

THE INTERPLAY BETWEEN WEB AESTHETICS AND ACCESSIBILITY

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Abstract

The use of visual aesthetics has been found to contribute to feelings of a positive Web experience. Accordingly, studies report strong correlations between aesthetics and facets of user experience like usability and credibility, but does this hold for accessibility also? Some believe that Web aesthetics impedes accessibility, while most Web designers perceive that the accessibility initiative is restrictive design-wise. These misconceptions have slowed down the advancement of an inclusive Web. Firstly, it is clear that the relationship between Web aesthetics and accessibility is still poorly understood. Secondly, tools capable of analysing the aesthetic quality of Web pages and relaying associated accessibility status information are lacking. This thesis addresses these two problems.

In order to investigate this relationship, the aesthetic judgements of 180 users were elicited to help classify Web pages based on their visual quality using Lavie and Tractinsky’s framework. The classified Web pages were then technically and manually audited for accessibility compliance using 4 automated tools, and 11 experts who used a heuristic evaluation technique known as the Barrier Walk-through (BW) method to check for barriers which could affect people with visual impairments. Our results consistently showed that Web pages judged on Lavie and Tractinsky’s classical aesthetic dimension as being ‘clean’ had significant correlations with accessibility, suggesting ‘cleanness’ to be a suitable proxy measure for accessibility. Expressive dimensions showed no such correlations.

This insight was used to develop the EIVAA tool aimed at predicting the aesthetic quality of Web pages and using the information to provide accessibility ratings for the pages. Quantitative evaluations show that the tool is able to predict aesthetic quality in a way that mimics gold standards, especially along the design dimension ‘clean’ where we observed tool-human correlations as strong as 0.703, thus making the associated accessibility predictions also acceptable. We envision that our findings will give the Web community a more holistic understanding of the interactions between the use of aesthetics and accessibility, and that our tool would inform Web developers of the implications of their designs.

Declaration

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institution of learning.

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Dedication

In loving memory of my Dad, Professor Ebong W. Mbipom who inspired me and gently urged me to the finish line, but slept just before I crossed the line.

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Chapter 1

Introduction

The World Wide Web (Web) is dominantly a visual medium, so it is little wonder that many Websites nowadays are laden with sophisticated and fancy visual designs in order to impress Web visitors. The ‘visual push’ strategy seems to work quite well considering the on-line behaviours of Web users. Most users perceive visually attractive Websites to be more credible [Karvonen, 2000; Robins and Holmes, 2008], usable [Hartmann et al., 2007; Phillips and Chaparro, 2009; Lavie and Tractinsky, 2004] and useful [Heijden, 2003; Cyr et al., 2006] compared with sites that are not as visually adorned. Sometimes, in a bid to attract these on-line visitors the appearance of a Web page is placed ahead of its functionality. How to maintain a balance between form and function has been a long standing issue for disciplines with elements of visual design [Crozier, 1994]. The present research seeks to address a case of this design dilemma by investigating the interplay between visual aesthetics and accessibility in the context of the Web.

Although highly attractive sites enhance positive Web experience for sighted users, these sorts of sites are speculated to hinder people with disabilities, especially those with visual impairments¹ [Sloan et al., 2000]. On the other hand, most Web designers perceive the accessibility initiative to be restrictive, and some are reluctant to embrace the guidelines that have been put in place [Petrie et al., 2004; Regan, 2004]. Web accessibility practitioners’ efforts to mediate between these two extremes have met with challenges, primarily because the current state of affairs seems not to support claims that appealing designs can go hand in glove with accessibility [Regan, 2004]. Consider the examples in Figures 1.1 and 1.2.

¹Visual impairments here include blindness, low-vision and colour-blindness.



Figure 1.1: Accessibility model: Homepage of the Web Accessibility Initiative Website (<http://www.w3.org/WAI/>). Accessed 18-12-2010.

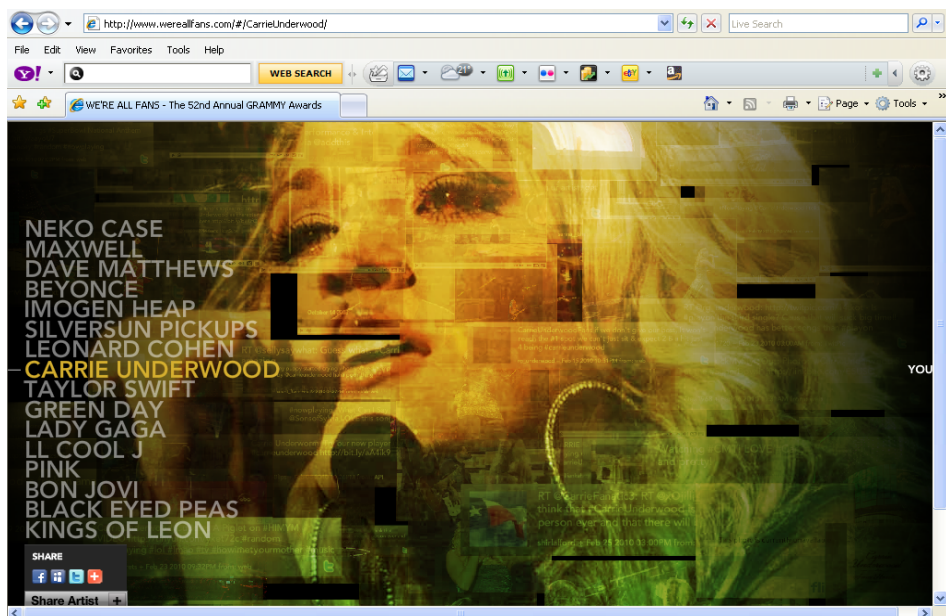


Figure 1.2: Visual design model: Homepage of the We're All Fans Website (<http://www.wereallfans.com>). Webby awards winner for best visual aesthetic design 2010 as selected by People's Voice. Accessed 18-12-2010.

The Web page in Figure 1.1 belongs to the Web Accessibility Initiative (WAI) which is a key organisation that helps to promote the accessibility mission in Web domains. It will therefore serve as an accessibility model. While the Web page in Figure 1.2 belongs to the We're All Fans Website which won the 2010 Webby awards under the best visual aesthetic design as selected by People's Voice, and so serves as a visual design model here. As we would expect, the accessibility model is top quality when it comes to ease-of-use irrespective of the user's particular circumstances. Notice, however, that it has a much simpler visual design compared to the homepage in Figure 1.2. The visual design model on the other hand is believed to be highly aesthetic. The homepage features a complex visual design, and is a mesh of small interactive squares which grow bigger as you roll your mouse over them. As accessibility is not one of the many criteria for this international Web innovations award [Regan, 2004], one wonders if any accessibility considerations were made for this visual design model. These sorts of combinations are commonplace on the Web today. Perhaps similar cases have contributed to framing the thinking of the Web community into believing that accessible Websites have limited visual appeal or creativity, while visually attractive sites pose a problem to accessibility, which may not be the case.

Until now, much of the work that has been done to address common misconceptions like the one we have just described has been anecdotal or advisory in nature. It is important that clarifications are made in order to: i) attract mainstream Web designers [Regan, 2004] and ii) make available further scientific evidence for use in Web accessibility education. Consequently, a major contribution of the research described here is to determine in an exploratory fashion the state of the art in accessible design. In particular, this thesis reports a first empirical attempt to investigate the relationship between Web aesthetics (as conceptualised in Lavie and Tractinsky [2004]'s framework) and accessibility through several user studies. The research outcomes would be used to inform the development of an automated framework, EIVAA² capable of analyzing the aesthetic quality of Web pages with the aim of providing proxy accessibility status information for the pages in question. The EIVAA tool is part of an open-source project known as the Eclipse Accessibility Tools Framework (ACTF)³. We envision that the tool would help inform Web developers of the implications of their designs.

²EIVAA - Empirical Investigation of Visual Aesthetics and Accessibility

³Eclipse ACTF - <http://www.eclipse.org/actf/>

1.1 Research Questions

To aid our investigation, three key research questions are considered in this thesis:

1. **What types of Web design come across as visually pleasing?** To enable us to answer this first question, Lavie and Tractinsky [2004]’s Web aesthetics framework will be employed to help rate and classify Web pages based on their visual quality. They found perceived visual aesthetic aspects of the Web to be “bi-dimensional”, with *classical* and *expressive* parts. Classical designs are simple, while expressive designs are sophisticated. Unlike other studies which employ the aforementioned framework, we are also interested in eliciting the Web design features which moderate users aesthetic judgements along these two dimensions. Such an understanding will be useful for the development of a more objective metric for Web aesthetics.
2. **What is the link between Web aesthetics and accessibility?** To address this question, technical and manual accessibility audits will be performed on Web pages whose aesthetic quality has already been determined in question 1 above. We will use automated evaluation tools and Web accessibility experts respectively. We conjecture that Web pages which are ranked high on the classical dimension will have fewer accessibility barriers, compared to Web pages classed as being expressive in their designs. Answering this question will help to address some of the common misconceptions that surround the relationship between Web aesthetics and accessibility.
3. **Can we build an automated framework which is able to evaluate the accessibility level of Web pages based on their visual designs?** At a high level, the way a Web page looks could be used to predict how easy or difficult Web users would find interacting with the page. Existing studies establish links between perceived aesthetic aspects of Web pages and their perceived usability (e.g [Heijden, 2003; Lavie and Tractinsky, 2004; Phillips and Chaparro, 2009]). However, none of these studies further explore the possibility of predicting functionality from visual appearance. Such a system is desirable, as it could provide proxy measures of functionality issues before actual user evaluations are conducted. It is important to state from the outset, however, that we do not recommend that such a system replaces manual Web evaluations or user testing, but that it compliments them.

1.2 Thesis Structure

Further descriptions of the research context, experiments and key findings are presented in the rest of the thesis which is organised as follows:

- **Chapter 2 - Background and Related Work:** A critical look at the existing literature reveals that while the interplay between visual aesthetics and some aspects of user experience like usability and credibility have received a lot of attention in the context of the Web, accessibility has not. Most studies report a positive relationship between Web aesthetics and the facet of user experience which they investigate. In the usability case, however, while some studies report a straightforward positive relationship, because Websites which users perceive to be aesthetically pleasing are also perceived to be easy to use. Other studies relay a more complex interaction, as such positive associations exist given certain conditions only. This insight is particularly important for our research work, since usability and accessibility are considered to be closely related facets of user experience.
- **Chapter 3 - A Case for the Research:** This chapter describes a preliminary study which was carried out to make the research problem clearer. This involved extending work done in a related PhD project, ViCRAM⁴ [Michailidou, 2010]. In ViCRAM, the researchers established that there was a link between Web aesthetics and complexity. Aesthetically pleasing Web pages were perceived to be simple, while their displeasing counterparts were perceived to be complex [Michailidou et al., 2008]. Accordingly, we conjectured that there may also be a link between the aesthetic quality of Web pages and their accessibility, seeing that complexity and accessibility are somewhat related Web concepts. To investigate this, we performed technical accessibility evaluations on Web pages which had previously been rated for their aesthetic quality in the ViCRAM project. Our findings led us to pursue more rigorous empirical studies reported in Chapters 4 and 5.
- **Chapter 4 - Web Aesthetics Studies:** Two studies (lab-based and online) were conducted to investigate how sighted users discriminate between Web designs. We were also interested in the Web page features which moderate these aesthetic judgements. A total of 180 participants were involved

⁴Visual Complexity Rankings and Accessibility Metrics

in the two studies. Both studies showed that there are several factors which influence the aesthetic judgements of Web users. Depending on the design dimension being evaluated, there were certain indicator properties possessed by Web pages which users relied upon to make their aesthetic judgements. For example, the presence of one main image, a mostly white background, and a sparse layout were important for rating a Web page as being clean (classical aesthetics), while the use of animations was more important for rating a Web page as being fascinating or creative (expressive aesthetics). These indicator properties proved useful for defining a more objective metric for Web aesthetics. This formed the empirical basis for the development of the EIVAA framework described in Chapter 6 of this research thesis.

- **Chapter 5 - Web Accessibility Audits:** In order to establish the link between Web aesthetics and accessibility, investigations into the accessibility levels of the homepages already investigated in Chapter 4 were performed using two approaches, technical and manual evaluations. In the technical evaluation, 4 automated accessibility checkers were used to examine all 50 Web pages under investigation for general accessibility compliance, before correlating the evaluation results with aesthetic aspects of the Web pages. No strong conclusions could be drawn across tools. This called for a further and more reliable accessibility audit. In the follow-up manual audit, a heuristic technique known as the Barrier Walkthrough (BW) method was employed. Eleven (11) Web accessibility experts examined a cross-section of the Web pages for barriers capable of affecting people with visual impairments. A major conclusion drawn here was that Web pages judged on the classical dimension as being clean had fewer accessibility barriers, compared to Web pages which were considered to be expressive in their designs. This was used to inform the EIVAA tool, especially on accessibility predictions.
- **Chapter 6 - Predicting Web Content Quality:** Here we describe a framework called EIVAA, which is also part of Eclipse ACTF. The framework is built on empirical findings from Chapters 4 and 5 of this thesis. The EIVAA tool is expected to predict the aesthetic quality of Web pages, and provide accessibility evaluations for the same Web pages. The framework represents a first attempt to use the visual appearance of a Web page to make recommendations regarding the page's functionality. It is built

on regression models which were created in a training exercise which involved selected programmatically detectable Web design features used as predictors on 50 homepages. The tool predicts Web visual quality along five design dimensions clean, pleasing, fascinating, creative and aesthetic in an objective fashion. It then relays the accessibility status of the Web page by examining the cleanness level of the visual design. Visual cleanness was found to be a suitable proxy measure for accessibility in the user studies described in the earlier chapters. We conclude with reports regarding the performance and limitations of the EIVAA tool on the training dataset.

