with care, in order to meet the surfers’ needs (psychology students enrolled at a university in the South of France). We deliberately varied the display modality, so as to avoid the presentation of this information becoming too monotonous (linear vs. nonlinear). “Linear” is the term that designates a standard format of written text bereft of the typographical features that allow different groups of information to be scanned. We therefore used the term “nonlinear” to describe a format featuring bullet points and indentations. Nielsen [67] used various indicators of efficiency to demonstrate the positive effect on comprehension and memorization of the physical layout of text on a Webpage. The same positive impact has been reported in psycholinguistic studies [68–70]. Accordingly, we decided to test these effects in our study. In the light of previous findings, we defended the hypothesis that a nonlinear layout in a Web page would act as a “good form” and would amplify the colour’s expected effect, unlike a linear layout.

6.2. Experimental material

For experimental purposes, three versions of the same site were developed in order to allow participants to navigate a site in a single colour (blue, orange or grey) in addition to white (see Fig. 6).

This experimental Website, called “Psych-Aix”, was developed in order to meet the informational needs of psychology students. The information provided to users related to the psychology courses offered at the University of Provence (France) and to leisure activities available in Aix-en-Provence. Contrary to the material presented in the first study, which was confined to the Psych-Aix homepage, the material for this second study consisted of a fully-fledged, 19-page Website. The main menu on the Website’s homepage was divided into two main sections (Studies and Leisure Activities). This menu and its two sections always remained on the screen, in a horizontal navigation bar at the top of each page (cf. Fig. 6). The order of presentation in this navigation bar was counterbalanced (i.e., Studies–Hobbies or Hobbies–Studies). These two sections were each divided into three subsections. These were “Psychology”, “Studying” and “Student Life” in the Studies section, and “Music”, “Sport” and “Going out” in the Leisure Activities section. Each of these three subsections comprised three pages: a page
with a brief introduction in linear format and two other pages of information, each containing approximately 300 words. For instance, the “Studying” subsection contained “Introduction”, “Courses” and “Job Opportunities” pages. For easy access, these pages featured a navigation submenu on the left-hand side to supplement the main menu at the top of the page (cf. Fig. 6). It should be noted that, aside from the introductory page, one of the pages in each subsection was displayed in linear form, the other in nonlinear form (with bullet points). The order of these two formats was counterbalanced.

6.3. Participants

Thirty-six undergraduate psychology students took part in this experiment. As the Website was intended to provide information about psychology courses, we took the view that participants with an interest in this area would be more motivated to explore the site and less inclined to indulge in passive navigation. We also checked that all the participants had basic knowledge about surfing on the Internet.

These students were assigned to one of three experimental groups: 12 had to navigate the blue site, 12 the orange site and 12 the grey site.

6.4. Procedure

Each participant individually performed the three tasks, always with the same computer and at the same place.

The instructions for the first task (“navigating the Website”) were as follows: “Imagine that you have a friend who is a secondary-school pupil. He or she is planning to study psychology at Aix-en-Provence University. The Psych-Aix association has created a Website to provide new students with useful information about what they can expect to find when they arrive. You must visit this site and decide whether it could be useful for this pupil. When you have finished navigating the site, I will ask you to write to your friend about it.”

Once the participant had indicated that he or she had understood these instructions, the experimenter launched the Snagit software in order to record the user’s movements. The participant then logged onto the site and started to visit it.

At the end of the navigation task, Snagit was stopped and the participant performed the second task (“writing a letter”). To this end, he or she was provided with a sheet of paper and instructed as follows: “You have just navigated the Psych-Aix Website. You are now going to spend 10 min writing to the future psychology student to tell him/her what you think and feel about this site and its contents.” After 10 min of writing, this second task came to an end.

Each participant had one final task to perform. This consisted in filling in a questionnaire about the usefulness and value of the information relating to the psychology courses and leisure activities on offer in the university town. In addition, they had to answer three kinds of questions relating to (1) their general appreciation of the colour of the site they had visited, (2) the prevalence of this colour on Websites, and (3) the value and usefulness of the information they had found on the Psych-Aix Website.

6.5. Independent variables and dependent variables

There were two independent variables: colour and linearity of page. The colour of site was blue, orange, or grey. The page in each subsection was displayed in linear form or in nonlinear form (with bullet points).

