Consumer Responses to Colors of E-Commerce Websites: An Empirical Investigation

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1. Introduction

During the past 15 years, one of the most important influences on business has been the rapid development of the Internet and e-business technology. In a relatively short space of time, the Internet, or more specifically, the world wide web, has evolved from being a novelty used purely as an entertainment and communication device by a handful of technology aficionados into a transforming concept that is now seen as an essential business tool (Simeon, 1999; Poon & Swatman, 1999; Aldridge et al., 1997; Herbig & Hale, 1997; Cotter, 2002). The design of e-commerce websites interface is thus receiving increasing managerial and research attention in online retail context.

E-commerce websites are trying to increase their sales through a personalized merchandising mainly based on the *theatralization* of the interface. However, if online personalization has been extensively studied in information systems research, web users reactions to such personalization are not known yet (Ho, 2006).

From a cognitive point of view, the simple fact of getting lost on a webpage for example, seems to be the consequence of user's difficulties to manage simultaneously two cognitive activities: processing and locating (Tricot, 1995). Unfortunately, it changes the affective states and factors such as aesthetically pleasing color combinations can play an important role in generating positive affect, which may be particularly relevant for e-commerce website. Indeed, in this retail context, companies try to encourage users to associate a given brand with positive affective states. A few studies have been conducted on this topic. Norman (2002) worked on aesthetics and emotion in design, Eroglu et al., (2001, 2003) investigated the effects of atmospheric cues of the online store on shoppers' emotional and cognitive states, showing that they affected their shopping outcomes. Nonetheless, none research can be found on the effects of colors on the memorization and buying intention, by considering the impact of affective states as a mediating variable of the "colors-memorization/buying intention" link. Similar to traditional in store stimuli, online colors can provide information about the retailer (e.g., the quality or type or retailer, the target audience of the retailer) as well as influence shopper responses during the site visit (Eroglu et al., 2003). The consumers affective states can directly affect the website visit duration. It is

then possible to presume that consumer's emotion and mood affect the website visit duration, a domain already investigated (see Danaher et al., 2006).

This duration can help maintaining user interest in a site (Bucklin & Sismeiro, 2003, Hanson, 2000) and give users more time to consider and complete purchase transactions (Bucklin & Sismeiro, 2003). Enhancing user's interest helps to generate repeat visits, which lead to greater long-term sales according to Moe & Fader (2004). From a business investment point of view, Demers & Lev (2001) show that sites with longer visit duration also have higher monthly stock returns. Therefore, one can undoubtedly think that the visit duration is directly related to the buying intention in an e-commerce website: the more you stay if you feel in a good mood and emotion, the higher your intention to buy will be. A possibility for enhancing the visit duration comes from the design of the e-commerce website. Web designers have to *"continually weigh how visual elements affect audience perceptions and uses of online information. Such factors can be complex when designing materials for a particular group […] designers must now think in terms of global audiences"* (del Galdo, 1996; Nielsen, 2001).

In their effort to spur Internet users to buy, brands do not seem to focus systematically on color choice when conceiving or updating websites. However, when consulting a website, Internet users browse web pages designed to arouse their attention based on factors such as colors, sound animation, texts, animations, pictures, textures, graphic design and advertising. Aware of the significant and widely known impact of the atmosphere inside stores on the prospective buyers' behavior in a traditional buying situation (Kotler, 1973; Donovan & Rossiter, 1982; Filser, 1994, 2003a, 2003b; Lemoine, 2003), there is need to understand the effects of colors, as an atmospheric variable and as a component of e-commerce interfaces, on online consumer behavior. Although the color variable is a widely researched topic in various fields (Divard and Urien, 2001), there is a lack of studies focusing on color in the online context. As such, our knowledge regarding how the colors of e-commerce websites can influence online consumer behavior is scarce.

In an attempt to address this gap, the aim of this paper is to examine how the colors of an e-commerce website can help consumers to memorize information so as to end up buying on the website. The paper presents an empirical study of the effects of e-commerce website color on the memorization of product information and buying intention. Unlike most empirical studies dealing with color by comparing warm and cold colors, we examine color by focusing on its hues, brightness and saturation so as to demonstrate that its influence varies according to the intensity of each of these three components. Our findings show that the colors used on an Internet website have a positive effect on memorization of product information and buying intention, which is also mediated by the affective states. They emphasize the role of affect – mainly composed of emotions and moods (Derbaix & Poncin, 2005) – as a mediating variable.