- **Chapter 7 - An Evaluation of the EIVAA Framework:** This chapter demonstrates the predictive capabilities of the EIVAA tool on an entirely new dataset comprising 10 homepages. Here we compare the aesthetic ratings performed by the tool with that of its human counterparts. In an on-line study, 137 Web users rated the new set of Web pages on their aesthetic quality as before, and afterwards the EIVAA tool was used to rate the pages along the same lines. Quantitative and qualitative evaluations conducted show that the tool is able to predict the aesthetic quality of Web pages, and make recommendations regarding their accessibility levels in a manner that closely mimics gold standards or its human counterparts. In particular, the tool obtains the highest accuracy predictions for rating visual cleanness and we explain what this means for accessibility status predictions. Discussions regarding the tool's accuracy achievements for the other four design dimensions investigated are also presented in this chapter.
- **Chapter 8 - Conclusion and Future Work:** This chapter recaps the main contributions of our research. We envision that the findings discussed in this concluding chapter will help to address some of the misconceptions that surround Web aesthetics use and accessibility. We also acknowledge the fact that there may be other factors moderating the interplay between Web aesthetics and accessibility which we did not investigate in this thesis. Some examples include the types of tools used for Web development, the designer's background and level of accessibility awareness and an individual's or organisation's adherence to accessibility guidelines, either for business or legal reasons. These represent possible future directions for the work described in this thesis, and we discuss them accordingly in this chapter.

1.3 Publications

The research described in this thesis led to the publication of 4 technical reports (See Appendix E) and 3 peer-reviewed papers. The peer-reviewed papers are outlined here in chronological order:

- i. Mbipom, Grace. *Good Visual Aesthetics Equals Good Web Accessibility*, SIGACCESS Accessible Computing, Issue 93, pp 75 - 83, 2009.

This paper provides an overview of the EIVAA project. It describes a formative study (See Chapter 3) which was conducted to help make the research problem and area of interest clearer. Results showed that there was a link between visual aesthetics and Web accessibility which required further investigations. An earlier version of the paper was presented at the ASSETS'08 doctoral consortium, Halifax, Canada. This provided an opportunity to discuss the current project with experts in the field. Insights on how to refine our methodologies, and suggestions regarding future research directions were gained in the process (Paper acceptance rate = N/A).

- ii. Mbipom, Grace and Harper, Simon. *The Transition From Web Content Accessibility Guidelines 1.0 to 2.0: What This Means for Evaluation and Repair*, in proceedings of the 27th ACM International Conference on Design of Communication, Bloomington, Indiana, USA, pp. 37 - 44, 2009

In the course of our research, a new set of Web accessibility guidelines, WCAG 2.0 were enacted by the World Wide Web Consortium (W3C) (See Chapter 2). This paper sought to understand how the change affects our research. No major issues were envisaged (Paper acceptance rate = 51%).

- iii. Mbipom, Grace and Harper, Simon. *The Interplay Between Web Aesthetics and Accessibility*, in proceedings of the 11th ACM International Conference on Accessible Computing, Dundee, Scotland, UK, pp. 147 - 154, 2011

This paper reports a further empirical investigation (See Chapters 4 and 5) on the relationship between Web aesthetics and accessibility. The study revealed the relationship to be a conditional one. Web pages judged on the classical dimension as being visually clean had fewer accessibility barriers, while expressive designs and other aesthetic dimensions showed no relations with accessibility. The work suggested that visual cleanness may be a suitable proxy measure for accessibility (Paper acceptance rate = 30%).

Chapter 2

Background and Related Work

A review of previous studies on Web aesthetics and accessibility is presented here. The review provides a theoretical background for the work described in this thesis, and allows us to justify our research objectives and experimental approaches based on insights gained from the literature. The chapter is divided into two main sections. In the first part we begin by giving a brief overview of Web aesthetics as a sub-discipline of Human Computer Interaction (HCI). We outline the prevalent research directions and approaches used in the field. In the second part we introduce Web accessibility and also provide an overview of the area. We then discuss some of the common accessibility evaluation methods available in the literature. A synopsis which highlights salient aspects of the existing literature and how they relate to our work is provided in every sub-section. The survey reveals that while there has been a lot of controversy regarding the interplay between these two Web constructs (i.e. aesthetics and accessibility) and their impact on user experience, not much empirical work is evident in the area.

2.1 Web Aesthetics

Web aesthetics research is mainly concerned with investigations regarding the visual quality of Web resources. Work in the area is particularly important for determining user preferences [Schenkman and Jonsson, 2000], as well as understanding the impact of certain types of visual design on Web experience. This in turn helps Web designers to improve on the visual presentation of their Websites for increased user satisfaction. Another argument for the study of Web aesthetics

is the fact that research findings may be used to validate theories of aesthetic perception. A good number of these theories are alien to Web domains, as they have their origins in fields such as philosophy, experimental psychology and the arts. Consequently, studies in Web aesthetics help to foster cross-disciplinary research (e.g [Pandir and Knight, 2006; Lindgaard et al., 2006; Tuch et al., 2009]).

Existing studies have consistently established that the visual quality of a Website influences the way users perceive or interact with it (e.g [Blanco et al., 2010; Bonnardel et al., 2011; Cyr et al., 2010; Djamasbi et al., 2010; Hall and Hanna, 2004]). In e-commerce for example, the visual quality of a Website may be crucial for winning over casual viewers, especially for sites which offer products and services that are competitive [Lindgaard, 2007]. Attractive Websites could also make visitors linger on a page, even when the information they are seeking is not present [Nakarada-Kordic and Lobb, 2005]. As such, Web aesthetics proves to be a powerful tool for luring and maintaining user interest. Positive relationships have also been reported between visual aesthetics and some aspects of user experience. For example, at first sight users perceive information obtained from a Website with good visual aesthetics to be more credible than that from a site with poor visual aesthetics [Robins and Holmes, 2008]. Perceived visual aesthetic aspects of Websites have also been reported to be closely related with perceived usability [Lavie and Tractinsky, 2004; Hartmann et al., 2007; Phillips and Chaparro, 2009]. Attractive Websites are also perceived to contain more useful information, compared with sites that are not as visually adorned [Heijden, 2003]. Furthermore, studies have established how quickly Web users make aesthetic appraisals which ultimately lead to these associations on viewing or interacting with a Website [Lindgaard et al., 2006; Tractinsky et al., 2006; Zheng et al., 2009]. Findings of this nature have sustained interest in Web aesthetics.

One of the many challenges faced by researchers in HCI is defining a scope for visual aesthetics [Heller, 2005]. Arguments about suitable terminologies, metrics, approaches and paradigms are commonplace (e.g [Frohlich, 2004; Hassenzahl and Monk, 2010; Monk, 2004; Norman, 2004; Petersen et al., 2004; Overbeeke and Wensveen, 2004]). The present state of affairs is partly attributed to the youthful nature of visual aesthetics research in HCI [Heller, 2005; Norman, 2004]. It is also important to note that disagreements of this nature are not peculiar to HCI domains alone, but also observable in contributing disciplines like philosophy. An example of an area where different philosophical schools of thought disagreed was

on whether to adopt an objective or subjective approach for aesthetic appraisals. To evaluate the aesthetic quality of a visual stimulus, an *objectivist* focuses more on the physical properties of the object being viewed. These include properties like harmony, balance, order, cohesion, homogeneity, equilibrium, symmetry, proportion and regularity [Tatarkiewicz, 2006]. While a *subjectivist* considers the feelings of the person viewing the stimulus to be more important for aesthetic judgements [Kant, 1790]. This and many other practices in contributing and related disciplines have shaped Web aesthetics research in HCI.

The current scope of research in Web aesthetics seems to be limited to the validation of aesthetic theories from related disciplines, the development of frameworks for operationalizing Web aesthetics and investigations regarding the effect of Web aesthetics on user experience. While the cross-disciplinary nature of the area causes researchers to rely on approaches used in contributing disciplines, there is the need to take into account the peculiarities of the Web. Not all aesthetic theories and empirical approaches founded in contributing or sister fields may be suitable for Web domains. Unlike works of arts and geometric shapes used as test beds for aesthetic theories in related fields, the Web is a much more complex and interaction-driven entity. Few studies adopt exploratory approaches which allow researchers to look out for experimental outcomes that are unique to the Web (e.g [Lavie and Tractinsky, 2004]). This seems a reasonable way to undertake research in Web aesthetics, considering the area’s nascent state.

2.1.1 Definition and context

A major bone of contention in disciplines where aesthetics is studied is its definition. This dilemma is captured in one definition for aesthetics which states that “the word aesthetics is nothing but a loose term lately applied in academic circles to everything that has to do with works of art or with the sense of beauty” [Santayana, 1904]. In HCI alone, the word ‘aesthetics’ is used in several contexts, and there are many definitions for it. The majority of studies capture a general sense of beauty (e.g [Hartmann et al., 2008; Hassenzahl, 2004; Lavie and Tractinsky, 2004; Lindgaard et al., 2011; Robins and Holmes, 2008]). There are other contexts which emphasize pragmatic aspects (e.g [Fiore et al., 2005; Petersen et al., 2004; Wright et al., 2008]). There are also those which explore aesthetics of interaction design in relation to psychological theories surrounding cognition, emotion and affect (e.g [Desmet and Hekkert, 2007; Kim et al., 2003; Koo and Ju, 2010;

Porat et al., 2007; Porat and Tractinsky, 2008]). More complex explanations for interaction aesthetics based on critical theories are also available (e.g [Bardzell, 2009; Bardzell and Bardzell, 2008; Bertelsen and Pold, 2004]).

Consequently, it is important that we provide a definition and context for our discussion on visual aesthetics. In very simple terms, visual aesthetics is made up of two words *visual* and *aesthetics*. According to the Oxford English Dictionary (OED) ¹, ‘visual’ relates to sight or seeing, while ‘aesthetics’ refers to a set of principles concerned with the nature and appreciation of beauty. It is this general sense of beauty that we will speak about, rather than a complex philosophical construct (See similar definitions to ours in [Lindgaard et al., 2006; Tractinsky and Lowengart, 2007]). The terms Web aesthetics, visual aesthetics and aesthetics will be used interchangeably as defined, except when discussing studies where the word ‘aesthetics’ is taken out of the context specified here, and used in an exceptional manner. We do not provide any further debates on the definition of the term ‘visual aesthetics’ in this research thesis.

2.1.2 Governing research directions

As shown in Figure 2.1, the existing literature reveals that Web aesthetics research has mainly been governed by one of three study aims:

- There are those studies which have concentrated on replicating experiments to validate visual aesthetic theories and findings from contributing fields such as philosophy, experimental psychology and art. In such studies, Web pages are used as visual stimuli in place of works of art or geometrical shapes which served as test materials for early work in related disciplines.
- There are also studies which have sought to develop frameworks to facilitate the operationalization of Web aesthetics. Web aesthetics frameworks typically comprise sets of adjectives, phrases or conceptual structures by which Web visual designs may be described, measured or classified.
- Lastly, there are those studies which have focused more on investigating the effect of Web aesthetics on various aspects of user experience like usability and credibility. Conclusions are mostly drawn from empirical investigations involving study participants who undertake real-world Web related tasks.

¹OED - <http://www.oed.com/>

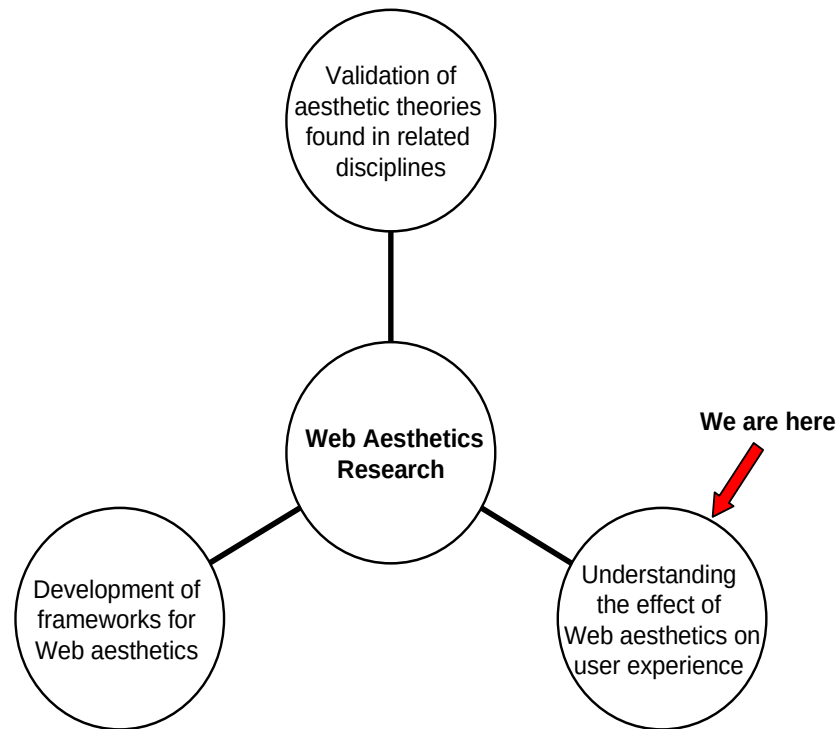


Figure 2.1: The current scope of Web aesthetics research

The Web and Aesthetic Theories

Of the many visual aesthetic theories founded in related disciplines, only a few have been investigated in detail in Web domains. Aesthetic theories tend to fall into one of two categories. While some are formulated primarily around a visual stimulus of interest, others capture the general aesthetic behaviours of humans.

