

Simple Beauty: The impact of visual complexity, prototypicality and color typicality on aesthetic perception in initial impression of websites.

Master's Thesis of:

Anna Hanchar, B.Sc.

Institute of Psychology
Department of Cognitive Psychology and Methodology
University of Basel

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Thesis Supervisors:

Elisa D. Mekler, MSc.

Department of Cognitive Psychology and Methodology, University of Basel

Dr. Alexandre N. Tuch

Department of Cognitive Psychology and Methodology, University of Basel

Prof. Dr. Klaus Opwis

Department of Cognitive Psychology and Methodology, University of Basel

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Abstract

Two studies were conducted in order to determine the impact of visual complexity, prototypicality and color typicality on the beauty appraisals of corporate websites with respect to first impression. The first study was concerned with the relation between visual complexity, prototypicality and perceived beauty of websites. Websites of low visual complexity and high prototypicality were perceived as more attractive. Visual complexity affects beauty appraisals earlier than prototypicality. The influence of prototypicality became more apparent with increase of time. These findings support the ideas of information-processing stage model of aesthetic perception of Leder, Belke, Oeberst and Augustin (2004), where visual complexity influences aesthetic impression at an earlier stage compared to prototypicality.

The second experiment aimed at providing a better understanding of the relationship between prototypicality and color, and their effect on the beauty appraisals of websites in regard to initial impression. There are some indications that color affects perception of prototypicality, but its influence on visual complexity is stronger. Websites with less typical color concepts were perceived as more attractive compared to those with more typical color concepts. The results of both studies show that beauty appraisals are affected within 17 milliseconds by visual complexity, prototypicality and color.

Introduction

The importance of the phenomenon called first impression was demonstrated by the research in different scientific domains such as cognitive psychology, social psychology and human-computer interaction studies, where first impression was considered as a base for developing general opinions regarding an object and the subsequent behavior towards it (Lindgaard, Fernandes, Dudek & Brown, 2006; Lindgaard, 2007; Lindgaard, Dudek, Sen, Sumegi & Noonan, 2011; Tuch, Presslauer, Stöcklin, Opwis & Vargas-Avila, 2012b). In the study of Stanford, Tauber, Fogg and Marable (2002) was revealed that users make their credibility-based decisions about the people or the organization behind a website based on its overall visual appeal.

The research in this area shows that first impression forms in a very short time frame. In the classical studies of mere exposure effect, Zajonc (1980, 2001) found out the participants' ability to perceive stimuli in a time between 1 and 20 milliseconds. Lindgaard et al. (2006) have shown the possibility of building consistent judgments about a website within 50 milliseconds. Moreover, Lindgaard and Dudek (2002) suggest that first impression may be long-lasting, which attributes to confirmation bias and postulates the tendency of people to favor information that confirms their beliefs or hypotheses and to ignore disconfirming evidence. In other words, if users have a positive feeling towards a website, gained by positive first impression, they may continue to like it regardless of how successful the interaction and the experience with the site has been (Phillips & Chaparro, 2009).

Current research advances towards better understanding of factors that contribute to forming of first impression of a website, especially the ones that influence positive vs. negative judgments. Thus, the importance of visual complexity and vertical symmetry in aesthetic website design was revealed (Tuch, Vargas-Avila, Opwis & Wilhelm, 2009; Tuch,

Bargas-Avila & Opwis, 2010). Lindgaard et al. (2006) suggested that color is an important predictor of first impression's direction. Hekkert, Snelders and Van Wieringen (2003) showed that users prefer novel designs, but only if prototypicality is not violated.

Further research is needed to explore how the process of first impression occurs, what factors underlay this process, how these factors interrelate and what these factors consist of. Leder et al. (2004) proposed the information-processing stage model of aesthetic processing, where such factors as complexity, color and prototypicality were enumerated as crucial predictors of aesthetic appraisals. The purpose of this study was to further examine the effects visual complexity, prototypicality and color typicality on first impression of websites. Highlighting these topics might help improve the present state of knowledge and the principles of web design, gaining as a result web pages that induce positive first impression.

Theoretical background

First impression and the process of aesthetic perception

In the last decade of Human-Computer Interaction (HCI) research the importance of first impression and its far-reaching influence on further judgments about a particular website became the topic of numerous studies (e. g. Tractinsky, Cokhavia, Kirschenbaum & Sharf, 2006; Lindgaard et al., 2006; Michailidou, Harper & Bechhofer, 2008; Tuch et al., 2012b). Starting with the seminal experiments of Lindgaard et al. (2006), who were able to show the consistency of initial impression, large number of experiments tried to investigate how exactly first impression was built and what factors contributed to it (Basso, Goldberg, Greenspan & Weimer, 2001; Hekkert et al., 2003; Tractinsky et al., 2006; Harper, Michailidou & Stevens, 2009; Tuch et al., 2012b). In the set of three studies, Lindgaard et al. (2006) highlighted that the first impression might be stable over the course of time. Moreover, presentation duration of 50 milliseconds is sufficient for perceiving and building a reliable judgment about visual appeal of a web page. Supporting the findings of Lindgaard et al. (2006), Tuch et al. (2012b) also revealed that 50 milliseconds was enough to form the first impression of a website regarding beauty appraisal. Furthermore, participants were able to perceive different factors that build the impression of a web page (Tuch et al., 2012b). Thus, the findings suggest the ability of humans to perceive and react on such stimuli as web pages in a very short time. The type of these reactions determines a user's opinion about a web page and a decision either to use a particular page or rather to reject it. Specifically, aesthetics or visual appeal, perceived beauty, attractiveness (all these terms are used as synonyms in this work) play a prominent role in perception of whether websites are suitable for further use (Sillence, Briggs, Harris & Fishwick, 2006), whether they are trustworthy, reliable (Basso et al., 2001; Lindgaard et al., 2011) or usable (Hassenzahl & Monk, 2010; Tuch et al. 2012a).

Current research stream in HCI endeavors to achieve a better understanding of the exact factors that make web pages attractive or unattractive for users.

The problem of what constitutes aesthetics or beauty, what exactly makes things beautiful, and what produces a pleasurable experience interested the scientists and artists over the past centuries (Moshagen & Thielsch, 2010). On the one hand, beauty was conceived as a property of an object that produces a pleasurable experience in any perceiver. In contrast to this view, known as objectivist approach, the so-called subjectivist view proposes the idea of the dominant role of a perceiver. Anything is beautiful as long it pleases the senses, and this depends on the qualities of the person. One of the logical extensions of these approaches is the interactionist perspective, the combination of both theories. This approach suggests that beauty is a function of properties of an object and characteristics of a perceiver. The latter point of view conforms to one of the modern concepts in the domain of visual aesthetics and perception, namely the processing fluency theory (Reber, Schwarz & Winkielman, 2004). This approach postulates that the aesthetic experience is linked to the processing demands of an object. More attractive objects are those that are easier for perception and cognitive processing fluency, which requires certain characteristics of an object, but depends on mental traits of a perceiver (Reber et al., 2004). An important question to answer is: which particular features and physical properties of an object could facilitate or, on the contrary, impede the cognitive processing. For instance, within the scope of Gestalt psychology, such parameters as amount of information, symmetry, and clarity are considered important for aesthetic perception (Moshagen & Thielsch, 2010). The line of research in visual aesthetics, including the HCI domain, examined various factors coinciding with characteristics of aesthetic objects and identified that features such as prototypicality (Hekkert et al., 2003; Sen & Lindgaard, 2008; Tuch et al., 2012b), complexity (Michailidou et al., 2008; Tuch et al., 2009; Tuch et al., 2012b), and color (Brady & Phillips, 2003; Hall &

Hanna, 2004; Coursaris, Swierenga & Watrall, 2008; Bonnardel, Piolat & Le Bigot, 2011) were crucial for aesthetic perception.