2. Background

Readability represents the reaction time required to find a target word when searching on a website (Hall & Hanna, 2004). Although readability is informative with respect to basic processing, it does not address higher-level outcomes of processing such as retention, which is based on the cognitive architecture. The term "cognitive architecture" refers to the manner in which cognitive structures are organized. The two most important aspects of human cognitive architecture relevant to visually based instructional design and around which

there is broad agreement are the *working memory* and the *long term memory* (Sweller, 2002). While considerable work by many researchers over several decades has been devoted to the organization of human cognitive architecture (Sweller, 2002), far less effort has gone into investigating the memorization of the information presented on websites. De Groot (1965) work on chess (first published in 1946) demonstrated the critical importance of long-term memory to higher cognitive functioning. He demonstrated that memory of board configurations taken from real games was critical to the performance of chess masters who were capable of visualising enormous numbers of board configuration. The skills depended on schemas held in long-term memory, thanks to the retention of information.

Retention is a very important factor for the large number of information-based websites that exist. It is an important factor for e-learning applications, since the user's goal is usually to retain the information beyond the time the page is being read. This also applies to information included in e-commerce sites, since the users tasks are often facilitated when they can retain information from page to page. Thus, measures of higher level processing, such as retention, remain an important topic in examining the effects of text-background color combinations, for the success of e-commerce, e-learning and e-government websites.

2.1 Color

Although color is a widely researched topic (Divard & Urien, 2001), to this day very few studies focus on this variable within the online context. Research is limited to several studies about the impact of colors on Internet site readability providing advice about how to choose the most harmonious colors (Hill & Scharff, 1997; Hall & Hanna, 2004), while usability research experts, such as Nielsen (2001), make managerial recommendations. Yet color is omnipresent in e-commerce websites. Generally speaking, it affects consumer behavior in compliance with Mehrabian and Russell's (1974) Stimulus Organism Response (SOR) psycho environmental model.

E-commerce website interfaces seek to place consumers in a particular context by activating the sensory system (hearing or sight) and enable one to perceive their emotional, cognitive, psychological, physiological and behavioral responses through their being altered. The perception of a website's atmosphere lies almost exclusively in its visual aspect since 80% of the information processed by the Internet user's brain comes from sight (Mattelart, 1996). Among the behavioral reactions caused by website atmospherics, the visit frequency of a website depends on colors, which are considered as factors of positive influence; on the contrary, a limited use of colors in e-commerce websites is considered as a factor of negative influence (Lemoine, 2008).

The color contains three principal components (Trouvé, 1999):

- *Hue* (or chromatic tonality) is the attribute of the visual sensation defined according to the colors denominations such as blue, green, red…;
- *Saturation* provides the proportion of chromatically pure color contained in the total sensation;
- *Brightness* corresponds to the component according to a surface illuminated by a source that seems to emit more or less light.

Unlike most empirical studies dealing with color by comparing warm and cold colors, we have decided to focus on its hue, brightness and saturation so as to demonstrate that its influence varies according to each one of those components' intensity. In color literature, Bellizzi & Hite (1992), Dunn (1992), Drugeon-Lichtlé (1996) and Pantin-Sohier (2004) chose

hue as the main variable in their experiments and showed that brightness and saturation should be taken into consideration when conducting experiments about color. As Valdez (1993), Drugeon-Lichtlé (2002), Gorn et al. (2004) and Camgöz et al. (2002) had shown regarding the brightness component of color, it seems more interesting to compare hue and brightness than to compare warm and cold colors when trying to determine what consumers recall and what spurs them to buy. Indeed, in everyday life there is no support helping consumers to recall the content of an e-commerce website they visited or to compare it with another offer. The feeling of aggressiveness felt by consumers when visiting an e-commerce website – partly due to the use of rather bright colors – does not result in a more efficient memorization of information, nor to a stronger buying intention.

2.2 Color perception within interfaces

Color perception is a complex process in that it is more than a mere physiological or psychological fact. It is also formed by consumer's national culture, general education and socio-professional background. According to general psychological data (Fleury & Imbert, 1996), every individual is endowed with a physiological ability to perceive colors (Wright & Rainwater, 1962; Nakshian, 1964; Wilson, 1966; Jacobs & Suess, 1975; Kwallek et al., 1988).

On a website the interface represents the graphic chart, a set of rules composed of two colors: the foreground color also called "tonic" or "dynamic" color and the background color, labeled "dominant color" by webmasters. These colors reveal the contrast, which correspond to a strong opposition between the foreground and the background colors, as defined by W3C[1] (Accessiweb, 2008). Its main function consists in favorising the readability of the displayed information, and *a fortiori* the memorization process.

Kiritani & Shirai (2003) show that the effects of screen background colors on time perception vary according to the tasks performed by Internet users. When reading a text written on a white, blue or green screen background users have the feeling that time passes more slowly. When users are merely conducting a simple search and only need to understand the meaning of a sentence, then the screen background color does not have any impact on how they perceive time duration.

Hill & Scharff (1997) have demonstrated the importance of contrast (dynamic color vs. dominant color) when searching for information within a page. They obtained better readability scores when resorting to chromatic colors (green dynamic color on yellow dominant color).

The results of Corah & Gross (1967) suggest that recognition between colors was made when the differences of contrasts between the various forms and the standard forms were larger.