Berlyne's arousal theory: One well known aesthetic theory is Berlyne's arousal theory [Berlyne, 1960, 1971, 1974]. Berlyne proposed that an increase in stimulus 'arousal potential' (e.g complexity) brings about an increase in aesthetic pleasure up to a saturation point where pleasure begins to diminish with increased complexity, giving rise to an inverted U-curve function for aesthetic pleasure and a linearly increasing line for complexity. In studies where Berlyne's work was investigated explicitly in the context of the Web, the most pleasing homepages were not necessarily complex [Knight and Pandir, 2004; Tuch et al.,

2009]. Perhaps, the unique nature of the Web is responsible for this outcome. Unlike works of art or polygons, Web pages are designed with interaction in mind. While complexity may be seen as a visual pleasure enhancer for works of art, geometrical shapes and some types of digital layout designs [Cleveland, 2008], complexity in the context of the Web mostly affects task performance negatively and should be kept to the barest minimum [Fu et al., 2007; Germonprez and Ziguers, 2003]. When given visual search and recognition tasks, Web users were found to perform better on low complexity homepages [Tuch et al., 2009]. The complexity levels of visual designs go a long way to determine how users will respond to a Website [Geissler et al., 2006; Michailidou et al., 2008; Stevenson et al., 2000].

Birkhoff's aesthetic measure: Birkhoff defined aesthetic measure (M) as the ratio between visual stimulus' order (O) and complexity (C) levels (that is $M = O/C$) [Birkhoff, 1933]. His work inspired a computational approach to aesthetic appraisals. In computational aesthetics, the aesthetic value of a visual stimulus is derived from certain mathematical formulations which define the physical properties of the object in question. His approach has been extended in HCI (e.g [Ngo et al., 2000; Ngo, 2001; Ngo et al., 2003]), as well as Web domains (e.g ([Bauerly and Liu, 2006; Zheng et al., 2009]) to measure other objective properties which he did not previously theorize. When Birkhoff's two variables (order and complexity) are placed side-by-side with other factors like the use of images/graphics, animations, colour or beauty in the context of the Web, the latter group of variables seem to be more strongly related with Web visual aesthetics. In a study where the aesthetic preferences of Web users were investigated, a combination of pictures and beauty emerged as more important determinants for participants' preference and visual appeal ratings [Schenkman and Jonsson, 2000]. However, order and complexity emerged as important factors for functionality considerations in Web design [Schenkman and Jonsson, 2000; Wang et al., 2010].

Zajonc - feelings and thoughts: Based on empirical evidence, Zajonc argued that feelings, especially 'affect' do not always require cognition. In other words, people are able to state their affective preferences (likes and dislikes) without giving much thought to it [Zajonc, 1980]. Accordingly, one study showed that Web users could reliably decide which homepages they liked and which ones they

disliked within as short a time as 50 milliseconds of exposure, suggesting the importance of creating a good first impression in Web design [Lindgaard et al., 2006]. First impressions have also been employed in other studies which seek to understand the aesthetic behaviours of Web users (e.g [Michailidou et al., 2008; Robins and Holmes, 2008; Tractinsky et al., 2006; Zheng et al., 2009]). In e-commerce environments, the psychological responses of Web users also vary along cognitive and affective lines in a distinct manner, depending on the aesthetic dimension being considered. Aesthetic dimensions which relate with clarity or orderliness in design (aesthetic formality) impact the cognitive processes of users, and in turn influence their perception of the overall service quality of the Website. While aesthetic dimensions which relate with the impressiveness of design (aesthetic appeal) impact the affective processes of users, with an overall effect on their satisfaction levels [Wang et al., 2010]. The latter study demonstrates the need to design Websites in a way that caters for both affective and cognitive aspects.

In a Nutshell: Aesthetic theories which are formulated primarily around a visual stimuli of interest (e.g polygons, other geometrical shapes and art works) tend to have a lower chance of being validated as true or consistent in Web domains, compared to theories which primarily capture the aesthetic behaviours and responses of human beings. While Web pages differ significantly from those other aesthetic objects, human aesthetic behaviours may not change much across disciplines. This finding is particularly insightful, as it will help researchers explain or account for the differences across study domains. In the present research we are more interested in the aesthetic behaviours or responses of Web users.

Frameworks for Web Aesthetics

Efforts to express Web aesthetics in a somewhat quantitative fashion to facilitate experimentation have led to the development of various frameworks. One of such frameworks specifies that Web aesthetics be treated as a “bi-dimensional” construct with *classical* and *expressive* dimensions. The former dimension emphasizes clarity and orderliness in design, and is described by the adjectives *clean*, *clear*, *symmetrical*, *pleasing* and *aesthetic*. While the latter highlights a Web designer’s ingenuity, and is described by the adjectives *fascinating*, *original*, *creative*,

sophisticated and *uses special effects* [Lavie and Tractinsky, 2004]. Their taxonomy has been widely adopted and validated in several studies (e.g [De Angeli et al., 2006; Coursaris et al., 2010; Hartmann et al., 2008; Tuch et al., 2010]).

A close examination of their framework, however, will reveal that some of the terms are similar. For example, the following pairs of terms clean/clear and original/creative are closely related, and this fact may come across in practice. Participants in experiments may perceive the Web design dimensions explained by the affected adjectives to be the same, and this may lead to unnecessary cases of duplication in study results. Michailidou et al. [2008] observed very high correlations in their user models for the clean and clear aesthetic dimensions for example. Furthermore, some of the adjectives in Lavie and Tractinsky [2004]’s framework (e.g pleasing and aesthetic) represent generic design concepts which may be difficult to quantify or manipulate from a Web designer’s perspective. It may not be clear to a designer what aspects of a Website to adjust in response to a poor rating on pleasantness from a client [Moshagen and Thielsch, 2010]. Their framework has also been criticized for the inclusion of the term ‘aesthetic’, firstly as a design dimension of aesthetics [Lindgaard et al., 2006], and secondly under the classical dimension only [Moshagen and Thielsch, 2010].

A similar framework divides Web aesthetics into *aesthetic formality* and *aesthetic appeal*. Aesthetic formality speaks of beauty in form, while aesthetic appeal speaks of impressive designs [Wang et al., 2010]. Their work extends that of Schenkman and Jonsson [2000] who found that Web users perceived the aesthetic variables *order*, *legibility* and *complexity* on a formal dimension, while *beauty*, *meaningfulness* and *overall impression* were perceived on an appeal dimension. The first dimension triggers user responses which are cognitive in nature, while the second triggers affective responses [Wang et al., 2010]. When their framework is compared with Lavie and Tractinsky’s own framework, aesthetic formality relates with classical aesthetics, while aesthetic appeal relates with expressive aesthetics.

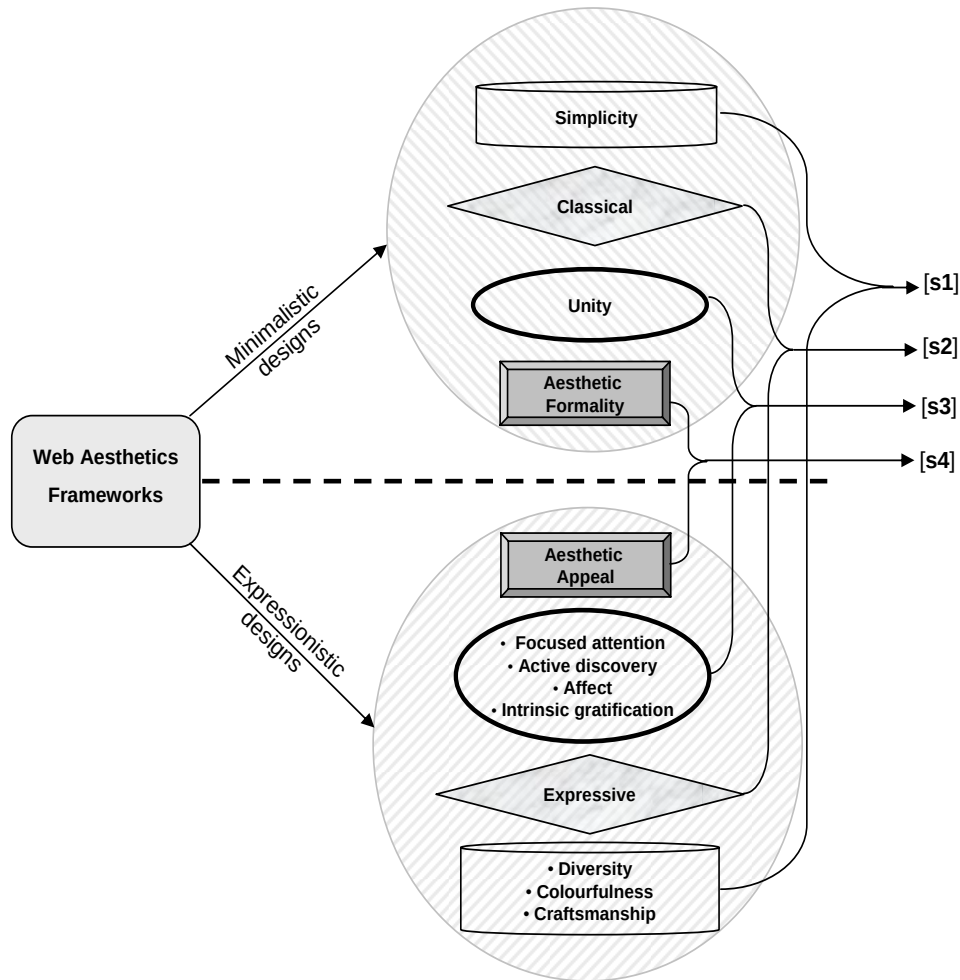
Specific to e-commerce Websites, is yet another framework which comprises five aesthetic dimensions which include *unity*, *focused attention*, *active discovery*, *affect* and *intrinsic gratification*. Unity captures a synergy of concepts and ideas, which ultimately helps the Web user to understand content; focused attention has to do with aspects of a Website which are capable of maintaining the user’s interest; active discovery models aspects of a Website that trigger curiosity; affect

speaks of the ability to emotionally engage the Web user; while intrinsic gratification is the ability of a Website to offer the required satisfaction [Jennings, 2000, 2001]. Clearly, unity here addresses the cognitive needs of Web users, while the remaining four dimensions address affective and emotional needs. Consequently, unity can be grouped along with classical or formal aspects of the aforementioned aesthetic frameworks, while focused attention, active discovery, affect and intrinsic gratification relate more with expressive or appeal aspects of Web design. Hence, a two-way classification still applies to their framework.

A more recent study proposed that the variables *simplicity*, *diversity*, *colourfulness* and *craftsmanship* be used to operationalize Web aesthetics. Simplicity refers to aspects that aid cognitive processing on the part of the Web user; diversity refers to visual richness in Web design; colourfulness captures the extent to which colours are employed, and craftsmanship captures the expertise of the Web designer [Moshagen and Thielsch, 2010]. Once again, a two-way classification can be applied to their proposed framework based on the variable definitions given. Simplicity relates with classical or formal aspects of design, while diversity, colourfulness and craftsmanship relate with expressive or appeal aspects.

Apart from the differences in their terminology base, all the frameworks examined here principally highlight two dimensions by which Web aesthetics may be operationalized. Web designs are either function-driven or appeal/emotion-driven [Hsu, 2011]. Occasionally, we may get a combination of both, which is the ideal case. The classification which has emerged here is consistent with art history where abstract art works are classified as either being *minimalistic* or *expressionistic* in their designs. Minimalistic designs are simple in form [Obendorf, 2009], while expressionistic designs are highly subjective and mostly convey the designer's own aesthetic taste [Strickland, 1993]. Also, minimalistic designs show strong positive relationships with functionality, while expressionistic designs correlate more strongly with affective, fun, engagement, appeal or emotional dimensions of Web design [De Angeli et al., 2006; Lavie and Tractinsky, 2004; Wang et al., 2010]. This taxonomy also lends support to Crozier [1994]'s work where he looks at design from a form vs function perspective. Figure 2.2 shows a two-way classification of the selected frameworks based on abstract art history.

In a Nutshell: Existing aesthetics frameworks for the Web are similar. All the frameworks examined in this section reveal two distinct ways by which Web

**Study Key**

[s1] - [Moshagen and Thielsch 2010]

[s2] - [Lavie and Tractinsky 2004]

[s3] - [Jennings 2000, 2001]

[s4] - [Wang et al. 2010]

Figure 2.2: Taxonomy of Web aesthetics frameworks based on abstract art history

aesthetics may be operationalized. Web designs can either be classified as being minimalistic or expressionistic, and this is consistent with abstract art history. Researchers therefore need to begin to think of ways of standardizing Web aesthetic dimensions. Attention should also be directed towards further validation of the existing frameworks, as this could help with metrics refinement should the

need arise. Since the frameworks are similar in many respects, Lavie and Tractinsky [2004]’s was used for our work while bearing in mind the criticisms found in the literature. Moreover, their framework is widely recognised in the field.

Web Aesthetics and User Experience

A greater portion of studies in the area have focused on uncovering the relationship between Web aesthetics and various aspects of user experience. User experience captures the interactions between a user and a piece of technology within a specified context [Hassenzahl and Tractinsky, 2006]. In current HCI practice, user experience leans more towards an evaluation of the technology being used, rather than the actual experiences of the user [Hassenzahl and Roto, 2007]. [Morville, 2004]’s framework for user experience makes this even more obvious. Figure 2.3 shows his honeycomb framework for user experience.