Several indicators or dependent variables were taken into account, according to the nature of the task.

The analysis of Website navigation was based on:

- duration of homepage exploration;
- duration of site exploration (excluding homepage exploration);
- mean time spent on each page;
- number of pages visited.

The scripts (i.e., letters to a friend) were analyzed in order to determine the amount of information that had been gathered on the site and introduced in these productions. This information could pertain to the psychology courses and leisure activities available in the university town, the participants’ feelings about the Website colours and other aesthetic features.

The questionnaire was designed to yield scores for colour preferences and the perceived value and usefulness of the information participants found on the Website.

7. Results

In this section, we present the results on Website navigation, the information included in the written productions and, lastly, the answers to the questionnaires.

7.1. Website navigation

7.1.1. Navigation duration

A one-way ANOVA was performed on the time spent navigating the homepage, with colour as a between-participants factor. The analysis revealed a main effect of colour, $F(2, 33) = 3.939, p < .05$, $\eta^2_p = .193$. Planned comparisons showed only that visitors spent significantly more time on the homepage of the orange site ($M = 106.6 s, SD = 27.64$) than they did on the homepage of the blue site ($M = 74.67 s, SD = 22.53$), $F(1, 33) = 7.509, p < .01$.

We also performed a $2 \times 2$ ANOVA on the duration of Website navigation, minus the duration for the homepage, with colour as a between-participants factor and linearity (linear, nonlinear) as a within-participants factor. The data are presented in Fig. 7. The analysis revealed main effects of colour and linearity, $F(2, 33) = 5.914, p < .01$, partial $\eta^2_p = .264$, and $F(1, 33) = 31.07, p < .001$, partial $\eta^2_p = .485$. The interaction between the two factors was also significant, $F(2, 33) = 3.550, p < .05$, partial $\eta^2_p = .177$. Inspection of Fig. 7 shows that visitors spent longer on linear pages than on nonlinear ones (i.e., indented lists). It also confirms that visitors spent longer on the orange site than they did on the blue site or the grey site. In addition, the colour-related difference was less strong for nonlinear texts than for linear ones.

We also performed a $2 \times 2$ ANOVA, with colour as a between-participants factor and linearity (linear vs. nonlinear) as a within-participants factor, on the mean time visitors stayed on each page. The analysis revealed a main effect of linearity, $F(1, 33) = 19.57, p < .001$, partial $\eta^2_p = .377$. On average, visitors spent longer on pages with linear texts ($M = 33.83, SD = 16.97$) than they did on pages with nonlinear (i.e., indented) texts ($M = 26.22, SD = 11.08$).

7.1.2. Number of pages visited

A one-way ANOVA on the number of pages visited did not reveal a significant effect of colour on the number of pages visited, $F(2, 33) = 2.783, p = .0763$ (orange; $M = 18.7$ opened pages, blue: $M = 15.3$ and grey $M = 14.5$ opened pages).

7.1.3. Information in written productions

A $2 \times 2$ ANOVA, with colour as a between-participants factor and linearity (linear, nonlinear) as a within-par-
participants factor, was performed on the number of items of information contained in the scripts. The analyses revealed a main effect of colour on the number of items of information, $F(2, 33) = 4.175$, $p < .05$, partial $\eta^2 = .201$, and a significant interaction between the two, $F(2, 33) = 9.876$, $p < .001$, partial $\eta^2 = .374$.

Inspection of Fig. 8 shows two patterns of results with respect to linearity. The letters written by visitors who had navigated on the orange site contained significantly more information that had been gathered from nonlinear (indented) texts ($M = 6.083$, $SD = 3.728$) than from linear ones ($M = 2.667$, $SD = 2.103$), $F(1, 33) = 9.876$, $p < .001$. The differences were not significant for the grey and blue sites, $F(1, 33) = 3.422$, $p > .10$ and $F(1, 33) < 1$. In addition, planned comparisons showed that visitors who had navigated on the orange site included significantly more information extracted from nonlinear (indented) texts than visitors who had navigated on the grey ($M = 1.917$, $SD = 1.621$) and blue sites ($M = 2.667$, $SD = 1.875$), $Fs(1, 33) > 10.48$, $p < .01$. The difference between the grey and blue sites was not significant, $F(1, 33) < 1$. Visitors who had navigated on the blue site ($M = 3.917$, $SD = 3.528$) included significantly more information in their letters that had
been gathered from linear texts than visitors who had navigated on the grey one (M = 1.583, SD = 1.832).