In addition, understanding how aesthetic perception occurs is crucial. Leder et al. (2004) proposed the information-processing stage model of aesthetic processing, an elaborated approach to the process of aesthetic perception of art objects applicable for studying perception of various types of visual stimuli in general (Tuch et al., 2012b).

The model includes five different processing stages enveloping different cognitive analyses (Figure 1). According to Leder et al. (2004), the process of aesthetic perception starts with intuitive and basic cognitive processes, which is described by the first and the second stages of the model (1) perceptual analyses and (2) implicit memory integration. The stages three (explicit classification) and four (cognitive mastering) are affected by the expertise and the knowledge of the perceiver, requiring a higher order of cognitive processes. At the last stage (evaluation) the processed information is evaluated in two levels, gaining two different outputs: aesthetic appraisal and aesthetic judgment.

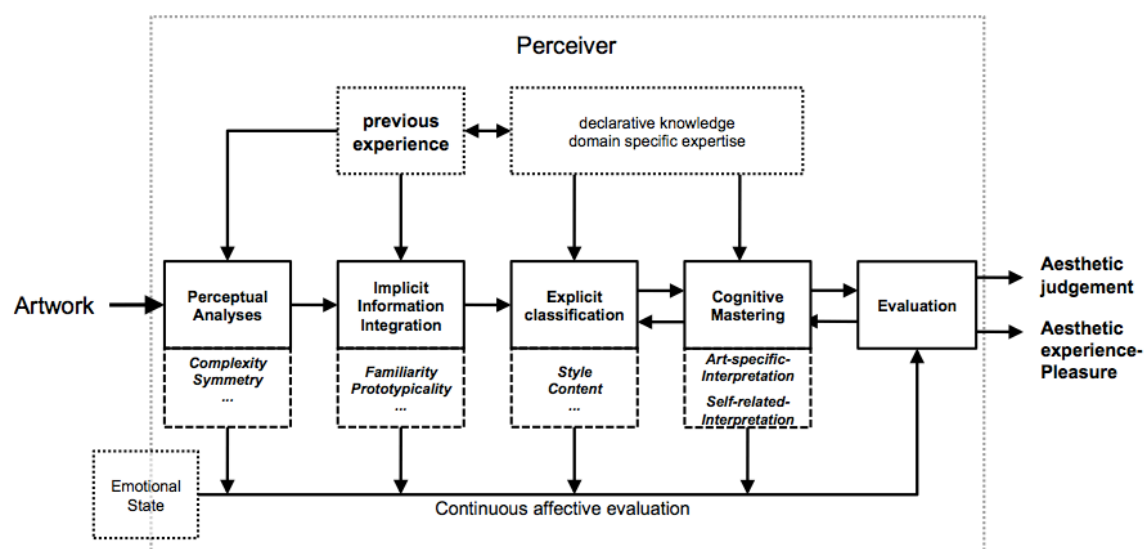


Figure 1. Information-processing stage model of aesthetic processing (adapted from Leder et al., 2004).

The difference between aesthetic appraisal and aesthetic judgment based on the origin of outputs' building: aesthetic appraisals descend from positively valued immediate subjective experiences, whereas aesthetic judgments entail references to normative criteria of what is aesthetic and are therefore concerned with the question of what should be considered aesthetic in a more artistic sense (Leder et al., 2004; Moshagen & Thielsch, 2010). Aesthetic appraisal and aesthetic judgment are not necessarily related. Thus, a perceiver may consider a certain object to be an important piece of modern art (aesthetic judgment), but may perceive this object as unattractive (aesthetic appraisal). The present work is only concerned with aesthetic appraisal.

The information-processing stage model assumes a relative hierarchy of the five processing stages and does not postulate a strict serial flow of information. However, it is possible to derive hypotheses concerning time-sensitive processing of a stimulus (Tuch et al., 2012b). Since the main point of interest of the present research is aesthetic appraisal, understood as an outcome originating from positively valued immediate subjective experiences, the first two stages of the model may play a crucial role concerning first impressions with the focus on impressions formed in a very short period of time (Tuch et al., 2012b). At the first stage, the perceived stimulus is analyzed perceptually, where an observer perceives physical characteristics such as complexity and color. Next, at the stage of implicit memory integration, the perceiver's previous experiences are involved, leading to comparison with existing mental models of an object of perception and making such features as prototypicality or familiarity important for processing the stimulus (Leder et al., 2004). The study of Tuch et al. (2012b) showed strong influence of visual complexity and prototypicality on perceived beauty ratings. However, for the presentation durations of 50 milliseconds, 500 and 1000 milliseconds the influence of both factors was equal, which was giving no support to the reasoning of Leder et al. (2004) that complexity and prototypicality are processed at

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different stages. In the studies of Zajonc (1980, 2001) the ability of participants to perceive various visual stimuli in a very short time frame, namely between 1 and 20 milliseconds, was highlighted. Thus, it is possible that the presentation time of 50 milliseconds is already sufficient for stimulus information to be processed within the second stage (implicit memory integration). Therefore, a further study with shorter exposure times considering the influence of visual complexity and prototypicality on perceived beauty was needed.

Visual complexity

Empirical studies in the HCI domain revealed the evidence of the visual complexity's role in aesthetic perception. For instance, Pandir & Knight (2006) showed negative correlation between pleasure and visual complexity. Michailidou et al. (2008) highlighted that users perceived less complex pages as better organized, more clear, clean and beautiful. Harper et al. (2009) revealed that a visually complex page is just as complex to visually disabled users. In addition, Tuch et al. (2009) found out the increase in users' experienced arousal during the observation of more visually complex websites. It also revealed the increased facial muscle tension (musculus corrugator). Furthermore, in the study by Tuch et al. (2012b) the importance of visual complexity in regard to aesthetic perception was shown.

In the model of Leder et al. (2004), visual complexity is mentioned as a crucial factor of the first stage in the process of aesthetic perception (perceptual analyses) of visual stimuli. The controversial but important in the field of aesthetic theory work of Berlyne (1974) denominated visual complexity, among other variables such as novelty and ambiguity, as one of the most important predictors of perceived aesthetic preference. Berlyne explained this notion by means of arousal potential, implying that arousal depended on level of complexity. More complex stimuli provoke high arousal, whereas stimuli of average complexity give a rise to a moderate arousal and stimuli with low complexity provoke low arousal potential.

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Further, the stimuli with a moderate arousal are pleasurable, whereas the stimuli with high arousal potential are experienced as unpleasant, and the stimuli with low arousal are experienced as boring. The latter studies do not support the idea postulated by Berlyne's U-shape between arousal and pleasure, showing rather a linear pattern (Martindale, Moore & Borkum, 1990; Tuch et al. 2012b). Although the prominence of visual complexity and its influence on viewers' perceptual state and behavior has gained some scientific support, there is a lack of studies concerning the role of visual complexity regarding first impression and aesthetic perception of websites. Further, it stills unclear, whether there is a difference in perception of visual complexity and prototypicality in terms of the processing stages of aesthetic perception (Leder et al., 2004).