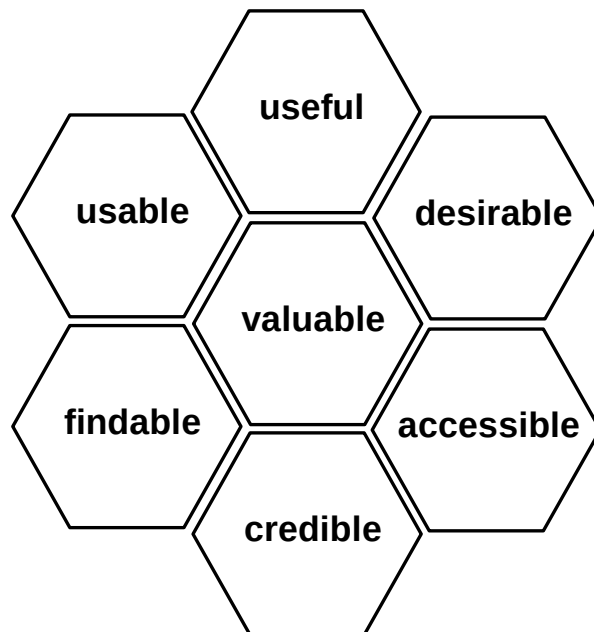


Figure 2.3: Facets of user experience [Morville, 2004]

Here we discuss studies which address the relationship between Web aesthetics and what is commonly referred to as user experience. We use Morville’s framework as an organisational guide to aid the classification of existing studies.

Web Aesthetics vs Usability: Usability speaks of ease-of-use [Morville, 2004]. It is one aspect of user experience that has received a lot of attention from the Web community and HCI in general. Some studies report a straightforward positive relationship between Web aesthetics and usability, because Web pages which users perceive to be visually appealing are also perceived to be easy to use (e.g [Brady and Phillips, 2003; Heijden, 2003; Li and Yeh, 2010; Lindgaard et al., 2011; Phillips and Chaparro, 2009]). However, researchers are yet to establish how long this relationship lasts for an actual Web interaction experience [Lindgaard et al., 2011]. Other studies report more complex relationships between the two Web constructs (i.e aesthetics and usability), as certain conditions are required for such positive associations to hold. For example, when the aesthetic qualities of Web pages are considered under ‘classical’ or ‘expressive’ dimensions as defined by Lavie and Tractinsky [2004], aesthetically pleasing Web pages on the classical dimension show stronger positive relationships with usability. Classical Web designs are simple and clear. Expressive designs, which are more complex and sophisticated tend to be less related with usability [De Angeli et al., 2006; Hartmann et al., 2008; Lavie and Tractinsky, 2004; Sutcliffe and De Angeli, 2005].

Furthermore, when users approach the Web with a less serious use intent, functionality issues are easily excused, thus giving way to a possible positive association of Web aesthetics with usability. However, for more serious use intent such positive relationships are checked, and may start to wane in the face of a severe usability crisis [Hartmann et al., 2008]. Also, positive relationships tend to hold between Websites which have high aesthetic appeal, and high usability from the outset, no particular trends exist for Websites with low aesthetic appeal and low usability [Lee and Koubek, 2010; Lindgaard and Dudek, 2003]. A recent study also suggests that the direction in which the relationship between aesthetics and usability is investigated is also a contributing factor, and in most cases it is responsible for the positive associations reported in many studies [Tuch et al., 2012]. The authors assert that aesthetics does not have an effect on perceived usability, rather it is usability that has an effect on perceived aesthetics after interaction with a Website of interest has taken place. They found that low usability results in lower ratings of perceived aesthetics. With these special cases in mind, the relationship between the use of Web aesthetics and usability can best be described as a conditional one, and this insight is important for our research as usability and accessibility are considered to be closely related facets

of user experience. In general, most studies tend to agree that before actual use of a Website occurs, there is a high likelihood of a positive influence of perceived aesthetics on perceived usability, and the two constructs are strongly related in a positive fashion. The controversies mostly arise post-use. While some studies support a continuous positive link between the two constructs after study participants have interacted with the Websites, others do not support such [Lee and Koubek, 2010]. These disagreements are speculated to arise from the differences in experimental design across studies [Lee and Koubek, 2010]. Possible factors include: usability manipulations [Hartmann et al., 2007, 2008; Lee and Koubek, 2010], visual appeal manipulations and Website genre selections or visual stimuli types [Lee and Koubek, 2010]. It may also be the case that it is difficult to accurately elicit factors which account for user perceptions, preferences, behaviours and associations across Web constructs [Lindgaard and Dudek, 2003]. User ratings on aesthetic preference and ease-of-use are not often consistent with actual performance [Schmidt et al., 2009]. Users make a lot of allowance in reality.

Web Aesthetics vs Credibility: Credibility in a generic sense is the extent to which users trust the information they receive from Websites [Morville, 2004]. Upon short exposure, users perceive information obtained from a Website with good use of visual aesthetics to be more credible than that obtained from a Website with poor visual aesthetics, even when the two Websites in question have the same content [Robins and Holmes, 2008]. For e-commerce domains, credibility is the customer's belief that the on-line service provider will deliver services as promised, without taking advantage of their vulnerabilities [Pavlou, 2003]. Design quality remains one of the key factors which influences on-line trust in e-commerce. Users feel more comfortable transacting with Websites that are beautiful [Karvonen, 2000; Wang and Emurian, 2005]. Once users can establish that the visual appearance of an e-commerce Website meets their expectations, they go ahead and make a purchase from the site in question [O'Brien, 2010].

Colour appeal, which is another important aspect of Web aesthetics also contributes significantly to on-line trust and satisfaction [Cyr et al., 2010]. These studies show that the visual quality of a Website plays more important roles than we think [Karvonen, 2000; Robins and Holmes, 2008]. The aesthetic quality of a Website determines whether a user will pay attention or not, given the many competing alternatives on the Web [Robins and Holmes, 2008]. So, visual appeal

judgements go a long way to influence those of trustworthiness [Lindgaard et al., 2011]. With increased familiarity, however, visual appearance may no longer influence on-line trust for e-commerce Websites [Liao et al., 2006].

Web Aesthetics vs Desirability/Preference: Desirability speaks of the emotions evoked from designs. These emotions drive our choice of products [Gajendar, 2008; Morville, 2004]. Desirability moderates brand preferences and identity [Morville, 2004]. Users prefer Web pages that are good looking, and beauty is one of the key factors that determines the overall impression a user has about a Web page [Schenkman and Jonsson, 2000]. One study found that as Web aesthetic attributes (e.g font and image size) increase, so does user preference [Schmidt et al., 2009]. These studies suggest a positive influence of aesthetic appeal on preference or desire in the context of the Web.

Web Aesthetics vs Accessibility: Accessibility is a fairly recent aspect of user experience. As such, not much empirical work has been done with regards to its relationship with visual aesthetics. Existing studies are mostly advisory in nature (e.g [Regan, 2004]). One empirical attempt to address this tension demonstrated how 3 out of 100 Websites ascertained to be highly accessible by people with disabilities were also found to have complex visual designs [Petrie et al., 2004]. The authors concluded that accessibility considerations do not prevent Web designers from creating Websites with complex visual designs. Along with the limited number of case studies employed, their work highlights one aspect of visual designs which is complexity. Visual complexity, however, happens to be a rather weak indicator of aesthetic pleasure in Web domains [Pandir and Knight, 2006; Tuch et al., 2009]. As such, questions regarding the relationship between the use of Web aesthetics and accessibility remain unanswered. This gap in the literature served as a key motivation for the research reported in this thesis.

Web Aesthetics vs Findability: Findability means that users can easily locate the information they need [Morville, 2004]. This is an important factor for the Web, considering the viewing attitude of users. Web users tend to be impatient [Nielson, 2006]. This facet of Morville’s framework is arguably a subset of usability and accessibility. One usability metric which is also used in accessibility studies is task completion time, and a common Web task employed in such studies

is information search. Consequently, findings on the interactions between Web aesthetics and usability or accessibility may apply here as well. Very few studies attempt to investigate findability as a stand alone aspect of user experience. Current findings suggest that perceived attractiveness or goodness has no effect on Web visual search [Nakarada-Kordic and Lobb, 2005; Schmidt et al., 2009]. In other words, the extent to which a Website is perceived to be beautiful or attractive does not affect how quickly or accurately participants find information. Interestingly, when the target search information was deliberately left out of a Website without the user's knowledge, people were willing to persevere in search of the target information on an attractive Website, as opposed to an unattractive one. Study participants were found to give up searching for information easily on Websites that were perceived to be ugly [Nakarada-Kordic and Lobb, 2005].

Web Aesthetics vs Valuableness: Websites must contribute to customer satisfaction, as well as bring in some profit [Morville, 2004]. The relationship between visual aesthetics and this facet of user experience is particularly important for e-commerce Websites. Studies have found that the extent to which a Website is perceived to be aesthetically pleasing is related to the degree to which users intend to purchase a given product off that site [Hall and Hanna, 2004; O'Brien, 2010]. This is more likely for purchase-involved users [Sanchez-Franco and Rondan-Catalua, 2010]. In mobile commerce environments (m-commerce), no significant relationship was found between design aesthetics on its own and intent to purchase (m-loyalty). However, aesthetics did contribute to m-loyalty when it was considered along with other important factors [Cyr et al., 2006].

Web Aesthetics vs Usefulness: Usefulness captures how beneficial the final product is to the user [Morville, 2004]. Attractive Websites have been shown to contribute to feelings of usefulness [Heijden, 2003]. Similar findings are reported in m-commerce environments [Cyr et al., 2006; Li and Yeh, 2010; Liao et al., 2006]. Consequently, Web aesthetics has a positive influence on perceived usefulness.

In a Nutshell: While the relationship between Web aesthetics and some aspects of user experience (e.g usability and credibility) have received much attention in the context of the Web, other aspects like desirability, accessibility and findability have not. Clearly, more work is required for these under explored aspects of user

experience. Our research is designed towards this end. In this research thesis, we report findings on the interplay between Web aesthetics and accessibility.

2.1.3 Experimental approaches

In a bid to achieve some of the research aims discussed in the previous section, a number of approaches have been employed by researchers in the field. In particular, we discuss aesthetic appraisal methods, cognitive processing levels using [Norman, 2004]’s work and some of the aesthetic terminologies explored. We present a taxonomy of selected aesthetic terminologies based on the aforementioned approaches. We also highlight some of the limitations of these approaches.

Aesthetic Appraisal

Objective and subjective appraisal methods represent two popular techniques used across disciplines. While the former primarily depends on object properties and more quantitative evaluations, the latter considers the opinions of the subject or person experiencing the stimulus and more qualitative evaluations, hence, their nomenclature. In Web aesthetics, both objective and subjective approaches have been explored, with the latter being more popular. Objective appraisals typically involve the measurement of Web page attributes using mathematical formulations or computerized programs in order to estimate aesthetic quality (e.g [Bauerly and Liu, 2006; Ivory et al., 2001; Wu et al., 2011; Zain et al., 2008; Zheng et al., 2009]). On the other hand, subjective appraisals take into account the aesthetic perceptions of Web users via user studies which comprise of surveys, questionnaires, think aloud sessions, group discussions and Web related activities carefully designed to elicit and investigate the desired behaviours (e.g [De Angeli et al., 2006; Coursaris et al., 2008; Hartmann et al., 2007, 2008; Hashim et al., 2010; Heijden, 2003; Lavie and Tractinsky, 2004; Lindgaard et al., 2006; Moshagen and Thielsch, 2010; O’Brien, 2010; van Schaik and Ling, 2009]).

A critical examination of most of the studies in the area will reveal a combination of both aesthetic appraisal methods to give a somewhat hybrid approach which some call *interactionist* aesthetics, as it is particularly difficult to keep the two approaches apart in practice [Lavie and Tractinsky, 2004]. It is common to ask participants in experiments to state their aesthetic preferences (*originally subjective*) for Web pages along design dimensions such as balance, symmetry, order,

complexity and so forth (*originally objectivist*) (e.g [Lavie and Tractinsky, 2004; Michailidou et al., 2008; Schenkman and Jonsson, 2000; Tuch et al., 2010]). This is done for one of two reasons. First, it facilitates subjective evidence, but also allows for scientific manipulation of experimental outcomes. Secondly, it is used to validate any links between objective and subjective approaches (e.g [Bauerly and Liu, 2006; Zheng et al., 2009]). Objective evaluations of Websites are performed for selected design dimensions using computational aesthetic algorithms, then subjective evaluations are carried out using the same design dimensions to check for any significant correlations between the two appraisal methods.

The appraisal approach also places a constraint on the aesthetic terminologies which may be investigated. While aesthetic dimensions like *balance*, *proportion*, *equilibrium*, *cohesion* and *symmetry* may be investigated objectively in a straightforward fashion, dimensions such as *interesting*, *clean*, *sophisticated*, *professional* and *pleasing* are more easily determined using subjective means.

Cognitive Processing Level

The extent to which the mental processes of end users are employed in aesthetic judgements of Web pages is equally important for subjective appraisals. Norman [2004] captures this in his three beauty processing levels which include: visceral, behavioural and reflective levels. The first level is appearance-based, and is characterised by the immediacy with which opinions about the object of interest or stimulus is formed. At the second level, evaluations of beauty emanate from either positive or negative experiences during use. The third level of beauty is said to arise from careful thought. At this level, we are fully aware of our emotions and can judge adequately. According to Norman, this third level leverages from our past experiences, intellectual abilities and personal interpretational powers to rate any experience as being pleasing or displeasing. Norman maintains that beauty is best evaluated at this third level. Here, we classify existing studies on Web aesthetics using Norman's beauty processing levels as a guide:

Visceral Level Processing: Visceral or appearance-based approaches are characterised by short exposure to the Websites to be judged [Lindgaard et al., 2006; Michailidou et al., 2008; Robins and Holmes, 2008; Tractinsky et al., 2006; Zheng et al., 2009]. Studies which are based on first impressions report the suitability of exposure durations as short as 50 milliseconds (ms) [Lindgaard et al., 2006].