During an experiment where colored labels had been stuck to screen backgrounds, Camgöz et al. (2002) observed that brightness, saturation and hue had a specific impact on each colored screen background.

Biers & Richards (2002) have studied the impact of dominant color on the perception of promoted products and found that backgrounds with cold hues, such as blue, increased product value and reduced the risk of purchase postponement, especially with regards to regular Internet users.

Hall & Hanna (2004) studied the impact of dominant and dynamic colors on how readability was perceived and aesthetic aspect experienced, as well as on memorization of information

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[1] http://www.w3.org/

and on intentions. According to them, sites promoting knowledge transfer must display black texts on white backgrounds, achromatic colors with maximum contrast. In parallel, e-commerce websites should merely use chromatic colors due to the higher aesthetic appreciation score which is correlated with higher purchase intention. Blue is the favorite hue when it comes to buying intention. These results underline the importance of taking into consideration the impact of the color's components (hue, brightness and saturation), as well as the contrasts occasioned by the foreground and background colors.

Moss et al. (2006) demonstrated that the impact of colors varied according to gender. According to them, differentiation mechanisms have an impact on how an e-commerce website is perceived, not based on price but based on website ease-of-use and the pleasure felt by users.

3. Research model

The model explains how the colors of an e-commerce website and their components - hue, brightness and saturation - can have an impact on the buyer's affective state of emotions and mood and cognitive states of memorization and buying intention (Figure 1).

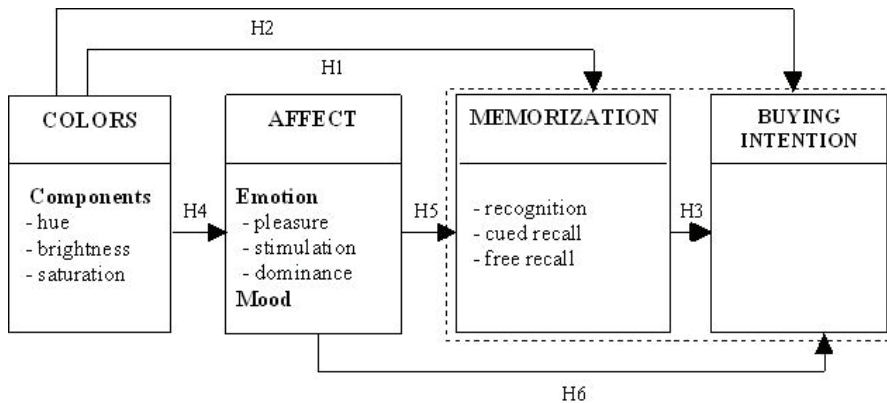Fig. 1. Conceptual model of the research

3.1 Memorization

Memorization is a very important factor for the large number of information-based websites that currently exist. It is important for e-learning applications, since the user goal is usually to retain the information beyond the time the page is being read. This also applies to information included in e-commerce websites, since consumer tasks are often facilitated by memorizing information while navigating. Drawing on offline setting, memorization can be influenced by the colors of an e-commerce website.

In order to understand the effects of color on consumer memorization we have to take into account the quality and quantity of information a consumer has memorized while visiting an e-commerce website. We posit that memorization varies according to the colors of the website, and especially according to the contrast between the dominant and dynamic colors, in agreement with the work of Hall & Hanna (2004).

In general, information is stored according to an encoding process enabling one to sort out information thanks to criteria which will then allow one to retrieve this information. The role of these criteria is to connect a piece of information to other similar information already stored (Ladwein, 1999). In order to examine the information memorized by each participant, we resort to recognition and recall, two procedures belonging to a method of information retrieval based on overall stimulus in long-term memory. Be it free or cued, recall enables individuals to mimic mentally a stimulus to which they are not exposed during the evocation, for instance, their past reaction to a promotional action (Filser, 1994). Thus, we can hypothesize:

H1: The colors of an e-commerce website will have a positive effect on memorization

3.2 Buying Intention

Intention is activated by a desire or a need (Darpy, 1997) and desire is viewed as an active process (O'Shaughnessy, 1992). Although buying intention is more than a mere desire, it is not a promise to buy (O'Shaughnessy, 1992), it is the outcome of a cognitively handled desire. According to Darpy (1997), echoing the studies of O'Shaughnessy (1992), Howard (1994) and Belk (1985) "*Intention results from a desire or a need handled on the cognitive level and leading to purchase planification*".