Prototypicality

In order to recognize things, people tend to classify all objects around them into groups, which share the same properties. For those object categories for which exist many instances (e. g. cars or websites) people build so-called prototypes, which happens through experience (Hekkert & Leder, 2008). Prototypicality refers to how typical an item is for the category to which it belongs, and can be defined as "the amount to which an object is representative of a class of objects" (Leder et al., 2004, p. 496). To perceive an object as prototypical or representative of a class of objects, antecedent experience with these objects is indispensable. Through that experience mental models of a class of objects are developed. As is explained by processing fluency theory and confirmed experimental, prototypical or easier to process objects are favorable for the perceiver (Reber et al., 2004). This notion conforms to the "mere-exposure" paradigm of Zajonc, where people prefer previously seen pictures or signs (Zajonc, 1980; 2001). Aesthetic preference of prototypical objects was empirically shown for a variety of human artifacts such as cubist paintings, houses, interior designs, musical

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performances and consumer products (Hekkert et al., 2003). Sen and Lindgaard (2008) confirmed the findings of Hekkert et al, (2003), suggesting positive relation between aesthetic appeal and prototypicality for a set of stimuli consisting of images representing basic object categories such as guitars, chairs or cars. Martindale et al. (1990) found preference for prototypical colors.

Prototypicality is difficult to measure as it relies on the individual experience of the beholder. However, Roth, Schmutz, Pauwels, Bargas-Avila & Opwis, K.. (2010) demonstrated the existence of consistent mental models for different web page types. The study revealed that users generally agree about the locations of many, but not all, web objects despite the difference in experience with the Internet. In the study concerning relation between prototypicality, novelty and aesthetic preference of products Hekkert et al. (2003) found that people preferred novel designs only as long as the novelty did not affect prototypicality. Experiments of Tuch et al. (2012b) demonstrated that prototypicality was an important factor for aesthetic perception in the context of first impressions of corporate websites. However, further research to clarify how prototypicality influences aesthetic appraisals of websites and influences the process of aesthetical perception is to perform.

Study 1

Aim of study 1

The objective of the first study was to extend the findings of Tuch et al. (2012b) and to investigate the impact of visual complexity and prototypicality under the condition of very short presentation duration. According to model of Leder et al. (2004) visual complexity affects users' perception on an earlier stage than prototypicality. However, under the condition of 50 milliseconds the impact of both factors remained equal. Further experiments with shorter presentation duration were performed. It was hypothesized that visual complexity and prototypicality have a significant impact on aesthetic appraisal of the users in regard to first impression. Less complex web pages are perceived as being more beautiful in comparison to more complex pages, and more prototypical websites are perceived as being more beautiful compared to less prototypical sites. Moreover, deferring to model of aesthetic processing (Leder et al., 2004), it is expected that the effect of prototypicality amplifies with longer presentation times, whereas the effect of visual complexity remains stable across the used time conditions. Hence, an interaction of presentation duration and prototypicality, but not of visual complexity, is to be expected.

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Method

Design.

A three-way mixed design with the within-subject independent variables visual complexity (low vs. high) and prototypicality (low vs. high) was used in this study. The between-subject independent variable was presentation time with three levels (17 vs. 33 vs. 50 ms¹). The dependent variable was perceived beauty.

Participants.

Participants were recruited through a university database and contacted by email. In total 82 participants (57 females), mainly undergraduate psychology students of the University of Basel, took part in the experiment. Their mean age was 27.3 years (SD 9.9), and the age ranged between 16 and 63 years. The participants were experienced computer and Internet users (M= 10.1; SD = 4.1; Range = 2-30 years) and used web regularly. They had no education in either visual design or web design. As a reward for taking part in the study they received 10 Swiss francs. Participants were randomly assigned into one of the experimental conditions, which were the presentation times.

Apparatus and materials.

The E-prime 2 software (Psychology-Software-Tools, 2002) was used for conducting the

¹ By reason of the TFT screen' refresh rate particularly these levels of presentation time were chosen. Furthermore, the presentation duration could only be achieved approximately. The mean exposure time for 17 ms condition was 16.67 ms (SD = .47), for 33 ms condition- 33.27 ms (SD = .44) and 49.98 ms (SD = .44) for the 50 ms condition.

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experiment. All computers were desktops with 17" TFT screens; resolution of 1440 x 900 pixels and a refresh rate of 60 Hz. The resolution of stimuli was 1000 x 800 pixels.

The selection of stimuli.

The stimuli used in this experiment were taken from the study of Tuch et al. (2012b). Based on the research of Roth et al. (2010), where in the study on mental models six different categories of web pages (company pages, social networking sites, online newspapers and news portals, online shops, search engines, and various types) from the 100 most visited websites of the USA, Germany, Austria and Switzerland (alexa.com; August 2010) were extracted, it was decided to focus on one category of websites, namely business or company websites. Particularly this category was shown as a largest one. Moreover, the findings of this study highlighted that users seemed to have a very consisted model of company websites.

In their study, Tuch et al. (2012b) used the screenshots of real home pages of web pages in order to provide possibly high ecological validity. All screenshots were taken at the same resolution of 1280 x 1024 pixels and reduced to the 1000 x 800 pixels for the main study. To define an appropriate set of stimuli authors conducted an online study. At first, a sample of 464 business websites was collected. It was the most visited pages in August 2010 according to <http://www.alexa.com> within the following business categories: chemicals, energy, accounting, aerospace and defense, automotive, biotechnology and pharmaceuticals, financial services (Tuch et al., 2012b). Next, the authors eliminated the sites that had (1) a contentless intro page, (2) a shopping basket, (3) advertisement (banners), (4) an archive or (5) a content language other than English or German, reduced the sample to 270 websites. As elimination criteria the findings of Roth et al. (2010) were used, where the typical for a business web page, expected by user, website-elements were listed. Then, selected 270 websites were rated by 267 participants in an online survey on visual complexity and

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prototypically (for further detail cf. Tuch et al., 2012b). For our study the 79 websites of high vs. low visual complexity and high and low prototypicality were chosen. The medium visual complexity condition was excluded for this study owing to the linear relation of visual complexity and beauty, which was revealed by Tuch et al. (2012b). Figure 2 shows examples of screenshots for all categories.



Figure 2. Screenshot examples for all four experimental categories.

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Measurements.

To assess the perceived beauty a visual analog scale (VAS) was used with the anchors ugly and beautiful. All ratings were given using a computer mouse to click on the corresponding area of the scale. For the statistical analysis, data obtained by VAS was converted to a scale ranging from 1 to 9.

Procedure.

The experiment was conducted in the computer laboratory of the Institute of Psychology, a room with 20 independent computer workplaces. The participants were seated in front of a desktop monitor, separated from each other by wooden walls forming experimental boxes. They controlled the progress of the experiment with a computer mouse. All instructions were displayed on the screen, but each participant was allowed to contact the experimenter if necessary. A set of 79 screenshots of business websites was presented to the participants, one after another in a random manner. Participants were asked to rate each web page on perceived beauty immediately, without thinking too much. Presentation time of the websites was varied according to the experimental condition a participant was assigned to. To avoid the effect of extended perception of the presented stimulus and make sure that participants perceived each stimulus for exactly chosen duration, a masking procedure was used (cf. Fei-Fei, Iyer, Koch & Perona, 2007). As the mask was used a random visual noise pattern (Rolke & Hofmann, 2007), which was consisted of arrangement of black and white pixels. The mask had the same resolution than the stimulus (1000x800 pixels). Figure 3 depicts the masked stimulus presentation trial.