Behavioural Level Processing: For studies which investigate Web aesthetics at the behavioural level, participants are allowed to perform real-world Web related tasks before rating their experience [De Angeli et al., 2006; Hartmann et al., 2007; Lavie and Tractinsky, 2004; van Schaik and Ling, 2009]. Advocates for aesthetics of use suggest that this approach better suits aesthetics of interaction (e.g [Overbeeke and Wensveen, 2004]). With this approach, however, extra care must be taken to ensure proper manipulation of the tasks which study participants are to undertake, as this may influence experimental outcomes [Hassenzahl, 2004; Hartmann et al., 2007; Lee and Koubek, 2010]. Also, users tend to mix up visual aesthetic attributes under investigation with other system characteristics like usability, or related constructs such as preference, likability, emotional aspects and satisfaction, making it difficult to properly account for any associations or outcomes [Hassenzahl, 2004; Lindgaard and Dudek, 2003]. At times, what participants report in the end may not match their performance. So, care must be taken to interpret and report findings accordingly [Schmidt et al., 2009].

Reflective Level Processing: At the reflective level, participants are given a lot of time to make aesthetic judgements. Participants may be allowed to view all test stimuli (i.e Web pages) at once, to enable them to compare and contrast [Pandir and Knight, 2006]. They could also be allowed to work in groups, hold discussions about their aesthetic choices and try to come up with justifications for their choices (e.g [Hartmann et al., 2008]). Unlike the previous two approaches, the participants are generally expected to give some thought to their choices.

Aesthetic Terminologies

The literature on Web aesthetics research reveals the use of an unending list of adjectives and phrases related to beauty or aesthetic pleasure. Table 2.1 presents a taxonomy of selected aesthetic dimensions investigated in the literature. As we would observe from Table 2.1, some of the aesthetic dimensions explored are quite ambiguous in nature, as it is not exactly clear how these dimensions should be defined or quantified [Norman, 2004]. The large number of aesthetic terminologies has also led to overlaps. Different terminologies/adjectives are used to describe the same aesthetic dimension [Norman, 2004; Lindgaard et al., 2006], making it difficult to effectively compare studies [Moshagen and Thielsch, 2010].

Table 2.1: Selected aesthetic terminologies explored in Web domains.

TERMINOLOGIES	APPRAISAL APPROACH		COGNITIVE PROCESSING LEVEL		
	<i>Subjective</i>	<i>Objective</i>	<i>Visceral</i>	<i>Behavioural</i>	<i>Reflective</i>
Clean	[s01, s04, s07, s10, s12, s13, s15, s16, s18, s20]		[s04, s10, s12, s13, s15]	[s01, s07, s10, s16, s18, s20]	
Pleas(ant/ing)	[s01, s07, s10, s12, s13, s14, s15, s16, s18, s20]		[s10, s12, s13, s14, s15]	[s01, s07, s10, s16, s18, s20]	[s14]
Clear	[s01, s03, s04, s07, s16, s18, s20]		[s03, s04]	[s01, s07, s16, s18, s20]	
Aesthetic	[s01, s05, s06, s07, s10, s12, s13, s15, s16, s18, s20]		[s05, s10, s12, s13, s15]	[s01, s06, s07, s10, s16, s18, s20]	
Symmetry	[s01, s05, s07, s11, s13, s16, s18, s20]	[s05, s08]	[s05, s11, s13]	[s01, s07, s16, s18, s20]	
Fascinating	[s01, s07, s10, s12, s13, s15, s16, s18, s20]		[s10, s12, s13, s15]	[s01, s07, s10, s16, s18, s20]	
Sophisticated	[s01, s07, s10, s12, s13, s16, s18, s20]		[s10, s12, s13]	[s01, s07, s10, s16, s18, s20]	
Creative	[s01, s07, s10, s12, s13, s15, s16, s18, s20]		[s10, s12, s13, s15]	[s01, s07, s10, s16, s18, s20]	
Original	[s01, s07, s16, s18, s20]				
Uses special effects	[s01, s07, s16, s18, s20]				
Admirable	[s01]				
Dull	[s01]				
Noisy	[s01]				
Unique character	[s01]				
Intriguing	[s01]				
Vulgar	[s01]				
Exciting	[s01]				

TERMINOLOGIES	APPRAISAL APPROACH		COGNITIVE PROCESSING LEVEL		
	<i>Subjective</i>	<i>Objective</i>	<i>Visceral</i>	<i>Behavioural</i>	<i>Reflective</i>
Old fashioned	[s01]			[s01]	
Fun	[s01]			[s01]	
Lack imagination	[s01]			[s01]	
Standard	[s01]			[s01]	
Enjoyable	[s01]			[s01]	
Realistic appearance	[s01]			[s01]	
Harmonic	[s01]			[s01]	
Modern	[s01]			[s01]	
Monotonous	[s01]			[s01]	
Artistic	[s01]			[s01]	
Skillfully designed	[s01]			[s01]	
Applies good taste	[s01]			[s01]	
Energetic	[s01]			[s01]	
Challenging	[s01]			[s01]	
Convenient	[s01]			[s01]	
Wretched	[s01]			[s01]	
Colour(ful/-use)	[s01, s03, s09, s17, s19]		[s03, s09, s17, s19]	[s01, s09]	
Simple	[s01, s03, s08, s09, s17, s19]		[s03, s08, s09, s17, s19]	[s01, s09]	
Overloaded	[s01]			[s01]	
Professional	[s01, s08]		[s08]	[s01]	
Organised	[s01, s04]		[s04]	[s01]	
Beaut(y/iful)	[s01, s02, s04, s13]		[s02, s04, s13]	[s01]	

TERMINOLOGIES	APPRAISAL APPROACH		COGNITIVE PROCESSING LEVEL		
	<i>Subjective</i>	<i>Objective</i>	<i>Visceral</i>	<i>Behavioural</i>	<i>Reflective</i>
Complex(ity)	[s01, s02, s04, s14]		[s02, s03, s04, s14]	[s01]	[s14]
Legibility	[s02]		[s02]		
Comprehension	[s02]		[s02]		
Overall impression	[s02]		[s02]		
Meaningfulness	[s02]		[s02]		
Order	[s02]		[s02]		
Interesting	[s03, s04, s14]		[s03, s04, s14]		[s14]
Well-designed	[s03]		[s03]		
Good layout	[s03]		[s03]		
Imaginative	[s03, s16]		[s03]	[s16]	
Visual appeal	[s03, s11]		[s03, s11]		
Contrast	[s11]		[s11]		
Attractive	[s10, s12]		[s10, s12]	[s10]	
Spontaneous	[s16]			[s16]	
Innovative	[s16]			[s16]	
Bright	[s17, s19]		[s17, s19]		
Tense	[s17, s19]		[s17, s19]		
Strong	[s17, s19]		[s17, s19]		
Static	[s17, s19]		[s17, s19]		
Deluxe	[s17, s19]		[s17, s19]		
Popular	[s17, s19]		[s17, s19]		
Promising	[s17, s19]		[s17, s19]		
Fresh	[s17, s19]		[s17, s19]		
Valuable	[s17, s19]		[s17, s19]		
Sexy	[s17, s19]		[s17, s19]		

TERMINOLOGIES	APPRAISAL APPROACH		COGNITIVE PROCESSING LEVEL		
	<i>Subjective</i>	<i>Objective</i>	<i>Visceral</i>	<i>Behavioural</i>	<i>Reflective</i>
Balance	[s05, s11, s17, s19]	[s05, s08]	[s05, s11, s17, s19]		
Density/Groupings	[s05, s11]	[s05, s08]	[s05, s11]		
Equilibrium		[s08]			
Appealing	[s08]		[s08]		
Captivating	[s17, s19]		[s17, s19]		
Adorable	[s17, s19]		[s17, s19]		
Classical	[s17, s19]		[s17, s19]		
Futuristic	[s17, s19]		[s17, s19]		
Mystic	[s17, s19]		[s17, s19]		
Hopeful	[s17, s19]		[s17, s19]		
Plain	[s17, s19]		[s17, s19]		
Sharp	[s17, s19]		[s17, s19]		
Powerful	[s17, s19]		[s17, s19]		
Calm	[s17, s19]		[s17, s19]		
Elegant	[s17, s19]		[s17, s19]		
Familiar	[s17, s19]		[s17, s19]		
Cute	[s17, s19]		[s17, s19]		
Vibrant	[s17, s19]		[s17, s19]		
Concise	[s17, s19]		[s17, s19]		
Conventional	[s17, s19]		[s17, s19]		
Surreal	[s17, s19]		[s17, s19]		
Vague	[s17, s19]		[s17, s19]		
Diversity	[s09]		[s09]		[s09]
Craftsmanship	[s09]		[s09]		[s09]

‡ Please note that the study key is available on the following page.

Study Key

s01 - [Lavie and Tractinsky, 2004]	s11 - [Lindgaard et al., 2011]
s02 - [Schenkman and Jonsson, 2000]	s12 - [Tractinsky et al., 2006]
s03 - [Lindgaard et al., 2006]	s13 - [Tuch et al., 2010]
s04 - [Michailidou et al., 2008]	s14 - [Pandir and Knight, 2006]
s05 - [Bauerly and Liu, 2006]	s15 - [Mbipom and Harper, 2011]
s06 - [Hartmann et al., 2007]	s16 - [Coursaris et al., 2010]
s07 - [De Angeli et al., 2006]	s17 - [Park et al., 2004]
s08 - [Zheng et al., 2009]	s18 - [Hartmann et al., 2008]
s09 - [Moshagen and Thielsch, 2010]	s19 - [Kim et al., 2003]
s10 - [van Schaik and Ling, 2009]	s20 - [Sutcliffe and De Angeli, 2005]

Also, most of the studies have focused on subjective evaluations, rather than objective ones [Bauerly and Liu, 2006]. Of these subjective evaluations, visceral and behavioural cognitive processing level have received the most attention, with reflective evaluations being the least explored. As such, our findings on beauty studies in Web domains partially support Norman [2004]’s statement that:

“Most discussions of beauty focus upon either surface appearances (visceral) or deep, hidden meaning (reflective). Few accounts talk of behavioral beauty or pleasure, of the pleasure of the smooth responses of a well-crafted mechanism, or the anxiety when one feels out of control.”

Furthermore, certain aesthetic terminologies have received more attention than others (e.g aesthetic terms in [Lavie and Tractinsky, 2004]’s framework). This further lends support to the popularity of their framework. Also, while some terminologies have been operationalized, others have not. It is more straightforward to operationalize terms like *balance* and *symmetry*, whereas terms like *attractive* or *fascinating* cannot be easily captured by computational formalisations.

Key Decision Points: We made use of subjective methods and visceral level responses for our user studies. In agreement with Lindgaard et al. [2006] and Zajonc [1980], we believe that Web users are able to make reliable aesthetic judgements at first sight. The aesthetic terminologies we investigated were selected from Lavie and Tractinsky [2004]’s framework. In general, the results of the review reveal opportunities in the area of the development of more objective approaches to aesthetic measure. Although subjective evaluations are important for gaining an understanding of the way users perceive an IT product [Lavie and

Tractinsky, 2004], the objective aspects provide a means for designers to assign quantified values to their designs [Bauerly and Liu, 2006]. The two components should be seen as complimentary. Both are needed for a holistic design experience.

2.2 Web Accessibility

Web accessibility addresses equality of Web use by end users irrespective of ability, technological devices in use or environment. Consequently, the accessibility initiative seeks to ensure an inclusive Web [Sloan et al., 2006]. This means that people with disabilities can also benefit from the services provided on the Web, and that they are not discriminated against in any way. Apart from the fact that interacting with the Web gives users with disabilities a sense of belonging [Henry, 2006], it also makes them feel more independent [Pernice and Nielsen, 2001]. Several actions have been taken, mostly legal and educational to make Web developers, builders of user agents, authoring tools and providers of Information Communication Technology (ICT) resources in general incorporate accessibility.

Some stakeholders are still divided on what accessibility entails in practice [Brajnik, 2006; Meyer, 2005; Petrie and Kheir, 2007]. Moreover, the best method to adopt when testing Websites for accessibility compliance remains a controversial aspect of the field [Brajnik, 2006]. Other challenges include the fact that the accessibility culture requires time and dedication to imbibe [Regan, 2004]. Furthermore, the lack of awareness on the part of the user has also been a clog in the wheel of a more inclusive Web. Most Web users with disabilities are not aware of the available features for maximising accessible design benefits when browsing [Meyer, 2005]. Sloan et al. [2000] also highlight another complication arising from the user's end, which is the ability to use the available assistive technologies.

With the potential socio-economic benefit accessibility brings to the Web community, one would expect that the accessibility initiative would be well received by all. Unfortunately, this has not been the case. Its introduction has birthed several myths about its interactions with other existing Web concepts [Henry, 2006]. A good example of an area where there has been much tension is on the interplay between Web aesthetics and accessibility, especially as it affects users with visual impairments [Sloan et al., 2000]. Some of the common misconceptions include the belief that visually attractive Websites are not accessible, accessible

pages have boring visual designs and Web accessibility hinders the Web developer creativity-speaking. However, very little empirical data has been gathered to either support or reject these myths. Our research seeks to address this issue.

2.2.1 Definition and context

Stakeholders hold different views about the meaning of Web accessibility. One popular definition for Web accessibility is the one by WAI ². According to them, “Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web” [Henry, 2006]. Their definition seems to be all-encompassing in terms of the activities that persons with disabilities should be able to carry out when interacting with the Web. However, studies like Petrie and Kheir [2007] have criticised them on the grounds that they seem not to fully support their definition in practice.