Among the environmental factors recognized to produce important emotional and behavioral reactions on the consumer, color seems to play a big role. It serves to retain consumers longer on the e-commerce website according to certain criteria related to their perception of the interface. In particular, pleasure is increased with use of colors whereas the boredom can result from a weak use of them (Lemoine, 2008). This duration can help maintaining user interest in a site (Bucklin & Sismeiro, 2003; Hanson, 2000) and give users more time to consider and complete purchase transactions (Bucklin & Sismeiro, 2003). By enhancing consumer interest, it helps to generate repeat visits, which lead to greater long-term sales (Moe & Fader, 2004b). From a business investment point of view, Demers & Lev (2001) show that sites with longer visit duration also have higher monthly stock returns. Therefore, it can be assumed that e-commerce website colors are likely to have an impact on buying intention, as they can prolong the visit duration. Therefore, we propose:

H2: The colors of an e-commerce website will have a positive effect on consumer buying intention

There are many entries which are available in the memory and in the external environment. They can potentially be considered in decision making, but only a few will be used to make a choice in a given situation. Tactical choices effectively originate from decision made regarding the products we buy, including:

- considerations linked to the price (cheaper, use less of it, costs cheaper);
- considerations linked to the performance (the product functions in these conditions, it owns these qualities);
- considerations linked to the affect (I like the product, I love the product);
- normative considerations (my father advised me to buy it, my mother always uses this product);

It is important to understand the procedures which determine which small sample from the entry among all possibilities can be used as a base to make a choice. For these reasons, we propose:

H3: The memorization of e-commerce commercial information will have a positive effect on consumer buying intention

3.3 Emotion

We wish to bring to the fore the effects of colors on affect, which includes the emotions and moods experienced when visiting e-commerce websites. Emotions are short-lived but extremely intense. Their cause is unknown but their cognitive content obvious (joy, sadness, anger, fear, disgust). Their most obvious features are brevity and intensity. While emotions imply some kind of awareness of the information about the background and consequences of actions, moods refer to affective states of mind less likely to reach our consciousness. Moreover they last longer than emotions but are less intense (Forgeas, 1999).

To interpret colors one must go through a cognitive process which, in turn, arouses emotions in the Internet user. These emotions can fill users with a desire to buy, lead them to make a purchase or make them abandon the website. Perceived differently by each Internet user depending on his or her own way of perceiving colors, emotions involve a shift in his or her behavior.

3.4 Mood

Mood is generally is considered as a mild affective state that may influence cognitive processes such as evaluation, memory and decision strategies (Gardner, 1985). However, the observed effects of negative moods have been less consistent than those of positive moods. For example, Cialdini et al.'s (1973) negative state relief model of helping asserts that people in a negative mood will behave more charitably than others if the opportunity has potential for direct social or egoistic approval, suggesting that helping behavior may be quite a complex phenomenon not fully addressed by simpler explanations such as mood states (Swinyard, 1993). Gardner (1985) observed that the effects of mood may have special impact in retail or service encounters because of their interpersonal or dyadic nature, a view also supported by others (Isen et al., 1978; Westbrook, 1980).

According to Odom & Sholtz (2004), different colors tend to incur different moods. Studies have demonstrated the association of colors and mood by using diverse methods such as the objective impressions (printings), the clinical observations, the introspection and the experimental investigations (Wexner, 1954). Chebat & Morrin (2006) measured the effects of cold vs warm colors of a mall decoration on consumers. They showed that these were mostly guided by affective mechanisms, such as mood, or by other cognitive states, such as the evaluation of the mall environment quality. We believe that same mechanisms can exist in an online context.

Hence, we suggest the following hypotheses:

H4: The colors of an e-commerce website will have a positive effect on consumer affective states
H5: Consumer affective states will have a positive effect on consumer memorization
H6: Consumer affective states will have a positive effect on consumer buying intention

4. Research method

Our research method includes both a qualitative and a quantitative study. An exploratory qualitative study was conducted first to allow for verifying the importance of the research variables and the necessity of including them in our model to be tested. The proposed research hypotheses were then empirically tested through a quantitative study conducted in a laboratory setting.

4.1 Qualitative study

The main objective of the exploratory phase was to investigate the empirical knowledge gained by consumers and webmasters when browsing e-commerce websites. It mainly sought to confirm that colors have an impact on their perception, so as to prepare our quantitative study for data collection. The study was based on semi-structured interviews conducted with usual consumers and web designers, where we asked interviewees to speak about past visits to websites of their choice. From these interviews, topics referring to the affective states lived by the consumer in an online shopping situation emerged. These topics relate to the emotions and moods and show the importance attached by the consumers to the ease-of–use of a website. They also reinforce the proposed effects of variables such as color, as well as the quality of the images perceived by the consumers.

Participants

Participants were chosen according to their expertise with web sites (webmaster/simple user), their age, their sex and their social background. A participant is selected as an expert or not based on the answer in qualitative criteria of people selection, regarding the research objective. In our case, this selection was based on the answer to the question "have you already conceived or built a website?".

Method

The criterion of saturation of the data being retained (Mucchielli, 1991, p. 114), we interviewed 21 persons. The interview guide was structured and opened. It allowed us to obtain interviews related to the subjects purchase experience in e-commerce websites. We adopted a neutral attitude with regard to them so as not to influence them in the way they answered. Participants were questioned without being able to face a computer screen, in order to answer only by using their memory to restore the information evocating their navigation on the e-commerce website of their choice. Once every interview was re-transcribed, the duration of which ranged from 13 to 47 minutes in average, we obtained a verbatim of hundreds of pages.