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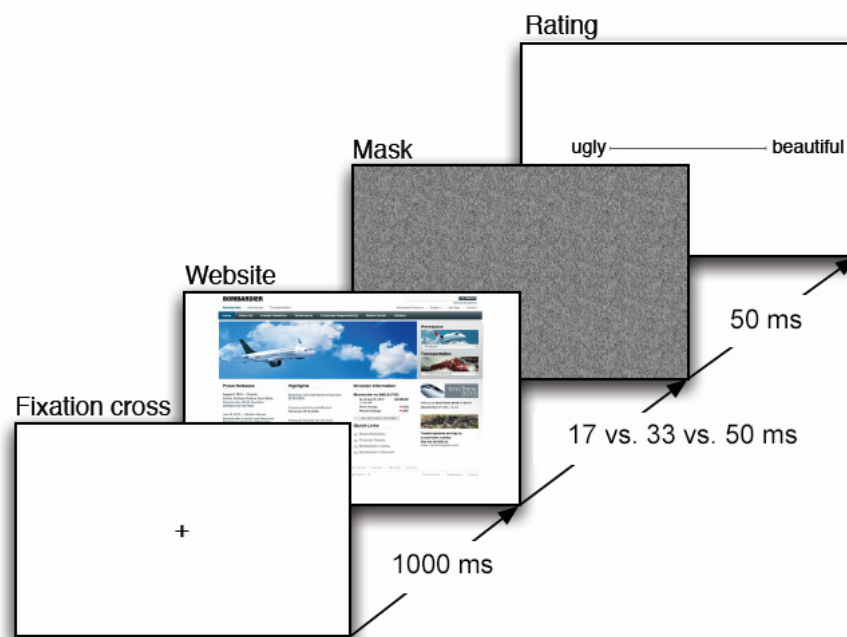


Figure 3. Procedure for a single trial used in this experiment (adapted from Tuch et al. 2012b).

Results

For all statistical tests an alpha level of .05 was used. The data was analyzed with three-way analysis of variance with visual complexity and prototypicality as within-subject independent variables and presentation time as a between-subject variable. Perceived beauty ratings were analyzed as a dependent variable.

Effects of visual complexity and prototypicality on perceived beauty

The results of the ANOVA are summarized in Table 1. The three-way interaction was not significant. Hence, all two-way interactions could have been interpreted without restrictions. A significant interaction between prototypicality and presentation time but a non-significant interaction between visual complexity and time were shown (Figures 4 and 5). The

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interaction between prototypicality and visual complexity was also significant. This interaction first becomes significant under 33 milliseconds condition. The significant main effects of visual complexity and prototypicality were shown. It means that the less complex web pages received higher beauty ratings compared to more complex ones, and highly prototypical web sites gained higher beauty rating in comparison to less prototypical web pages. Because of significance of the above-mentioned interactions, these main effects should have been interpreted with respect to significant interactions. The interaction between visual complexity and prototypicality, where the effect of visual complexity on beauty was stronger for the pages of high prototypicality and the effect of prototypicality was more apparent for sites of low visual complexity, indicated that the combination of low visual complexity and high prototypicality leads to the highest beauty appraisals. The interaction between visual complexity and presentation time meant a strong influence of visual complexity on the perceived beauty already within 17 milliseconds, whereas the interaction between prototypicality and presentation time showed less pronounced effect of prototypicality under 17 milliseconds condition, which became more apparent with increasing time. Additionally, all three presentation time conditions were analyzed separately. Again, significant main effects of visual complexity and prototypicality for each presentation time were discovered. These findings suggest that visual complexity and prototypicality affect the beauty appraisals already within 17 milliseconds. However, within 17 milliseconds the effect of visual complexity is more prominent than the effect of prototypicality. Lastly, no main effect of presentation time was shown. Descriptive statistics for all experimental conditions are presented in Table 2.

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Table 1

ANOVA for perceived beauty

	df	F	η^2_p	p
Within-subject				
PT	1	97.151	.552	.000
VC	1	85.601	.520	.000
VC x PT	1	30.851	.281	.000
PT x time	2	8,832	.183	.000
VC x time	2	1.460	.036	.238
VC x PT x time	2	2.453	.058	.093
error	79			
Between-Subject				
time	2	1.322	.032	.273

Note. VC = visual complexity; PT = prototypicality

Table 2

Mean and standard deviation of perceived beauty for all experimental conditions

	Time Condition					
	17ms (n = 30)		33 ms (n = 24)		50 ms (n = 28)	
	Visual Complexity					
	low	high	low	high	low	high
Prototypicaliy	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
low	4.53 (0.94)	4.31 (0.9)	3.84 (0.93)	3.81 (0.97)	4.17 (0.78)	4.01 (0.72)
high	4.89 (0.94)	4.37 (0.86)	4.92 (1.26)	4.06 (1.10)	5.23 (0.87)	4.25 (0.94)

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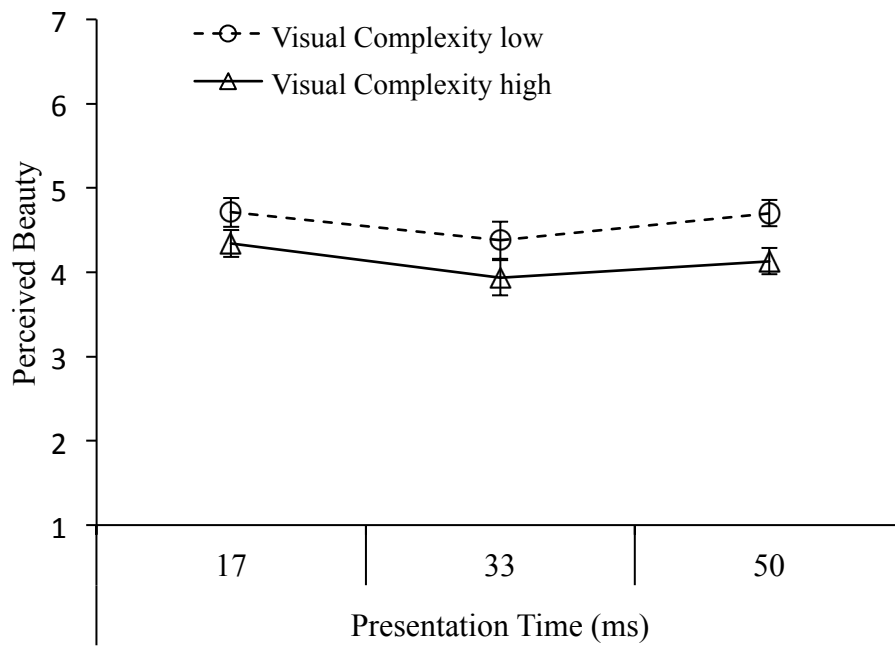


Figure 4. Effect of visual complexity on perceived beauty by different presentation times.

Error bars represent standard deviations.