Petrie and Kheir [2007] point out that although WAI has a user-centred definition for Web accessibility, which is commendable, they seem to have neglected this definition in practice, as they promote conformance to accessibility rules as specified in the Web Content Accessibility Guidelines (WCAG) 1.0 [Chisholm et al., 1999]. Consequently, Petrie and Kheir [2007] suggest that Web accessibility be defined as “...the extent to which a product/Website can be used by specified users with specified disabilities to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”. Their definition is adapted from the ISO 9241 definition for usability which is a closely related Web concept. They argue that this definition infers that user-centred criteria be satisfied in practice as constructs such as effectiveness, efficiency and satisfaction are well-established, and can be measured. In WCAG 2.0 [Caldwell et al., 2008] which is the latest release by WAI, the committee outlines more user-driven accessibility criteria in response to criticisms on the initial set of guidelines.

In the early part of our research where we investigate the interplay between Web aesthetics and general accessibility (Chapter 3), we measure the accessibility based on conformance to guidelines using automated checkers. In the more detailed investigations where we employ manual accessibility audits (Chapter 5), we focus specifically on accessibility issues which could affect Web users with visual impairments. In other words, we narrow down the scope of our work to the interplay between Web aesthetics and non-visual accessibility. People with visual

²Web Accessibility Initiative - <http://www.w3.org/WAI>

impairments constitute a large part of end users with disabilities who have access to the Web [Mankoff et al., 2005]. Web accessibility experts conducted audits on a cross-section of the Websites, bearing in mind users with visual impairments.

Components of Web Accessibility: Web accessibility has two major components namely: technical and human [Henry, 2006]. The former encompasses all the tools and technologies used to create, maintain and access Web content, while the latter comprises of people directly involved in building or using these tools, including Web users. Figure 2.4³ shows how the various components inter-relate.

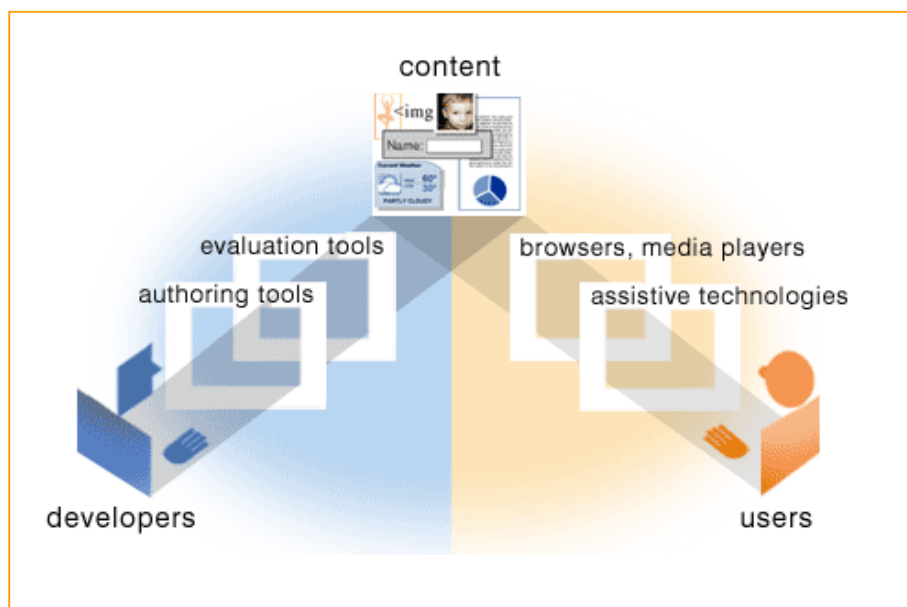


Figure 2.4: Components of Web accessibility [Henry, 2006].

Web Accessibility Guidelines: In order to promote the Web accessibility mission, certain guidelines have been put in place by some governments and interested organisations. Some popular ones include the Section 508⁴ standards adopted in the United States of America (USA), and Web Content Accessibility Guidelines (WCAG) proposed by the World Wide Web Consortium (W3C).

- **Section 508:** Section 508 enjoins federal agencies in USA to make their electronic and information technology services accessible to people with

³Graphics by Michael Duffy, DUFFCO Design - <http://www.w3.org/WAI/intro/components.php>

⁴Section 508 - <http://www.section508.gov/>

disabilities. The standards are somewhat related to those proposed by W3C. The W3C guidelines have a much wider coverage.

- **Web Content Accessibility Guidelines (WCAG):** These outline the steps to take in order to produce Web content that is accessible to people with disabilities [Henry, 2006]. WCAG 1.0 [Chisholm et al., 1999] was officially released on the 5th of May, 1999, and it has been widely adopted by Web practitioners [Brewer, 2004]. WCAG 1.0 contains 14 guidelines and 65 sub-guidelines or “checkpoints”. Each guideline provides an overview of the design best practice addressed, while the checkpoints describe what a guideline means in practice. An example of a WCAG 1.0 guideline is “provide equivalent alternatives to auditory and visual content”, while an associated checkpoint is “provide a text equivalent for every non-text element (e.g, via “alt”, “longdesc”, or in element content)...”. In addition, the checkpoints have been organised into three priority levels depending on their potential to cause problems for people with disabilities if not adhered to, with priority 1 being the most crucial or basic accessibility requirement. The priority levels are specified as follows (Taken from WCAG 1.0):

- **Priority 1:** A Web content developer *must* satisfy this checkpoint. Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents.
- **Priority 2:** A Web content developer *should* satisfy this checkpoint. Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents.
- **Priority 3:** A Web content developer *may* address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document. Satisfying this checkpoint will improve access to Web documents.”

Conformity is also measured at three levels A, AA and AAA, with AAA being the most difficult to satisfy:

- **Level A:** all Priority 1 checkpoints are satisfied;
- **Level AA:** all Priority 1 and 2 checkpoints are satisfied;

- **Level AAA:** all Priority 1, 2, and 3 checkpoints are satisfied. For more information on WCAG 1.0 please see [Chisholm et al., 1999].

Since the release of WCAG 1.0, a number of issues have been raised by researchers and interested parties. There have been concerns that the guidelines are complex and ambiguous [Kelly et al., 2005; Sloan et al., 2006]. Moreover, studies have consistently shown that Web content developers are not able to use these guidelines effectively for their work [Colwell and Petrie, 1999; Ivory and Chevalier, 2002]. For example, Colwell and Petrie [1999] found that Web designers had difficulties using the guidelines. This in turn affected their performance during implementation. Ivory and Chevalier [2002] also found that automated accessibility evaluation tools did not help Web professionals effectively create usable and accessible Websites, and these tools depend heavily on guidelines like the ones discussed above. Moreover, there have been speculations that the guidelines are theoretical [Kelly et al., 2005] and lack empirical foundation [Petrie and Kheir, 2007]. Thus, raising questions about the generalizability of these guidelines to real world situations [Kelly et al., 2005]. Accordingly, Petrie and Kheir [2007] showed that severity ratings of problems experienced by Web users with visual impairments were not significantly related with those offered by usability and accessibility guidelines through priority gradings.

Based on the feedback obtained from the Web community on WCAG 1.0, the W3C committee deemed it necessary to draft a second version. Consequently, WCAG 2.0 [Caldwell et al., 2008] was released on the 11th of December, 2008. WCAG 2.0 has 4 principles, 12 guidelines and 61 success criteria. Some of the features which differentiate WCAG 2.0 from WCAG 1.0 include the emphasis on i) testable “success criteria” ii) the 4 principles which govern Web accessibility (that is, Web content must be perceivable, operable, understandable and robust) iii) a technology-independent presentation, iv) ease of use and understanding on the part of the Web developer irrespective of expertise [Brewer, 2004; Chisholm and Henry, 2005; Kelly et al., 2008]. Alongside WCAG, two other sets of guidelines have been proposed by W3C to allow for a more thorough process to achieving accessible Web content. They are the Authoring Tool Accessibility Guidelines (ATAG) and User Agent Accessibility Guidelines (UAAG). The former specifies what developers of tools used to create and maintain Web content should do in

order to advance the accessibility mission, while the later explains how to make technologies used to interact with the Web accessible to people with disabilities, and how this helps in making Web content accessible in general [Chisholm and Henry, 2005; Henry, 2006].

2.2.2 Accessibility evaluation methods

Several methods have been developed and adopted for testing Web content for their accessibility levels. Some of them include: user/usability testing (e.g [Lunn et al., 2008; Mankoff et al., 2005; Petrie et al., 2004, 2006; Petrie and Kheir, 2007]), expert reviews/heuristic evaluation (e.g [Brajnik, 2006, 2008c; Mankoff et al., 2005]), use of automated tools [Mankoff et al., 2005; Petrie et al., 2004], screening [Mankoff et al., 2005], combination of automated tools and expert reviews/user testing [Brajnik and Lomuscio, 2007; Petrie et al., 2004], remote testing [Andreasen et al., 2007; Mankoff et al., 2005; Petrie et al., 2006], user-tailored testing [Vigo et al., 2007] among others. Here, we discuss some of the existing evaluation methods under three broad groups:

Manual Evaluation: Manual evaluations are those which require humans to be part of the evaluation process. In some cases, it requires that Web accessibility professionals or Web developers inspect the source code of Websites and their resulting visual designs, with the aim of identifying potential accessibility bugs [Brajnik, 2006, 2008c; Mankoff et al., 2005]. This is referred to as expert review. A typical example of the expert review evaluation technique is the Barrier Walkthrough (BW) method proposed by Brajnik [2006]. In the BW method, experts evaluate Websites against potential accessibility barriers capable of affecting users with specific disabilities or challenges. The severity levels for any barriers found are also taken into consideration. In some other situations, manual evaluation requires that the target user groups interact with Websites so that accessibility issues can be identified and evaluated. This is referred to as user testing. Usually, users with disabilities perform common browsing tasks on selected Websites in order to uncover the accessibility level of the pages in question [Mankoff et al., 2005; Petrie et al., 2004, 2006]. Another example of manual accessibility evaluation is user-tailored testing [Vigo et al., 2007]. This looks at making the evaluation results even more precise by undertaking specialist testing. The accessibility level of a Web page is evaluated with the individual requirements of

the user in mind. Remote testing is yet another method for conducting manual evaluations. In the remote testing case, the user may undertake the accessibility evaluation experiments from a location which is different from that of the researcher/evaluator/investigator [Mankoff et al., 2005; Petrie et al., 2006].

Screening is another type of manual accessibility evaluation technique where able-bodied people ‘pretend’ to have a disability. Challenges faced by people with disabilities are simulated to help identify accessibility issues [Mankoff et al., 2005]. For example, Web developers could use screenreaders without monitors. A screenreader is a software used by people with visual impairments. It is capable of reading Web content aloud in audio [Mankoff et al., 2005]. Sighted Web users could also work with a blank monitor and speech synthesizer or while being blind-folded [Yesilada et al., 2004]. Currently, manual evaluation techniques are agreed to be the most effective for accessibility testing [Mankoff et al., 2005]. However, they are very expensive to conduct [Petrie et al., 2006].

Technical Evaluation: Technical evaluation has to do with the use of automated tools for accessibility compliance testing [Petrie and Kheir, 2007]. These automated tools are software programs capable of identifying accessibility issues within a Web page. Usually, the source code of a Web page is matched against laid down Web design best practices like Section 508 or WCAG 1.0 or 2.0 discussed earlier. An accompanying report which highlights the accessibility issues identified is then generated. Some tools also suggest how to fix the issues highlighted. Examples of automated accessibility evaluation tools include: Bobby⁵, WAVE⁶, AChecker⁷ and Cynthia Says⁸ to mention but a few. For a complete list see the WAI Web page on evaluation tools⁹. Although technical accessibility evaluation and repair methods are currently less reliable than their manual counterparts, automated validation and evaluation tools still play a significant role in helping Web developers identify initial or potential accessibility bugs [Ivory and Chevalier, 2002]. In general, automated accessibility checkers are more effective when used in combination with manual evaluations [Henry, 2006]

⁵Bobby - <http://www.cast.org/products/Bobby/index.html>

⁶WAVE - <http://wave.webaim.org/>

⁷<http://achecker.ca/checker/index.php>

⁸Cynthia Says - <http://www.contentquality.com/>

⁹List of Web Accessibility Evaluation Tools - <http://www.w3.org/WAI/ER/tools/complete>

Hybrid Methods: Hybrid methods combine more than one approach for measuring accessibility conformance. This way, the evaluator benefits from the individual strengths of the combined methods. An example of an evaluation technique which employs a combination of methods is SAMBA [Brajnik and Lomuscio, 2007]. SAMBA combines technical evaluation with expert reviews. Figure 2.5 shows a taxonomy of accessibility evaluation methods by Brajnik [2008a].