Results

The exploratory qualitative analysis enabled us to note that color was actually an integral part of the atmosphere on e-commerce websites. This variable even seems to hold a more important role than we thought prior to the analysis: color was mentioned more than 79 times during the interviews carried out. Some elements which appear essential to the interface are:
-    elements related to usage - putting the organization of the site as a main factor, thanks to its clarity and the readability of its tree structure,

- elements allowing a rapid navigation within the site, by the provision of search engines in particular.

Color was actually mentioned by all the interviewees as a means of principal location within the interface of the site. It is perceived as an aid for consumer moves and sometimes caused aggravation if it appeared too violent.

" *times you feel aggravated, irritated, because it does not function well, because there are bugs or because it attacks you, yes it can attack you, when it is too "violent" at the level of the colors"* (respondent 14).

Not only is color part of the website design, but when soft, it also seems to comfort consumers thus filling them with enough self-confidence to buy an item in an environment to be "tamed": " *What I like in the site Boursorama website, it is a site initially on the general level that is comfortable. Comfortable visually speaking I would say."* (respondent 16)

It serves the organization of the information by highlighting useful zones systematically sought by the surveyed Internet users: "*it remains practical, therefore with doors, really accessible, or in any case visible, where I am able to make my reference marks easily. By zones possibly defined by executives, and then zones of text in fact. A regrouping of texts on certain places."* (respondent 5).

When used in compliance with the contrasts advocated by Itten (1970), color can prove very timesaving, a major asset in the relationship between consumers and websites. "*I will spend more time on a site which will have a large catalog, or products similar to what I seek, therefore always containing contents."*

As we mentioned, making information search easier by implementing rules specific to ergonomics and human computer interaction, the colors encountered when browsing an e-commerce website enable Internet users to navigate it more easily, according to its layout.

"*Thus there is the speed already, it is important but it can be more due to the material with ADSL or not,… I do not know if one can control this, and if not, colors help to locate a little bit what one wants, how to explain that… if it is clear and neat if the screen by far were looked at, one knows what the various parts of the site contain more or less. But it is true that most important are the links for me."*

Usability seems to play an important role in the consumer's perception of the e-commerce website's services and information provided. The content analysis pursued during this exploratory phase allowed us to verify that the color played an important role on the affective states lived in an online shopping situation. It also permitted us to determine certain characteristics appropriate for online purchase which differentiate it from purchase in traditional context. The respondent of interview 19 confirms this by saying that "*…the more readable the site, the more one wants to spend time on it"*. He further reinforces his assertion about the factors which discourage him to revisit a particular website: "*… if the site is complicated to access, has a complicated address in the address bar which is completely unmemorizable in order to revisit the same page, a difficult readability, too many animations… "*. This testimony corresponds to the one of the respondent of interview 3 who is more direct about the appearance of the e-commerce website: "*… its brightness encourages me to go and consult a commercial website, if it is clear and convivial. And what discourages me is, if it is all the reverse"*.

Discussion

Besides being pleasant to look at, information must be structured so that the visitors can easily distinguish the main thing from the accessories (principle of pregnancy) and that

available information is treated on a hierarchical basis (Ladwein, 2001). Among this essential information which is likely to be of interest to the consumer, we can distinguish the links or the interactive and informational zones, providing access to a particular zone of the website that the company wishes to put to the fore front. These links permit transitions from one page to another or provide access to "higher level" information. They need to be easily located. Their recognition can be facilitated by color, which constitutes one of the characteristics of information systems: to make any zone of the page more easily interactive by the creation of a feature which changes the state of a textual link or a button when the mouse is over it. Independently of the graphic style of the link, it is important that the visitor can discriminate very quickly which links are important and understand where they lead (Spool et al., 1999).

The non-recognition of these links can quickly become tiring and frustrating. Their recognition, which corresponds to fast identification of the possible actions on the website, is crucial for the consumer to get the impression that he is in control of the website. The use of color is thus pivotal in making links easily recognizable.

A quantitative analysis follows, showing that the effects of the colors of an e-commerce website on the Internet user, and, in particular, on his affective states, are not neutral.

4.2 Quantitative analysis

A laboratory experiment was conducted with 440 participants in order to test the proposed hypotheses. An e-commerce website selling music CDs was especially designed for the experiment. For each CD, participants could see the CD cover, the album title, the artist name, and seven pieces of information: music style, online store price, music company price, sale percentage, delivery time, state (new or used) and delivery charge. In addition, there was a CD description of 160 characters (around 20 words), next to the CD cover.