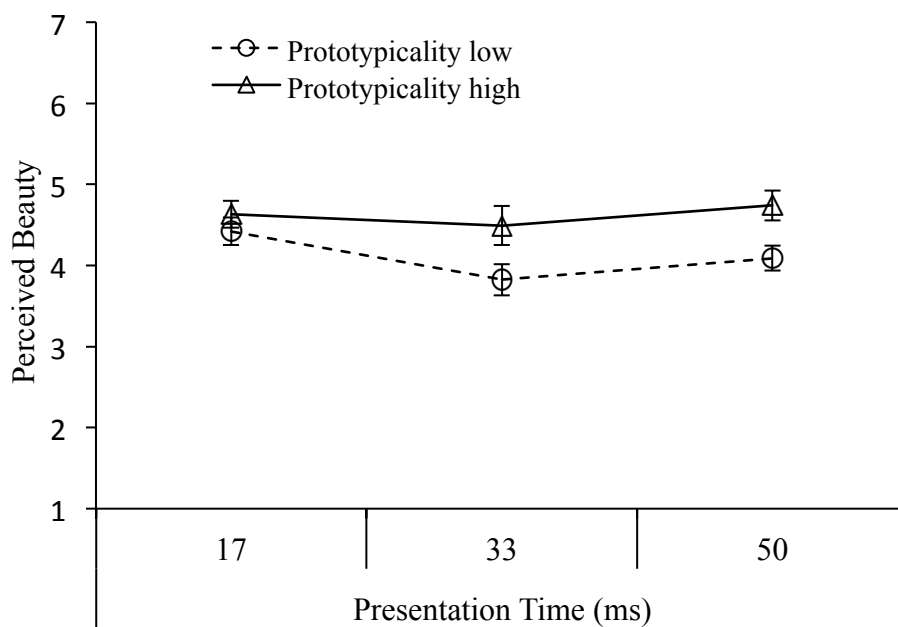


Figure 5. Effect prototypicality on perceived beauty by different presentation times. Error

bars represent standard deviations.

Discussion

The results of this study support the findings of Tuch et al. (2012b), showing the important role of visual complexity and prototypicality in aesthetic perception of web sites, especially regarding the first impression, which occurs within a very short time. The combination of low visual complexity and high prototypicality gains the most favorable beauty appraisals. This interaction first becomes significant within 33 milliseconds condition. Moreover, the findings of the study convey the notion that visual complexity and prototypicality can even be perceived in under 50 milliseconds and within this time the process of aesthetic perception occurs. Despite the presence of the effects of both visual complexity and prototypicality factors at 17 milliseconds level, the effect of prototypicality is less pronounced in comparison to the effect of visual complexity. This finding is consistent with the reasoning of Leder et al. (2004), supporting the idea about processing stages of aesthetic perception, where visual complexity affects perception at an earlier stage than prototypicality.

In present studies it was not scrutinized what makes a web site perceived more or less visual complex and more or less prototypical by users. Investigation of underlying factors of visual complexity and prototypicality is the next step in research domain of visual aesthetic in HCI. Perception of visual complexity of an image depends on such features as the amount of grouping that a user unconsciously performs, familiarity with the scene and existing knowledge of objects inside the scene (Michailidou et al., 2008). This point of view refers to the role of prototypicality for perception not only as an independent factor as well in association with visual complexity. However, there is a lack of studies investigating what factors prototypicality may consist of. There is evidence for location typicality (Roth et al., 2010). Nevertheless, the role of other factors that are able to build certain mental models needs to be studied. One of such factors could be color. Color exerts an influence on affective

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perception, which happens on an emotional level, and requires a very short time to be processed, contributing in building of first impression (Lindgaard, 2007; Bonnardel et al., 2011). Martindale (1984) highlighted the great impact of color typicality in the study, where such factors as color, color typicality, complexity and size of polygons were varied. Hall and Hanna (2004) showed the advantage of background/text color combinations familiarity for further retention and readability in regard to educational web pages.

The research of color's impact is still in its infancy, partly due to complexity of the subject. It is difficult to control and measure wavelengths, brightness and saturation. The perception of colors depends on lighting, state of the perceiver and monitor features in the context of studying of websites (Lindgaard, 2007). Nevertheless, existing research shows that chromatic color combinations of commercial websites, including blue, appear to be preferred by users (Hall & Hanna, 2004). This is supported by findings of Lindgaard (2007), where users generally viewed cooler colors, such as blue, more favorably than warmer colors, such as red or yellow. Brady and Phillips (2003) investigated the impact of color and visual balance of a web page on perceived beauty, understanding under visual balance equal distribution of visual objects on the page. They manipulated location of the site's objects, color on the basis of triadic color scheme (compliant vs. discordant with the scheme variations) and both. Participants preferred the original web page and the altered balance site over the site with manipulated color and the site with both color and balance manipulations. Bonnardel et al. (2011) investigated both layout structure and color preference in regard to their influence on quality of interaction with the website. The authors revealed that effect of color was contingent on physical layout. Thus, color is considered as an important salient factor that contributes to building first impressions and could affect experiences with the page. Furthermore, color and layout, or localization of certain elements on a website, are somehow interrelated. The study of Roth et al. (2010) revealed existence of consistent

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mental models for location typicality of web pages. Tuch et al. (2012b) highlighted that typical business web pages were perceived as more beautiful. Therefore, it is possible to assume that users may also develop concrete expectations regarding the color combinations of a typical website in a particular category.

The above-mentioned studies mostly used just one color in each version of a website to investigate the impact of color, which led to low ecological validity and rather problematic generalization of their results (Bonnardel et al., 2011). In the study of Lindgaard (2007) user's negative first impression of a homepage of the local Government website was explained by color combination. However, in that particular case the layout of the page was rather atypical for this websites' category, which might also be a reason for low beauty appraisal rates. That means, color and layout could both contribute to building of mental models of a particular website category and therefore be crucial predictors of users' perception. Thus, color (or, more precisely, color combinations) must be taken into account and controlled.

Impact of color is particularly important in regard to first impressions, when users perceive properties of web page within very short time span, catching the most prominent object's features such complexity, prototypicality and color (Leder et al., 2004). From that perspective it is essential to investigate the role of color combination's typicality of existing websites, making a further step in research concerning aesthetic appraisals regarding first impressions of a web page.

Study 2

Aim of study 2

The second study aimed to examine the impact of color typicality on aesthetical perception of websites. It was assumed that websites' color preferences of participants found in a number of studies (Brady & Phillips, 2003; Hall & Hanna, 2004; Lindgaard 2007; Bonnardel et al., 2011) might be associated with certain user expectations regarding a particular category of websites, e.g. company web pages. Consistency of expectations and reality or its accordance with mental models facilitates informational processing and leads to higher preference of familiar objects over unfamiliar and ones that are more difficult to process (Hekkert et al., 2003; Reber et al., 2004; Hekkert & Leder, 2008). Hence, color as an important predictor of user preferences, might contribute to perception of websites as prototypical or less prototypical and therefore affect their beauty appraisals. To prove this hypothesis the second study was divided into two parts.

First part of this study attempted to examine the impact of prototypicality and complexity upon beauty appraisals of corporate websites, turned into black-and-white under presentation duration conditions, the same as in the first study. It was hypothesized that visual complexity but not prototypicality have a significant impact on user aesthetic judgments with regard to first impressions. Less complex web pages are perceived as being more beautiful in comparison to more complex pages, but no difference between more prototypical websites and less prototypical sites regarding beauty appraisals was expected. Furthermore, no interaction between presentation duration and prototypicality as well as no interaction between exposure duration and visual complexity were assumed.