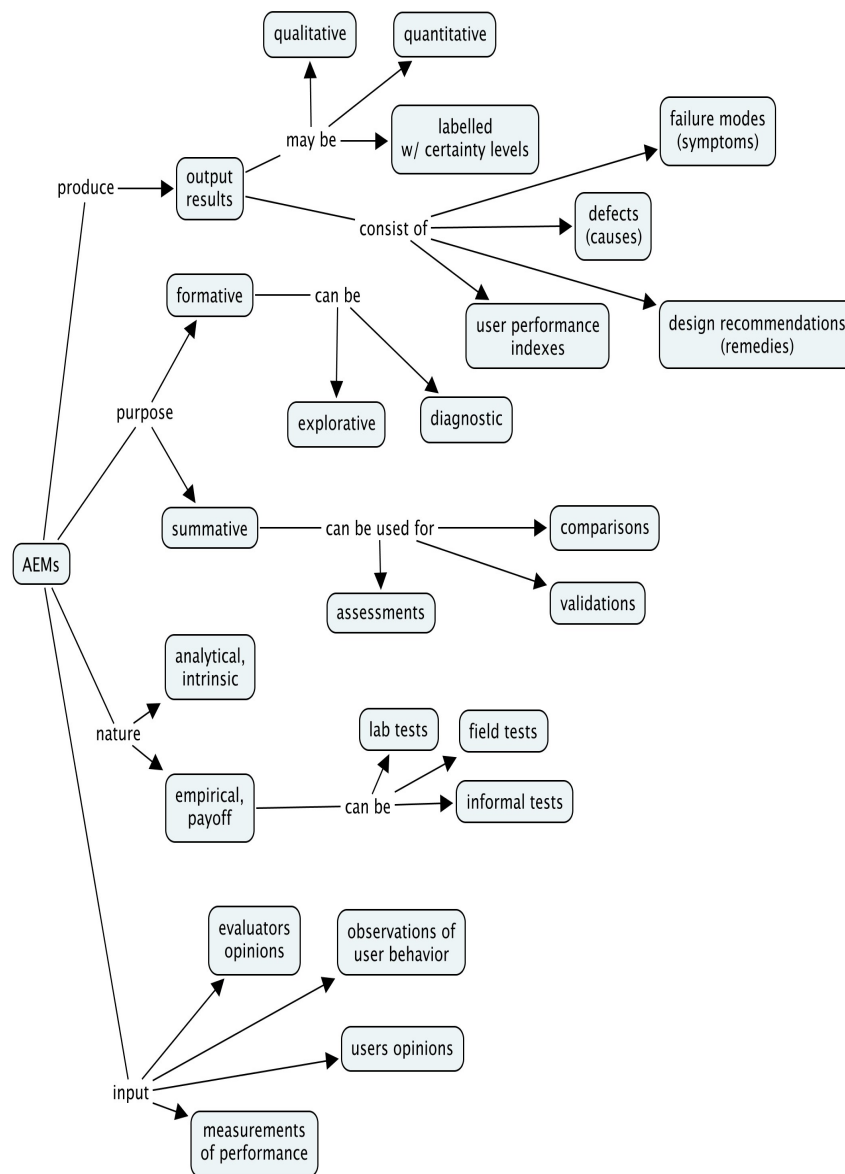


Figure 2.5: Taxonomy of accessibility evaluation methods [Brajnik, 2008a].

Key Decision Points: In this thesis, we make use of both technical and manual accessibility evaluations. Technical evaluations were used in the formative stages of the work (Chapter 3), while manual accessibility evaluations involving Web accessibility experts were used for more rigorous empirical accessibility investigations (Chapter 5). During the manual audits, the Web accessibility experts also made use of some automated tools or browser accessibility features to aid them. Thus, we can say that a hybrid approach was employed overall, and this is the most effective method for testing accessibility in the context of the Web.

2.3 Summary

In this chapter we have presented a critical review of selected studies on Web aesthetics and accessibility. The results of the review suggest that Web aesthetics and accessibility research are still in their formative stages. This is evident in the amount of work that presently looks at developing evaluation metrics and defining scopes for investigating these two Web constructs. On the aspect which is of particular interest to us, that is the effect of Web aesthetics on accessibility, the review reveals that very few studies explicitly address this issue. Moreover, closely related studies employ approaches that are either anecdotal or not widely validated. Consequently, subsequent chapters of this thesis report empirical investigations on this issue, starting with a preliminary study in Chapter 3.

Chapter 3

A Case for the Research

This chapter reports a formative study which marks the beginning of a series of studies intended to address the research gap identified in Chapter 2. The study examines the link between Web aesthetics and accessibility from a ‘technical’ perspective. By technical, we mean that an automated tool was used to examine Web pages for their accessibility [Petrie and Kheir, 2007]. Automated evaluation was chosen because of the nature of the study which was only formative. In particular, we were interested in finding out if this relationship was significant enough to motivate further research. The preliminary study involved extending part of the work done in a related PhD project, ViCRAM: Visual Complexity Rankings and Accessibility Metrics [Michailidou, 2010]. The ViCRAM researchers established that there was a link between the aesthetic quality of Web pages and their visual complexity. Aesthetically pleasing Web pages were perceived to be simple, while their displeasing counterparts were perceived to be complex [Michailidou et al., 2008]. Therefore, in the present research we conjectured that there could also be a link between the aesthetic quality of Web pages and their accessibility levels, seeing that complexity and accessibility are somewhat related Web concepts. Section 3.1 describes aspects of the work which we re-used from ViCRAM. The rest of the sections (section 3.2 onwards) describe work done in the current project.

3.1 Stimuli

The 30 Web pages used for the study were locally stored versions from ViCRAM [Michailidou, 2008]. The pages had originally been selected from Alexa¹ top 100

¹Alexa - <http://www.alexa.com>

Websites in the United Kingdom as of 18th December, 2007 when their study was first conducted. The Web pages represented common genres available on-line such as news, e-commerce, personal, academic and social-networking Websites. Table 3.1 shows the Web pages used and their Uniform Resource Locators (URLs). Screenshots of the Web pages are available in Appendix A.

Table 3.1: Web pages used in the formative study and their URLs

Web Page	URLs
Amazon UK	http://amazon.co.uk/
AnnoteaProject	http://www.w3.org/2001/Annotea/
AutoTrader	http://www.autotrader.co.uk
BBC UK News	http://news.bbc.co.uk/
BBC UK	http://www.bbc.co.uk
BloggerPostHQ	http://blog.last.fm/2007/08/29/audio-fingerprinting-for-clean-metadata
BloggerPostDE	http://www.agenturblog.de/
Blogger Dashboard	http://www.blogger.com/home
Delicious	http://del.icio.us
Ebay	http://www.ebay.co.uk/
Firefox	http://www.mozilla.com/en-US/
Flickr	http://flickr.com/
GoogleSearch	http://www.google.co.uk/search?hl=en&q=manchester&btnG=Google+Search&meta=
GumTree	http://www.gumtree.com
IMDB	http://www.imdb.com/
InvisionFree	http://invisionfree.com/
Job Centre	http://www.jobcentreplus.gov.uk/JCP/index.html
MegaUpload	http://www.megaupload.com
MySpace	http://www.myspace.com/
Orkut	http://www.orkut.com
Rapidshare	http://www.rapidshare.com
Rightmove	http://www.rightmove.co.uk
StudentNet	http://www.studentnet.manchester.ac.uk/
StudentNet SelfService	http://www.studentnet.manchester.ac.uk/selfservice/
WAI	http://www.w3.org/WAI/
Wiki Result	http://en.wikipedia.org/wiki/Wiki
Wikipedia	http://wikipedia.org/
Yahoo UK	http://www.yahoo.co.uk
Yell	http://www.yell.com/ucs/HomePageAction.do
YouTube	http://youtube.com/

A total of 55 participants volunteered for the ViCRAM on-line experiment where Web pages were ranked based on five visual aesthetic dimensions which included: ‘clean’, ‘clear’, ‘beautiful’, ‘organised’ and ‘interesting’. These adjectives were chosen from a pool of visual aesthetic terminologies found in Lavie and Tractinsky [2004]’s Web aesthetics framework. For the aesthetic perception component of our work, we re-used the ratings given by the participants in the ViCRAM project. Table 3.2 shows the Web pages and their mean scores for the aesthetic attributes.

Table 3.2: Web pages used in the formative study and their aesthetic rankings

Web Page	Clean	Interesting	Organised	Clear	Beautiful
Amazon UK	5.12	6.50	6.79	6.01	5.37
AnnoteaProject	6.29	4.08	6.42	6.06	3.69
Autotrader	3.52	5.13	4.94	4.25	3.71
BBC UK News	5.20	7.44	7.03	6.26	5.75
BBC UK	5.15	6.87	6.75	6.06	5.68
BloggerPostHQ	7.01	5.49	6.64	6.36	5.84
BloggerPostDE	6.25	4.96	5.89	5.64	5.86
Blogger Dashboard	5.37	4.87	5.69	5.28	4.36
Delicious	4.40	4.33	5.15	4.53	3.97
Ebay	5.56	6.72	6.80	6.31	5.78
Firefox	7.59	6.66	7.90	7.69	6.85
Flickr	7.48	6.94	7.56	7.29	6.68
GoogleSearch	6.63	6.44	7.73	7.48	5.42
GumTree	4.15	5.02	6.01	5.05	4.37
IMDB	3.94	5.90	5.53	4.63	4.50
InvisionFree	4.28	3.35	4.77	4.09	3.15
Job Centre	6.70	5.39	6.87	6.56	4.12
MegaUpload	3.95	4.24	4.47	3.68	3.70
Myspace	3.95	5.82	5.39	4.78	4.39
Orkut	8.45	4.68	7.69	7.46	5.34
Rapidshare	6.03	5.02	6.14	5.80	4.47
Rightmove	6.40	5.82	7.01	6.73	5.05
StudentNet	6.40	6.03	6.94	6.58	5.36
StudentNet SelfService	8.07	5.05	8.02	7.77	4.96
WAI	4.38	4.35	5.41	4.68	3.80
Wiki Result	6.05	7.05	7.47	6.85	5.85
Wikipedia	7.83	7.14	7.93	7.71	7.05
Yahoo UK	4.47	6.48	6.16	5.30	5.34
Yell	7.85	5.61	7.91	7.79	5.54
YouTube	5.18	7.12	6.66	5.85	5.55

3.2 Task and Procedure

The 30 Web pages were examined against Web Content Accessibility Guidelines (WCAG 1.0) [Chisholm et al., 1999] which was the stable version of the guidelines available as at June, 2008 when our preliminary study was conducted. The number of guidelines failed by the individual Web pages were noted. We were interested in the number of guidelines failed, rather than the individual checkpoints. If at least one checkpoint was violated under a guideline, then that was counted as one failure for the associated Web page, irrespective of the number of checkpoints failed under such a guideline. The reason for adopting this approach was that it was both straightforward and practical. The automated checker used, “Cynthia Says”² produces boolean results (pass or fail) at the end of the evaluation process, so we had to develop a way of quantifying the failures. It was therefore more straightforward to count the guidelines violated. If we think of the behaviour of Web developers, we can argue that the approach is also practical. If a Web developer is not aware of or does not observe a particular accessibility checkpoint, then he/she is likely to keep violating that checkpoint throughout the development process. This will in turn trigger many similar checkpoint failures, hence we counted the governing guidelines failed. The Web pages were tested for all three WCAG 1.0 conformance levels: ‘A’, ‘AA’ and ‘AAA’. Cynthia Says is one of the many automatic accessibility evaluation tools maintained in the on-line list³ by the World Wide Web Consortium. We chose Cynthia Says because it is a free Web-based tool that presents accessibility evaluation results in a clear manner. It uses the Section 508 standards or WCAG 1.0 guidelines as a basis for testing the accessibility level of Websites. Only one Web page can be examined per minute.

3.3 Results

The relationship between the aesthetic aspects of Web pages (Table 3.2) and their accessibility measured by the number of guidelines failed for the different conformance levels (Table 3.3) was examined using a Pearson correlation test. This was to help us to determine if there exist any significant relationship between the two. The statistical software used here and in the entire thesis was SPSS⁴.

²Cynthia Says - <http://www.contentquality.com/>

³<http://www.w3.org/WAI/ER/tools/complete>

⁴<http://www-01.ibm.com/software/uk/analytics/spss/>

Table 3.3: Web pages and the number of WCAG 1.0 violated

Web Page	A	AA	AAA
Amazon UK	2	7	8
AnnoteaProject	0	3	4
Autotrader	1	5	6
BBC UK	1	5	7
BloggerPostHQ	1	3	3
BloggerPostDE	1	4	5
Blogger Dashboard	2	4	5
Delicious	1	4	5
Ebay	1	6	7
Firefox	0	1	2
Flickr	1	4	5
GoogleSearch	1	5	7
GumTree	1	5	7
IMDB	1	6	8
InvisionFree	1	3	5
Job Centre	1	3	3
MegaUpload	2	6	7
Myspace	1	6	8
Orkut	1	4	5
Rapidshare	1	4	5
Rightmove	0	2	2
StudentNet	0	1	1
StudentNet SelfService	0	1	1
WAI	0	3	4
Wiki Result	0	4	5
Wikipedia	0	2	2
Yahoo UK	2	5	7
Yell	0	2	2
YouTube	2	6	8

3.3.1 Aesthetics and technical accessibility

Table 3.4 shows the relationship between the five aesthetic dimensions and technical accessibility. Recall that technical accessibility here is measured as the number of accessibility guidelines failed by a Web page. We observe moderate significant negative correlations between three aesthetic dimensions (clean, clear and organised) and the number of accessibility violations reported by Cynthia Says. Figures 3.1 to 3.5 have the graphs for the observed relationships.

Table 3.4: Correlation between aesthetics and technical accessibility

	Level A	Level AA	Level AAA
Clean	-0.483^a ($p=0.007$)	-0.639^a ($p=0.000$)	-0.681^a ($p=0.000$)
Clear	-0.492^a ($p=0.006$)	-0.512^a ($p=0.004$)	-0.545^a ($p=0.002$)
Beauty	-0.184 ($p=0.331$)	-0.170 ($p=0.369$)	-0.199 ($p=0.291$)
Organised	-0.450^b ($p=0.013$)	-0.415^b ($p=0.023$)	-0.458^b ($p=0.011$)
Interesting	0.007 ($p=0.970$)	0.177 ($p=0.350$)	0.178 ($p=0.345$)

a is significant at 0.01 and b is significant at 0.05 level (2-tailed).

3.3.2 Visual cleanness vs technical accessibility

Figure 3.1 shows a negative relationship between visual cleanness, and the number of guidelines failed by the Web pages when examined for AAA accessibility conformance. So, the cleaner the visual design of the Web page, the fewer the number of accessibility guidelines failed by the Web page in question.