Each respondent visited the website with a graphic chart which was randomly selected among the eight charts prepared for the experiment, explained in the next section. A balanced distribution of the graphic charts among all respondents was ensured. After viewing two CDs, an easy to see link appeared on the participants screen. The respondents were asked to complete a questionnaire with questions about memorized information, emotion and mood states and buying intention. Demographic data were also collected. Then each participant was asked to go to another room to pass the Ishihara's test. This last stage was the only reliable way to know if the respondent was color blind or not. This guaranteed the validity of our sample, by keeping people with a perfect vision of colors. After discarding questionnaires that were incomplete or filled by colorblind people (8% of the males), 296 valid responses were used for the analysis, with each graphic chart being visited by 37 respondents.

Experiment design

Carrying out this experiment under laboratory conditions allows us to draw valid conclusions about the groups surveyed (Jolibert and Jourdan, 2006). Internet enables one to conduct non-intrusive studies, meaning that Internet users are not even aware that their behavior is being analyzed (Dreze and Zufryden, 1997). However, when conducting a study focusing on color, one has to control and neutralize three major elements: screens, ambient light, and, above all, the participants' color perception (Fernandez-Maloigne, 2004). Since, these elements cannot be controlled in a distance study carried out over Internet, a

controlled laboratory setting had to be used for our study. Table 1 explains how each of the three elements was controlled, while further, detailed information can be found in Appendix 4.
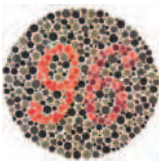
Fig. 2. The screen adjustment (calibration) of screens is possible with a probe	We can make sure that the colors featuring in the different charts framing our experiment appear just as we have defined them on the screens of our participants.
Fig. 3. The luxmeter enables to set up the brightness of the room at 1000 lux	By carefully defining the color of the walls and the brightness of the environment in which participants stay we can make sure that the colored appearance of the websites used for the experiment will not be altered by a too dim lighting or, on the contrary, by a too brightly lit room.
Fig. 4. Sample of the Ishihara test	One must make sure that participants do not have any color vision deficiency, which is extremely hard to check. Only two solutions can be resorted to: one can either rely on the good faith of the participant's statement, or ask an eye specialist to provide a certificate stating the participant's vision is not impaired[2].

Table 1. Conditions of the experiment

Design

The experiment design included 8 treatments (4 x 2) related to the 8 graphic charts devised for the website dedicated to the experiment. In order to measure the differences in color perception, we created 8 different graphic charts with varied hues, brightness and saturation. The color stimuli were modified in accordance with Munsell's system (Munsell, 1969), which enabled us to precisely define several levels of brightness and saturation for each hue. Besides, this is considered to be the most accurate system (Aumont, 1994). We observed the results related to brightness and saturation, the variations of which depended on the hues carefully selected beforehand.

To implement our first experimental design we employed the graphic chart used by Hill & Scharff (1997) which set the best readability rate in relation to contrast and we chose as chromatic colors a yellow dominant named Magnolia Yellow and a green dynamic named

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[2] Asking a participant for such a certificate would assuredly have let him/her guess that our experiment was focused on color, which would have biased the experiment. Following recommendations from eye specialist Professor Lanthony, we decided to have each participant take the Ishihara test in a room separate from the one where the experiment was conducted.

Newsvine Green. Starting from this chart, we reduced the brightness level of the two colors so as to obtain the second experimental design (Table 2). For experimental designs 3 and 4 we kept the same colors but switched dynamic and dominant colors. Experimental designs 5, 6, 7 and 8 are based on black and white (achromatic colors), the ones most frequently used on e-commerce websites, with different brightness and saturation levels, like those chosen for the experimental designs relying on green and yellow hues.

Graphic charts	Plan	Background (Dominant)				Foreground (Dynamic)				Plans explanations
		Name	H	B	S	Name	H	B	S	
Chart 1 – chromatic colors- Green and Yellow	1	Magnolia Yellow	60	100	20	Newsvine Green	120	40	100	(Hill and Scharff, 1997) showed that the sharp contrasts of his chart offered users the fastest reading speed possible.
	2	Magnolia Yellow	60	100	20	Granny Apple Green	90	80	100	Same chart as in the **Plan 1** with increased dynamic color brightness (from 40 to 80).
	3	Newsvine Green	120	40	100	Magnolia Yellow	60	100	20	Same colors as in **Plan 1.** Dynamic and dominant colors were switched.

Chart	Plan	Color 1				Color 2				Description
	4	Newsvine Green	120	40	100	Sunflower Yellow	60	100	60[3]	Same color's chart as in **Plan 3** with a decrease in dynamic color brightness (from 80 to 40).
Chart 2 – Achromatic colors - Black & White	5	White	0	100	0	Black	0	0	0	This chart is the most widely used one on e-commerce websites.
	6	White	0	100	0	Grey	0	60	0	Same color's chart as **Plan 5** with increased dynamic color brightness (from 0 to 60).
	7	Black	0	0	0	White	0	100	0	Same colors as in **Plan 5**. Dynamic and dominant colors have been switched.
	8	Black	0	0	0	Grey	0	60	0	Same chart as in **Plan 7** with a decrease in dynamic color brightness (from 100 to 60).