In the second part influence of color typicality on aesthetic perception was investigated. Following hypotheses were put forward. First, it was expected that color typicality affected beauty appraisal of websites. The web pages with more typical color

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concepts were supposed to be perceived as more attractive than those with less typical color concepts. Next, the increase of color typicality's influence with increase of presentation duration was hypothesized. It meant an interaction between presentation duration and color typicality.

Method

Design.

For the first part of the study a two-way repeated measures design with the within-subject independent variables visual complexity (low vs. high) and prototypicality (low vs. high) was used. For the second part within-subject design with independent variables color typicality low vs. color typicality high was conducted. The dependent variable was perceived beauty. Due to a technical issue, it was only possible to examine the 17 milliseconds condition.

Participants.

A sample of 59 participants (46 females), mainly undergraduate psychology students of the University of Basel, took part in the experiment. Their mean age was 26.8 year (SD = 8.96), and the age ranged between 17 and 53 years. The participants were experienced computer and Internet users (M = 11.42; SD = 3.8; Range = 5 – 25 years) and used web regularly. They had no experience in either visual design or web design. As a reward for taking part in the study they received course credits or 10 Swiss francs. Participants were randomly assigned to one of the experimental conditions, which were the presentation times. Due to the technical problem, the stimuli were presented to participants during 17, 33 and 34 milliseconds, where 17 milliseconds exposure time dominated. Thereby, only the data of the participants who observed the websites under 17 milliseconds in at least 80% of cases were

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involved in the analysis. In the first part of the study it was the data of 45 participants, and in the second part it was the data of 30 participants.

Apparatus and materials.

The same experimental setup as in study 1 was used.

The selection of stimuli.

Two sets of stimuli were created for the second study. For the first part the stimuli from the study 1 were turned into black-and-white versions of them. Their size remained the same as it was in the first study. For the second part a high-fidelity prototypical corporate web page using the Photoshop CS6 Extended software was created. As a base for website creation the findings of Roth et al. (2010) were taken into account. Different website-elements were chosen and located according to users expectations, provided by Roth et al. (2010). As the next step, 20 most visited in Switzerland business web pages (<http://www.alexacom>; March 2012) and 20 untypical pages (prototypicality low condition) from study 1 were chosen in order to transfer color concepts of these websites to the created prototypical corporate web page. The most visited corporate websites in Switzerland were considered as the base for building mental models of business web pages for Swiss users due to the fact that 'the user's mental model develops naturally while using a system' (Roth et al., 2010, p. 141). By-turn, 'prototypicality is represented by mental models built through experience' (Tuch et al., 2012b, p. 7). Thereby, the use of color concepts from both sets of web pages enabled to create two sets of stimuli with two levels of color prototypicality (high and low). As a transfer instrument, the Photoshop CS6 Extended software was used, which allowed ensuring the appearance of exactly the same colors as the ones that were used in the existing business websites.

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In order to choose the stimuli that are the most suitable for implementation in the main study, a preliminary online study was conducted. Participants ($n = 67$) were asked to rate 40 created mockups of corporate web page regarding their color typicality (The color concept corresponds to a typical company website) by means of a 6-point scale ranging from 1 (“not at all”) to (“very much corresponds”). To reduce the workload, each participant rated 20 websites (10 having typical color concepts and 10 of non-typical color concepts), presented in a random order to exclude an ordering effect. All participants were randomly assigned to a particular set of stimuli, and each stimulus was rated by at least 27 participants. Results showed that the websites with typical color concepts were perceived as more typical compared to the pages with non-typical color concepts $F(1, 39) = 4.94; p < 0.05$. Finally, 10 mockups of high color typicality with the highest typicality rating (means between 4.2 and 4.8) and 10 mockups of low color typicality with the lowest typicality rating (means between 2.8 and 3.6) were selected for the main study. Figures 6 and 7 present screenshot examples for both parts of the study.

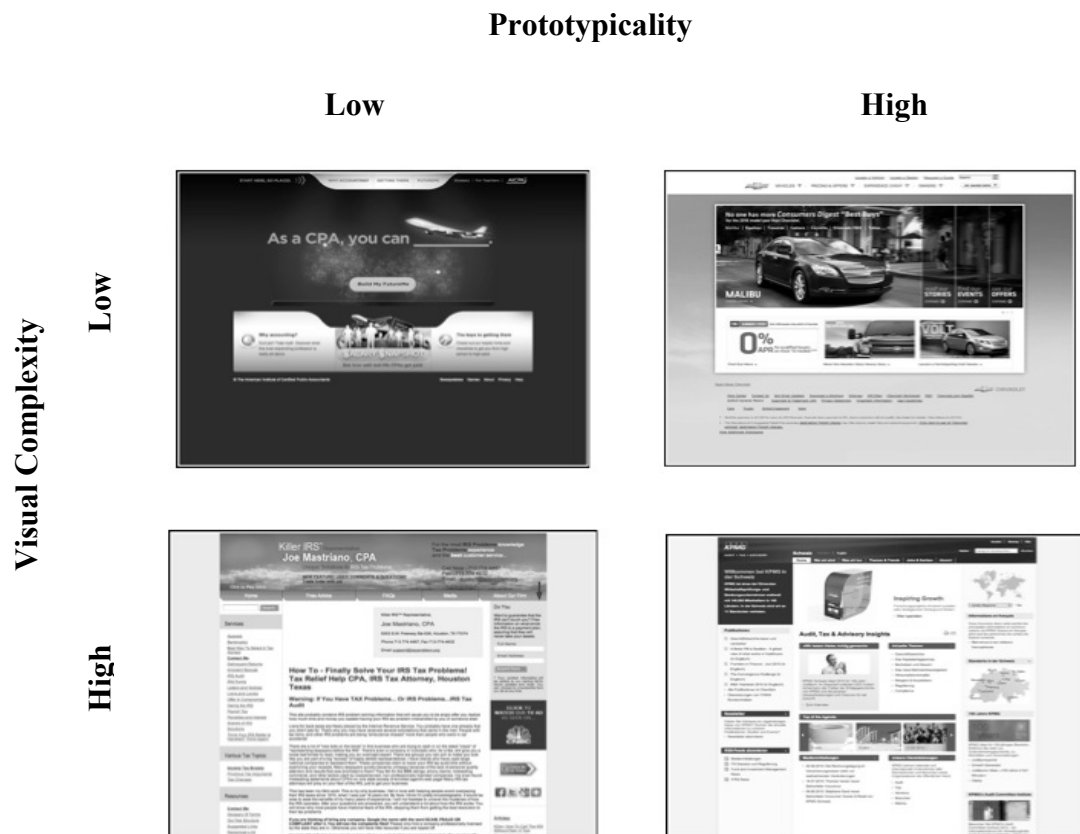


Figure 6. Screenshots examples of the study's first part for all four experimental categories.