7.1.4. Answers to questionnaires

A Kruskal–Wallis ANOVA revealed a main effect of colour on the level of participants’ general appreciation of the site, H(2) = 9.848, p < .01. Mann–Whitney tests showed that the level of general appreciation was significantly higher for the orange site (M = 3.33) and the blue site (M = 3.08) than it was for the grey site (M = 1.83), U = 27.00, adjusted z-statistic = −2.691, p < .05 and U = 28.50, adj. z = −2.571, p < .05).

Moreover, the Kruskal–Wallis ANOVA revealed a main effect of colour on judgments about the prevalence of the Website colour, H(2) = 7.602, p < .05. Mann–Whitney tests showed that visitors who navigated the grey site felt that this was an unusual colour for a Website (M = 2.08), whereas visitors who navigated the orange site (M = 2.91) and the blue site (M = 3.08) considered that these colours were quite usual for Websites, U = 33.50, adj. z = −2.315, p < .05 and U = 33.00, adj. z = −2.307, p < .05.

8. Discussion

This second study provided fresh insight into the impact of colours on Website users or visitors in relationship to the physical layout of the text. Although the content of the different versions of the experimental site was strictly identical, we obtained significant results according to site colour and text presentation (linear vs. nonlinear).

The effect of layout interacted with that of colour. Thus, in the case of the orange site, information presented in nonlinear form (i.e. in indented lists) was better memorized and featured more heavily in the written productions than linearly presented information, whereas visitors stayed for longer on linear pages than on nonlinear ones. This finding is in line with Website guidelines, which recommend presenting items of information as indented lists instead of linear texts [57]. Such results could be useful for identifying the conditions required for Website “scannability”, as well as for performing complementary analyses of the classical aesthetics dimension of sites [35].

In accordance with the results of the first study, users’ judgments were found to vary according to Website colour. However, the results of this second study went one step further, in that they also revealed the effects of colour on Website navigation, as well as on the memorization and retrieval of information.

Users found the grey site less appealing than the other two, which is in line with the users’ judgments expressed in the first study. In addition, its lack of attraction appears to have had consequences on the different indicators that were taken into consideration in this second study: participants spent less time navigating the grey site than they did navigating the orange site, and included fewer items of information (from both linear and nonlinear texts) in their written productions.

Since each experimental site was presented in a single colour, the “insipidness” of the grey colour may have led to a degree of disengagement, both in terms of mobilizing resources for performing the task (less time spent navigating the site) and in terms of efficiency (fewer items memorized and retrieved).

Blue seems to have had a slightly different impact from that observed in earlier studies. Although, in accordance with previous research, the blue site was greatly appreciated by visitors, it did not seem to motivate them to stay on it for longer. In actual fact, less time was spent on the blue site than on the orange one. This could possibly be interpreted as an indication of greater efficiency, at least in the case of linear texts, as blue site visitors included more linearly presented information in their written productions than grey site visitors did. However, in the case of nonlinear texts, visitors to the blue site introduced less information from indented texts into their letters than visitors to the orange site did.

Our study also yielded information about the colour orange that were new to the field of HCI. Contradicting previous suggestions about the effects of cooler versus warmer colours, our results showed that the orange site was greatly appreciated by the visitors, who spent more time on this Website than they did on the blue site. Thus, visitors may have felt more affinity with this site, which would explain why they stayed so long on it and found it so appealing. Letters about the orange site also contained the most information, this being especially the case when that information came from nonlinear texts. Thus, in our experiment, orange favoured not only information processing, but also the memorization and retrieval of information acquired from the Website.

Finally, this second study showed that there may be no direct and simple relationship between appreciations expressed by users and indicators based on their navigational behaviour while using Websites or other user interfaces. Conversely, the interpretation of results based only on users’ behaviour, such as time measurements, is frequently limited and has to be associated to other, and possibly subjective, measurements. In addition, we showed the interest of an analysis that is not only focused on Website users’ navigation but also on other cognitive processes, such as memorization of information. Therefore, we argue that both subjective and objective measurements are necessary for the evaluation of Websites and, more generally, user interfaces.