Table 2. Factorial design of the experiment

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[3] The color which should have been used for the text of the experimental plan 4, in order to preserve rates of luminosity and saturation in relation to the background color, could not be preserved. Indeed, this chart cannot be used given the lack of contrast between the two colors (foreground/background) which makes the reading impossible on a more or less old or difficult screen, for an individual presenting deficiencies with color's vision we refer to the directives of the w3c. We thus varied its degree of saturation.

Procedure

Respondents were asked to enter a room where all conditions cited above had been controlled before they started the procedure. The scenario of their entire participation to the experiment is presented in Table 3.

Stages	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Room	Laboratory – Prepared room for the experimentation (screens, light, walls)				Welcome room of school
Action	Presentation of respondents and topic of study	Sign up on the experimental *e-commerce* website	Visit of the experimental *e-commerce* website	Questionnaire	Ishihara's Test (color blind test)

Table 3. Scenario of the participation to the experiment

5. Measures

5.1 Memorization

Memorization was measured by recognition, cued recall and free recall.

To measure recognition, participants were asked to recognize two CD covers, each among two other covers of different albums by the same artist. Recognition scores ranged from 0 to 2, one for each CD cover they could recognize. Measuring recognition was not deemed useful since the participants answered to the questionnaires a few minutes after visiting the e-commerce website and 100% of them recognized both CD covers at least. Thus, we decided not to include recognition further in our analysis.

Cued recall was measured by asking the respondents to recall information about CDs they visited. A question with 3 alternative values (correct, wrong and "I don't know") was posed for each of the seven pieces of information related to a CD. Scores could thus be graded from 0 to 7 for each CD visited. Since participants were required to check out two CD covers, scores for cued recall ranged from 0 to 14.

In order to measure free recall, participants were asked to answer to an open-ended question related to a CD cover they had just seen. The question was "What do you remember from the information associated with this CD cover?". Free recall was measured by counting the number of items that participants could recall from those used in the CD description. Since participants could see two CD covers, each having a 20-element description, free recall value ranged from 0 to 40.

The score of commercial information memorization was the sum of the recognition score, cued recall score and free recall score, ranging from 0 to 56 (Table 4).

	Right answer	Wrong answer	Neutral answer (if applicable)
Recognition	[0 – 2]	0	0
Cued recall	[0 – 14]	0	0
Free recall	[0 – 40]	0	0
Total	[0 – 56]	0	0

Table 4. Synthetic table summing up the measurement of the memorization of commercial information

5.2 Buying intention

Buying intention was measured using a four-item scale developed by Yoo & Donthu (2001). The items were measured on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Already used in a similar context, its internal consistency was good, as presented in Appendix 1.

5.3 Emotions

Mehrabian and Russell (1974) pointed out two sets of methodological issues related to colors and emotions. The first one has to do with the lack of control or specification over the color stimulus, for instance, the lack of control over saturation and brightness when focusing on hues. We endeavored to control this aspect by resorting to Munsell's system (Munsell, 1969) to define the colors selected for our experiment's chart. The second has to do with the lack of liability and validity of the tools used to measure emotional responses to color stimuli.

To measure the emotions of participants visiting an e-commerce website, we will use Mehrabian and Russell's PAD scale (Pleasure Arousal Dominance) (Mehrabian and Russell, 1974).

- Pleasure: pleasure/displeasure, assessing the well being experienced by the individual;
- Arousal (stimulation): arousal/non-arousal, assessing the consumer's level of awareness (of the item) and activation;
- Dominance (domination): dominance/submission, assessing the feeling of freedom pervading the consumer when buying something on a website.

Since the reliability of the PAD scale remained continuously high and satisfactory throughout the experiments conducted by Valdez & Mehrabian (1994), we decided to use this method. Originating in the studies of Osgood et al. (1957) already centered on the "evaluation, activation and potency" triptych, this scale is still the most widely used to measure the consumer's affective states (Derbaix & Poncin, 2005). The scale is presented in Appendix 2.

5.4 Mood

To measure moods we resorted to Mayer & Gaschke's (1988) Brief Mood Introspection Scale (BMIS). It includes 16 items rated on a 5-point Likert scale ranging from definitely do not feel (1) to definitely feel (5). We selected it because it provides a quite exhaustive range of moods and is easy to supervise. It is presented in Appendix 3.

6. Data analysis and results

We followed both the General Linear Model (GLM) to test the impact of the colors of the graphic chart and variance analyses (ANOVA) to test the significance of the links between variables and the validity of the scales. We also examined interaction effects between hue and brightness with a series of regressions on each of the dependent variables.

6.1 Direct effects of the colors of the graphic chart on memorization

The colors did not show a significant impact on cued recall, according to the GLM analysis. However, an interaction effect on free recall exists (F = 2.484; p ≤ 0.061*) (Table 5).