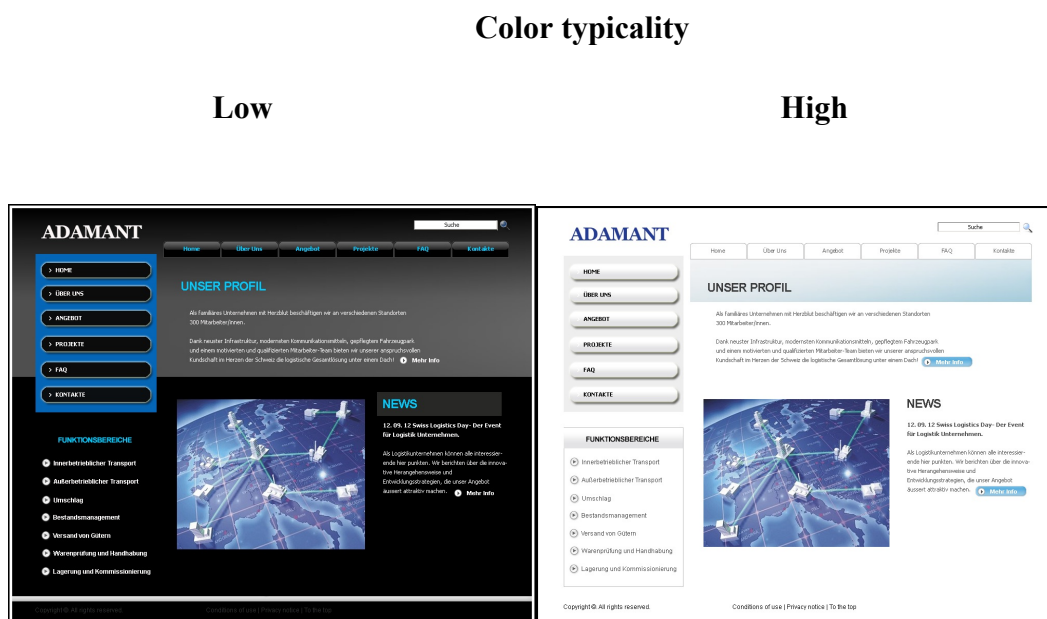


Figure 7. Example websites for the second part of the study for both experimental conditions.

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Procedure.

The experimental procedure repeated that of the study 1 with the exception that the study 2 consisted of two parts, where in the first part the set of 79 black-and-white stimuli was shown and in the second part 20 colored web pages were presented to the participants.

Results

For all statistical tests an alpha level of .05 was used. In order to investigate the effects of visual complexity and prototypicality on perceived beauty (first part of the study) a two-way repeated measures analysis of variance (ANOVA) with visual complexity and prototypicality as within-subject independent variables was used. For the second part paired-samples t-test with independent variables color typicality low vs. color typicality high was conducted. In both cases perceived beauty ratings were analyzed as a dependent variable.

Effects of visual complexity and prototypicality on perceived beauty in black-and-white websites

The results of the ANOVA and descriptive statistics for all experimental conditions are summarized in Table 3. The interaction between visual complexity and prototypicality was not significant. The significant main effects of visual complexity and prototypicality were shown. It means that the less complex web pages received higher beauty ratings compared to more complex ones, and highly prototypical websites gained higher beauty ratings than websites of lower prototypicality. However, the main effects remained weaker than they were in the first study, where the same stimuli but in colored version were involved. Again, the findings suggest that visual complexity and prototypicality affect beauty appraisals already within 17 milliseconds, but the influence of both factors became weaker for black-and-white web pages (effect size $\eta_p^2 = .105$ for visual complexity and $\eta_p^2 = .097$ for

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prototypicality), while for the same but colored web sites it looked different under 17 millisecond condition (effect size $\eta^2_p = .380$ for visual complexity and $\eta^2_p = .190$ for prototypicality respectively).

Table 3

ANOVA for perceived beauty for all experimental conditions for black-and-white stimuli

	M (SD)	M (SD)	df	F	η^2_p	p
	high	low				
Prototypicality	4.58(1.64)	4.45(1.58)	1	4.748	0.097	0.035
Visual Complexity	4.45(1.56)	4.58(1.66)	1	5.169	0.105	0.028
PT x VC			1	3.855	0.081	0.056
Error			44			

Note. VC = visual complexity; PT = prototypicality

Effects of color typicality on perceived beauty

The results of paired-samples t-test showed a significant difference between the experimental conditions, $t(29) = 2.35$, $p = .027$, $\eta^2 = .157$ (one-tailed). However, unlike the hypothesis, the participants rated web pages with less typical color concepts higher than websites of more typical color concepts under the condition of 17 milliseconds. It means that websites with less typical color concepts were perceived as more attractive compared to web pages with more typical color concepts. Mean and standard deviation of perceived beauty for both experimental conditions were $M(SD) = 4.48(1.04)$ for websites of low color typicality and $M(SD) = 4.25(1.19)$ for web pages of high color typicality respectively.

Discussion

The results of the second study showed no significant interaction between visual complexity and prototypicality within 17 milliseconds condition for black-and-white websites. However, the significant main effects of visual complexity and prototypicality were shown, signifying that less visually complex web pages were rated by participants higher regarding their beauty compared to more complex ones. Further, highly prototypical websites gained higher beauty ratings than websites of lower prototypicality. Compared to colored version of the web pages, where the effect of prototypicality was greater than the effect of visual complexity ($\eta^2_p = .380$ for visual complexity and $\eta^2_p = .190$ for prototypicality), the effects of visual complexity and prototypicality were revealed to be equally small for black-and-white stimuli (effect size $\eta^2_p = .105$ for visual complexity and $\eta^2_p = .097$ for prototypicality). That might indicate an influence of color on perception of visual complexity and prototypicality. Visual complexity seemed to be most affected.

Next, contrary to our hypothesis, participants perceived the websites with less typical color concepts as more beautiful than websites of more typical color concepts. As the first study revealed, at 17 milliseconds level the influence of prototypicality on beauty appraisals remains not prominent. Hence, 17 milliseconds presentation duration does not allow to make an implication, whether users generally prefer the websites with less typical color concepts over web pages with more typical ones. These results show that users can discriminate different color concepts within 17 milliseconds. It supports the assumption that color plays an important role for building first impressions (Lindgaard, 2006; Lindgaard 2007) and gives some support to the ideas of Leder et al. (2004), who assume that color is perceived at the stage of perceptual analysis. Further studies need to be conducted in order to examine the

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effects of visual complexity, prototypicality and color typicality under different presentation duration.

General Discussion

The results of the conducted studies reveal the importance of visual complexity, prototypicality and color typicality for aesthetic perception of websites concerning first impression. The first study, showed that the effect of prototypicality on aesthetic perception is more apparent among the web pages of low visual complexity, and the visual complexity's effect weakens among the web pages of low prototypicality. This interaction first becomes significant under condition of 33 milliseconds. Further, less complex web pages were perceived as more beautiful than more complex websites. More prototypical web pages gained a more positive first impression compared to less prototypical ones. No interaction between visual complexity and presentation time meant a strong influence of visual complexity on the perceived beauty already within 17 milliseconds, whereas the interaction between prototypicality and presentation time showed less pronounced effect of prototypicality under 17 milliseconds condition, which became more apparent with increasing time. Web pages of lower color typicality led to more positive first impressions than those of higher color typicality.

Visual complexity, prototypicality and color typicality affect aesthetic appraisals within 17 milliseconds presentation duration. It means that this short time span is sufficient for perceivers to embrace and process information about the visual complexity, prototypicality and color of a website and use these features to form the first impression. This results highlighted some evidence to support the ideas of Leder et al. (2004) regarding the stages of aesthetic perception, showing that visual complexity and color are processed at an earlier stage than prototypicality.