9. Conclusion

Although we support the idea that “attractive things work better” [6,7], it is important to determine what is appealing and efficient for users in a given context. In the case of Website design, a number of elements can have a significant impact on users’ or visitors’ perceptions, judgments and willingness to navigate particular sites e.g., [14–17].

The investigations presented in this paper provide fresh insight into the aesthetic aspects of interaction with Websites. From a theoretical perspective, some of our results showed that the emotions associated with the feeling of “beauty” and which therefore procure a feeling of “wellbeing”, played an important role in determining the length of the visit, the nature of the information that was consulted and the extent to which that information was retained. The time has come to extend research on emotional design [7] to Website development, in order to gain a better understanding of its effects.

From a practical perspective, our work allowed us to identify the colours that were regarded as appealing or, on the contrary, were rejected both by users and by Website designers. We also went one step further, by supplementing the analysis of designers and users’ preferences with analyses of the users’ navigation and the information (linear vs. nonlinear presentation) they retained and included in their written productions.

When searching a Website for information, users scan the pages, rather than reading them. Like Nielsen [67] and Goldman and Rakestraw [68], we found that users preferred to scan texts with the appropriate layout. For instance, pages containing bullet points appear easier to scan. In addition, one important result of our research was that the effect of colour was contingent upon the physical layout.

Nevertheless, although some Website designers may prefer to base their choices on their own feelings and preferences, others could benefit from recommendations relating to Website aesthetics and, more especially, from knowledge about the impact of Website colours on users’ performances. We showed that the colours
perceived by visitors constitute a determining factor in their interaction with a Website. Indeed, we also demonstrated that colours exert an influence not only during navigation but also afterwards, in complex activities such as producing written texts comprising information gleaned from a site.

As with all empirical studies, there were a number of limitations to the two studies we describe here, which may suggest directions for future research. First, while experimental settings were required on account of the research topic, they created an artificial environment. In particular, the homepages and Websites were presented to participants in a single main colour, which had the advantage of allowing us to perform a carefully controlled experiment. Then again, some real-life Websites are deliberately designed in one specific colour symbolizing a particular brand. For instance, red is emblematic of Coca-Cola and blue of IBM, while variations of black and grey are frequently chosen for luxury brands, such as Chanel. However, as was noted by some participants, some colour manipulations looked unnatural in the Website context, as most Websites combine several colours. Thus, additional research will have to be conducted in more complex (combinations of colours), but also more natural, environments.

Second, the number of participants in each of the studies was fairly small and the second study could usefully be replicated with designers as participants. Indeed, this could provide a means of persuading designers to adopt the user’s point of view.

Third, we chose to use an informational Website intended to be used by university students. This choice allowed us to increase the participants’ motivation in the second study. However, the purpose of a Website may also impact the choice of colours. Thus, some colours may be suitable for informational sites and others for commercial sites, given that the aim of informational sites is to promote the comprehension and memorization of information, whereas the aim of commercial sites is to motivate users to repeat visits and buy the products that are sold there. Additional research is therefore needed to explore the impact of colours in diverse Website contexts.

To conclude, the present study demonstrates the impact of different colour schemes on users. Its findings complement previous research on Websites. The results of the first study confirm that colours have the potential to influence both users’ and designers’ perceptions, although the two groups differed to some extent in their judgements about what constitutes an appealing colour. The findings of the second study go further, as they show that when Website colours are associated with a specific physical layout, they can affect users’ behaviours and cognitive processes. Therefore, the so-called “aesthetic dimensions” contribute not only to the “beauty” of interactive systems, but also to their “goodness”, to borrow Hassenzah’s terminology.

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Appendix A

Instructions given to participants in the first study when they access to the experimental site that presents the 23 homepages:

“Hello,

We are going to show you 23 versions of the same homepage in various colours. Please, let us know to which extent you like each of these versions. This homepage is the first page of a Website for students in Psychology at the University of Provence (Aix-en-Provence), which provided users with two kinds of information elements:

– studies: a general presentation of the discipline and the university program;
– hobbies: a general presentation of the activities at the University and outings in Aix-en-Provence.

To indicate to which extent you like the different versions of the homepages, you will have to select one out of a seven keys ranging from ‘I don’t like it at all’ to ‘I like it a lot’. After the selection of your answer, you will have to validate it in order to access to the following homepage.

After looking at all the homepages, we will ask you to answer to some questions.”

References