Effects of graphic chart colors upon cued recall			
	DF	F	p-value
Hue	3	0.404	0.750
Brightness	1	0.771	0.381
Hue x Brightness	3	0.616	0.616
Effects of graphic chart colors upon free recall			
	DF	F	p-value
Hue	3	0.288	0.834
Brightness	1	0.049	0.835
Hue x Brightness	3	2.484	0.061*

Table 5. Effects of graphic chart colors upon cued and free recalls

Participants provided equivalent answers to closed questions about the content of the website, no matter which colors were featured in the graphic chart (cued recall). These questions actually helped participants to memorize information in that they accurately added up the information that could be easily memorized. When no help was provided and participants had to remember what they saw on the website (free recall), colors proved very helpful to them. This is significant in that it shows that color needs to be taken into consideration when conceiving usable graphic charts. Indeed memorization seems helpful to evaluate the e-commerce's website usability.

After studying the ANOVAs carried out, we noted that the effect of brightness on free recall is most significant when hue 2 (green dominant color, yellow dynamic color) was employed. With a low level of brightness (brightness 1) participants remember the content of the website better than with a high level of brightness (brightness 2) (Figure 5).

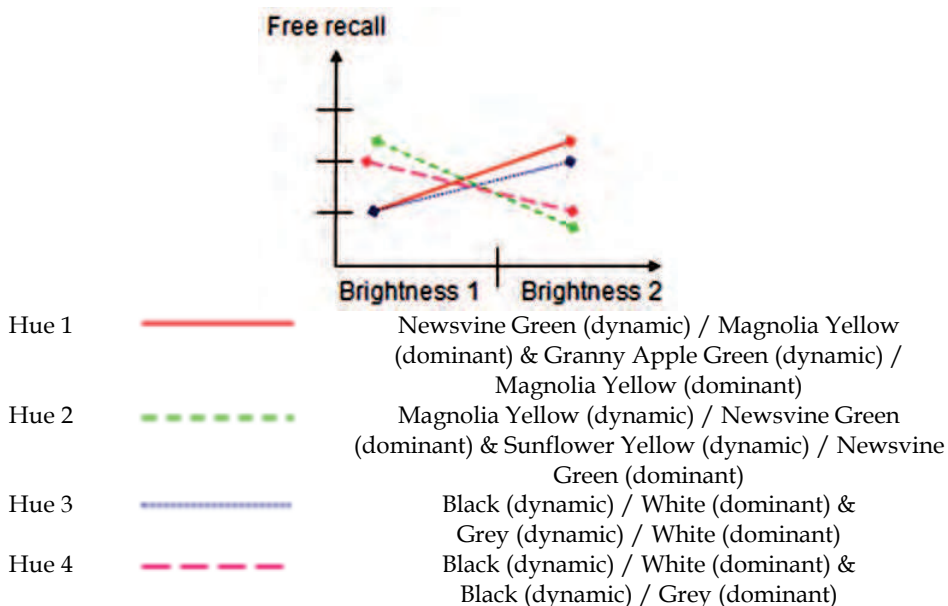| Hue 1	————————	Newsvine Green (dynamic) / Magnolia Yellow (dominant) & Granny Apple Green (dynamic) / Magnolia Yellow (dominant)
Hue 2	- - - - - - -	Magnolia Yellow (dynamic) / Newsvine Green (dominant) & Sunflower Yellow (dynamic) / Newsvine Green (dominant)
Hue 3	··················	Black (dynamic) / White (dominant) & Grey (dynamic) / White (dominant)
Hue 4	— — — —	Black (dynamic) / White (dominant) & Black (dynamic) / Grey (dominant)

Fig. 5. Effects of brightness on free recall

From this result, we understand that a lower contrast between dominant color and dynamic color enhances the memorization of the commercial information given on the website.

6.2 Direct effects of the colors of the graphic chart on buying intention

The results of the GLM analysis demonstrate that a graphic chart of an Internet website is very influential on buying intention (Table 6). Brightness has a significant positive effect on buying intention (F = 15.201, p ≤ 0.000). In line with our results for memorization, we note that when the dominant and dynamic colors' brightness is not too strong, buying intentions are the highest.

	DF	F	p-value
Hue	3	0.349	0.790
Brightness	**1**	**15.201**	**0.000***
Hue x Brightness	**3**	**3.732**	**0.012***

Table 6. Effects of graphic chart colors on buying intention

The GLM analysis shows that hue and brightness have a positive effect on buying intention (F = 3.732; p ≤ 0.012). The results of the ANOVA show that the effect of brightness on buying intention is only significant for hues n°1 (yellow = dominant color, and green = dynamic color) and n°2 (green = dominant color and yellow = dynamic color), with a chromatic color hue, but has no particular effect with a black and white hue chart. When contrast is higher and brightness increases, memorization decreases (Figure 6).

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