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The impact of visual complexity, prototypicality and color on the aesthetic appraisals

Supporting the findings of previous research (Michailidou et al., 2008; Tuch et al., 2009; Tuch et al., 2012b), visual complexity plays an important role in forming aesthetic appraisals in a way of negative linear relationship between aesthetics and visual complexity. This notion supports the findings of several studies (e. g. Michailidou et al., 2008; Pandir & Knight, 2006; Tuch et al., 2009; Tuch et al., 2012b), where visual complexity and beauty had a negative linear relationship. Next, prototypicality is also a strong predictor for aesthetic perception. More prototypical business websites were perceived as more beautiful than less prototypical ones, which suggests a positive relationship between prototypicality and beauty. In the first study the effects of visual complexity and prototypicality on beauty appraisals were stable and strong. The effect sizes were $\eta^2_p = .52$ for visual complexity and $\eta^2_p = .55$ for prototypicality.

In the second study it was possible to analyze the data only for one time condition of 17 milliseconds. The results of the first part suggest that color might at least affect perception of visual complexity. Even though both factors remain to have a significant impact on beauty appraisals also for black-and-white versions of websites, the effect sizes were relatively small: $\eta^2_p = .105$ for complexity and $\eta^2_p = .097$ for prototypicality, compared to results of the first study for 17 milliseconds, where $\eta^2_p = .380$ for visual complexity and $\eta^2_p = .190$ for prototypicality respectively.

Further, an interaction between visual complexity and prototypicality was found not significant in both studies for 17 milliseconds presentation duration. This interaction starts to be significant at 33 milliseconds, at least for colored websites. It means that web pages of high prototypicality and low visual complexity are perceived as most attractive, while atypical and visually complex websites gained the worst first impression.

Color typicality and aesthetic appraisal

In the second study (second part) we aimed at investigating the influence of color typicality on beauty appraisals, assuming that more typical color concepts should be more favorable for participants compared to rather atypical color concepts. The findings of the study revealed the opposite pattern, showing that at 17 milliseconds users prefer non-typical websites' color concepts to typical ones. There are several explanations for the obtained results. First, a small effect size ($\eta^2_p = .157$) and the findings of the first study, where prototypicality increased its influence in the course of time, might indicate that 17 milliseconds is not sufficient to process the typicality of color concepts, and the participants' responses can be explained by reaction on a very salient feature – color. Further research is essential to investigate the role of color concepts in perception of prototypicality regarding first impressions.

Visual complexity, prototypicality and color in the process of aesthetic perception

Concerning the ideas of Leder et al. (2004) about information-processing of aesthetic perception it was assumed that visual complexity affects aesthetic perception on an earlier stage (stage of perceptual analysis) than prototypicality, which was meant to be processed on the following stage (implicit memory integration). Thereby, it was expected that the effect of prototypicality increased in the course of time or with longer presentation durations, whereas the effect of visual complexity was supposed to be stable over the different presentation times. The results of the first study support these assumptions. Both factors had significant impact on beauty appraisals already within 17 milliseconds. However, the effect of prototypicality was less pronounced than the one of visual complexity.

In the second study, where in the first part black-and-white stimuli were involved, it was not possible to observe the influence of color on visual complexity and prototypicality with different presentation times. However, the results of the 17 milliseconds condition suggest

some implications. First, color is processed already within 17 milliseconds. No difference between visual complexity and prototypicality was found, suggesting, that color might affect perception of prototypicality, but most of all the one of visual complexity. It is possible, that within 17 milliseconds color is perceived as an independent salient feature, which influences a perceiver on affective level (Leder et al., 2004; Lindgaard, 2007; Bonnardel et al., 2011). Further studies with longer presentation durations are required to verify, whether color affects prototypicality as well or, in other words, whether color concept is a part of prototypicality and is embedded into users' mental models of corporate websites.

Limitations and further research

It's important to note the limitations of the present research to better provide a context for interpretation and further research. First, the conducted studies were laboratory experiments, where websites were presented as a number of pictures for passive viewing and rating. The experimental setting was strictly controlled and the experimental conditions were standardized. However, the ecological validity suffers from the rather unrealistic situation of dealing with websites. In real life users interact with web pages, not just observe them. Interaction affects user experience at a very high level. On the other hand, the first impressions are formed when users have just arrived on a website, and the process of initial impression's forming ought to be similar to the screenshot-viewing task, used in the present studies. Second, the web pages of the second study were altered in the first part and created for the second part, so they were not real web pages, which meant lowering of ecological validity. Third, the present studies were conducted with only business websites. It applies certain restrictions in regard to generalization of gained results on all existent categories of web pages. Fourthly, a technical problem occurred during the second study, which made it

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impossible to perform the planned analysis, where several time conditions were to be compared. Fifthly, the participants of all studies were mainly undergraduate students of the University of Basel, which might imply specific demographic factors, rather non-typical for the whole population. Also cultural aspect was not taken into account. It is possible that the influence of visual complexity, prototypicality and color concepts on beauty appraisals might differ among different cultures. Lastly, all three features that were investigated in the present research were studied without controlling underlying factors that build visual complexity, prototypicality and color concepts.

Further research is required to observe the effects of such aesthetic properties as visual complexity, prototypicality and color typicality in a more realistic situation, also where interaction with a website would be involved. It is necessary to investigate other website types, for which users have formed stable mental models, such as online shops or news websites (Roth et al., 2010), especially concerning prototypicality, color typicality and their interrelation. Experiments with different presentation durations are particularly important. There is some evidence regarding stability of first impression over time (Lindgaard and Dudek, 2002). Phillips and Chaparro (2009) postulate that if users have a positive first impression, they may continue to like a website regardless of how successful the interaction with the site has been. However, these ideas need further experimental investigation to reveal whether effects of first impression remain stable over time and after interaction with a website. Next, knowing that 'prototypicality is represented by mental models built through experience' (Tuch et al., 2012b, p. 7), it would be interesting to examine, whether perception of visual complexity is changing over time, while a user interacts with a website, becoming a part of users' mental models. Further, in the present studies only Swiss users were involved. There is, however, some indication of cultural differences in aesthetic preference (Zhang, Feick & Price, 2006, Lindgaard, Litwinska & Dudek, 2008). Hence, cross-cultural studies

are the point of interest. Lastly, it is important to explore underlying factors that constitute visual complexity and prototypicality. The fundamental principles of perception of color concepts remain a question for further research.

Conclusions

In summary, the present studies reveal the important role of such factors as visual complexity, prototypicality and color typicality in the process of building aesthetic appraisal. The results support and extend the previous research on aesthetic perception and allow implying several insights for designers working in the web design industry. Attractive design is a crucial criterion for users while making the decision whether to stay on a website or to leave it (Sillence et al., 2006).

First of all, it is desirable to provide visual complexity on the lowest possible level. Only essential information structured reasonably should be available. Long lists of links are to be avoided, and categorizing lists in smaller chunks is advised (Xing & Manning, 2005). Nice-to-have features can be involved, if they do not overcomplicate a design.

Secondly, it is essential to create highly prototypical designs. It means consistency of utilized icons and elements of a web page and their placement depending on the web page's category. For instance, the users expect such website elements as a search field, sign in/login or shopping cart fields to be placed in the upper right corner (Roth et al., 2010). "Back to homepage" link is expected in the top-left corner (Roth et al., 2010). A consistent template on each page is required, and important information is to be arranged near the top of the page.

In addition, it is important to be careful with color and color concepts. Color affects visual complexity and prototypicality. Thus, it is important to avoid overusing colors in the

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design in order keep visual complexity of a website to a minimum. The rather contradictory results regarding color typicality do not allow us making suggestions.

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