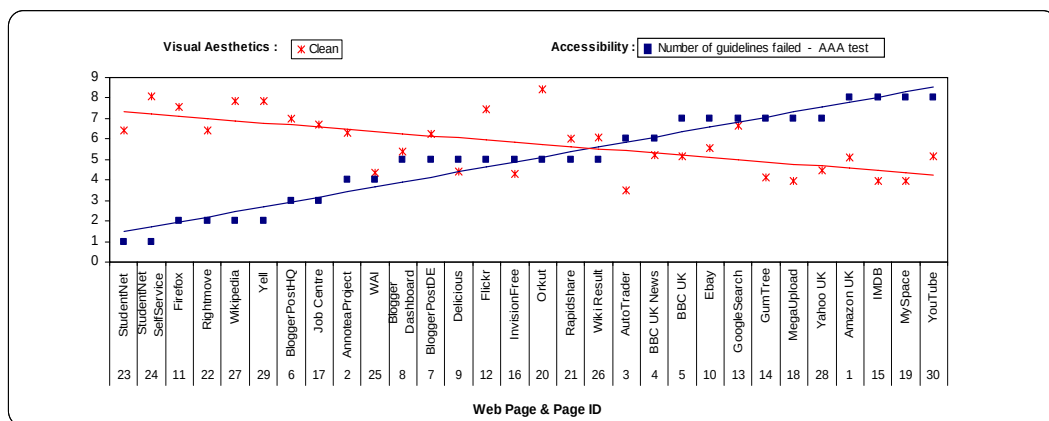


Figure 3.1: The relationship between visual cleanness and WCAG 1.0 failed by the Web pages when examined for AAA accessibility conformance.

In other words this suggests a direct positive relationship between the aesthetic dimension clean and accessibility. In practise this would mean that Websites designed with cleanness in mind (which is the tendency to apply moderation or avoid clutter) would likely result in more technically accessible Websites.

3.3.3 Visual clarity vs technical accessibility

Figure 3.2 shows a similar trend like the one described in the cleanness case. A negative relationship is observed between visual clarity, and the number of guidelines failed by the Web pages when examined for AAA accessibility conformance. So, lower points of visual clarity are associated with higher points of guideline failures. This is not very suprising when we think about the fact that these two design dimensions (i.e clean and clear) specified in [Lavie and Tractinsky, 2004]’s aesthetics framework are very closely related semantically-speaking. As such, we would expect similar outcomes regarding their link with accessibility. Again the results here suggest a direct positive relationship between the aesthetic dimension clear and accessibility from a technical perspective.

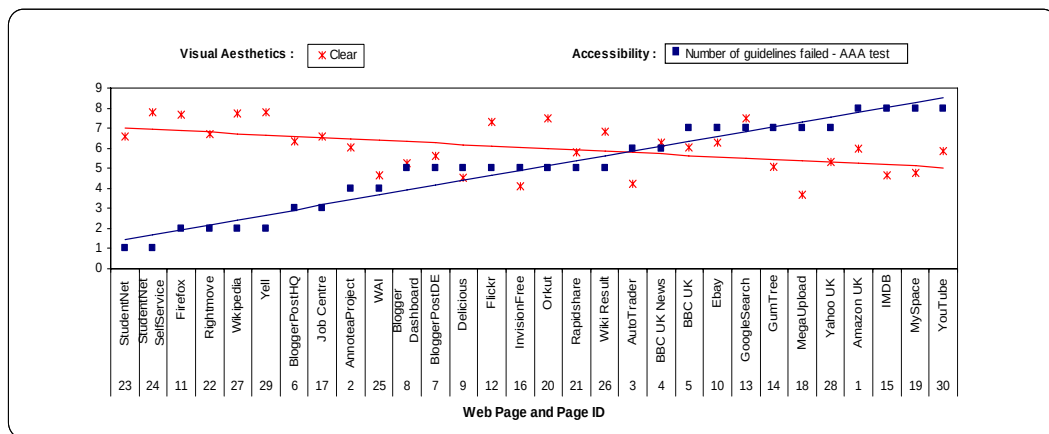


Figure 3.2: The relationship between visual clarity and WCAG 1.0 failed by the Web pages when examined for AAA accessibility conformance.

3.3.4 Visual beauty vs technical accessibility

Figure 3.3 does not show any clear significant trends for the relationship between visual beauty and the guidelines failed by the Web pages when examined for WCAG 1.0 AAA conformance. The Pearson correlation analysis also supports

this observation. We see a very weak negative relationship between the aesthetic dimension beauty and the number of accessibility violations in Table 3.4.

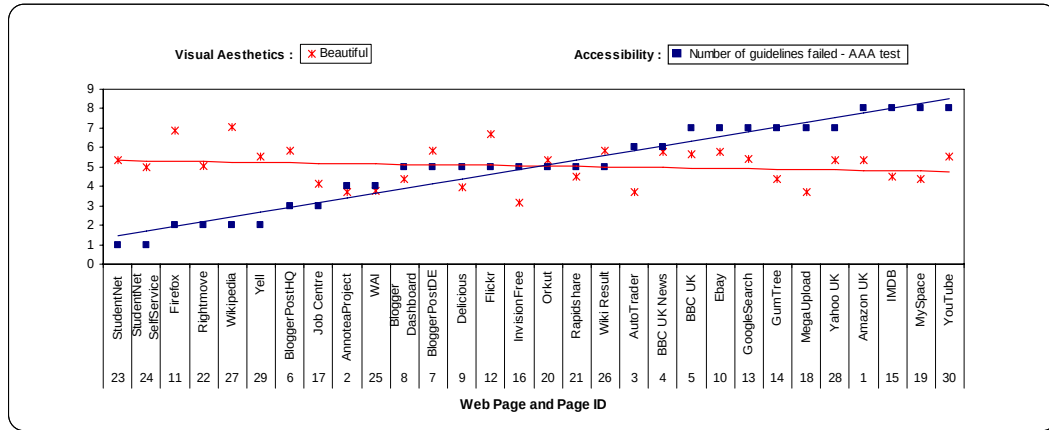


Figure 3.3: The relationship between visual beauty and WCAG 1.0 failed by the Web pages when examined for AAA conformance.

3.3.5 Visual organisation vs technical accessibility

Figure 3.4 shows a negative relationship between the visual organisation of Web pages, and the guidelines failed for WCAG 1.0 AAA conformance test. Guideline failures with higher values appear toward the right hand side of the graph, and this corresponds to areas where the visual organisation is low.

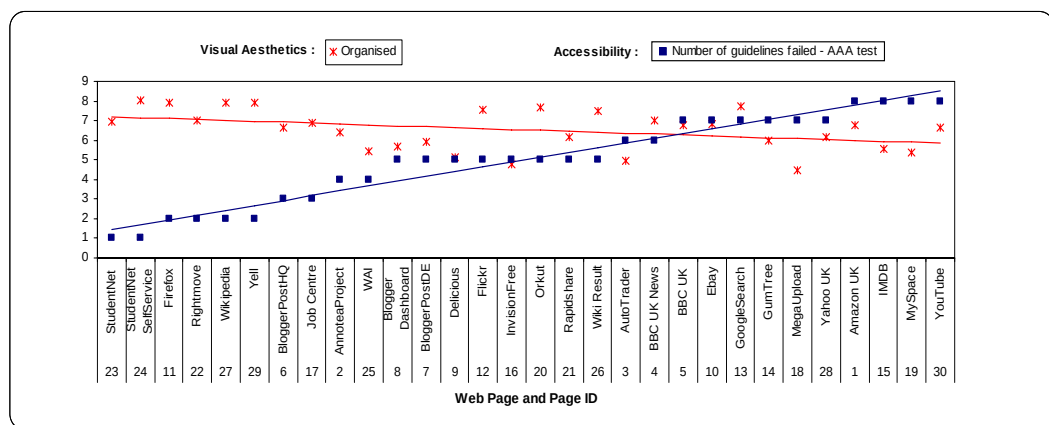


Figure 3.4: The relationship between visual organisation and WCAG 1.0 failed by the Web pages when examined for AAA conformance.

3.3.6 Visual interestingness vs technical accessibility

Figure 3.5 does not show any clear or significant relationship between visual interestingness and the number of guidelines failed for WCAG 1.0 AAA conformance. Table 3.4 reports a very weak relationship in a positive direction, meaning that the more visually interesting Web users found a Web page, the more technical accessibility errors present.

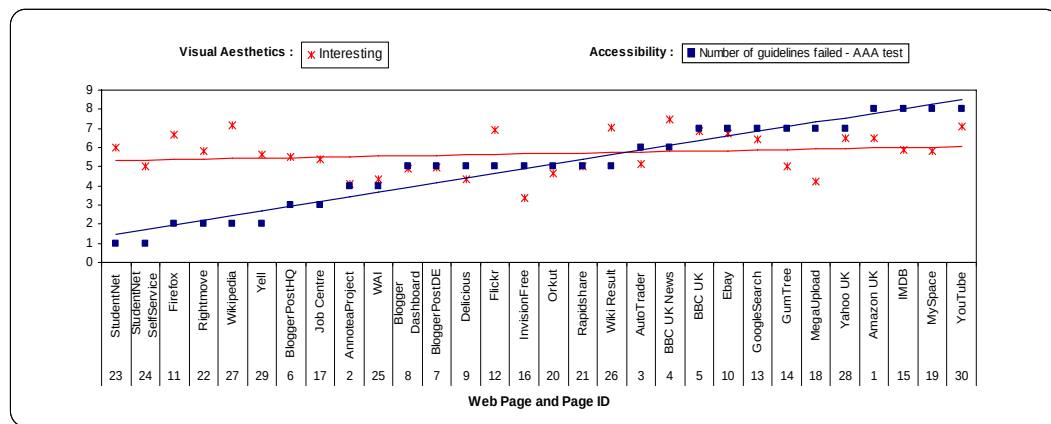


Figure 3.5: The relationship between visual interestingness and WCAG 1.0 failed by the Web pages when examined for AAA conformance.

The main aim of the preliminary study was to understand if there exists any relationship between visual aesthetic aspects of Web pages and their accessibility levels, measured by the number of guidelines failed when the pages are examined for WCAG 1.0 conformance. Also, we sought to know if this relationship was significant enough to motivate further research in the area. Significant inverse relationships were observed between ‘clean’, ‘clear’ and ‘organised’ visual aesthetic attributes, and the number of guidelines failed by the Web pages for all three conformance levels. However, the terms ‘beautiful’ and ‘interesting’ showed no significant relationships. So, Web pages that were perceived to be visually clean, clear and organised failed lesser numbers of WCAG 1.0 when tested for A, AA and AAA conformance. This suggests that visually pleasing pages in this context may be more readily accessible compared to their visually displeasing counterparts. However, further studies involving human evaluators are required on this issue. The visual aesthetic terms ‘beautiful’ and ‘interesting’ appeared to be the most subjective of the five terms examined in the study by Michailidou et al.

[2008]. We speculate that this subjectivity may have influenced the results. In addition, the word ‘interesting’ is ambiguous and may not be directly related to a Web page’s visual appearance. A careful look at the rankings done in [Michailidou, 2008; Michailidou et al., 2008] reveals that some of the Web pages which were agreed to be visually cluttered, confusing and disorganised across participants by virtue of the low visual aesthetic scores given to such pages received high ratings for being interesting. In our case, such pages were found to fail a greater number of the guidelines. Consequently, the term ‘interesting’ exhibited no clear trends when its relationship with technical accessibility was examined. The same explanation holds for the term ‘beauty’. However, ratings of beauty were less subjective than those of ‘interestingness’ in Michailidou et al. [2008]’s study. This effect came across in our results also.

The strong correlations between ‘clean’, ‘clear’ and ‘organised’ (classical aesthetics) visual aesthetic attributes and accessibility here suggest this class of Lavie and Tractinsky [2004]’s taxonomy to be more closely related with accessibility, at least from a technical perspective. Classical aesthetics is one of the two aesthetic dimensions for the Web proposed by Lavie and Tractinsky [2004]. It deals mainly with the structural outlook of the Web page as opposed to the other class, expressive aesthetics which highlights the designer’s technical expertise and showcases more appeal or affective aspects of design. In Lavie and Tractinsky [2004]’s work, classical aesthetics was also more highly correlated with usability compared to expressive aesthetics. Also, in Michailidou et al. [2008]’s study classical aesthetics was a better predictor of visual complexity issues. Perhaps, if Web developers pay more attention to aesthetic considerations along the classical line, they may be more likely to produce Websites which have fewer accessibility issues. However, more rigorous studies on these outcomes are required for stronger conclusions.

3.4 Summary

In this chapter, we have presented a preliminary study on the relationship between Web aesthetics and accessibility. The study indicates that there is a link between visual aesthetics and Web accessibility which should be further investigated. Chapters 4 and 5 contain more rigorous empirical investigations on this issue. In Chapter 4 more Web pages were examined for their aesthetic quality, compared to the formative study described here. As such, a wider range of Web

designs were taken into account considering the subjectivity of aesthetic preference. Furthermore, a total of 180 participants were involved in the aesthetic studies described in Chapter 4, compared to the 55 participants who took part in the ViCRAM project. In Chapter 5, a more reliable method for measuring Web accessibility is employed in addition to technical evaluations. Manual accessibility evaluations were also conducted by Web accessibility experts who are well versed in the field. The manual evaluation technique employed in Chapter 5 also distinguishes between disability types, and takes into account the severity of accessibility barriers found a Web page, whereas automated checkers do not.

Chapter 4

Web Aesthetic Studies

This chapter describes further attempts to classify Web pages based on their visual quality. Here, we examine a larger number of homepages than we did in the preliminary study reported in Chapter 3. The large data set allows us to explore a wider range of Web visual designs. We report two sets of empirical studies here. The first is a lab-based experiment which involved 30 Web users, while the second is an on-line experiment which was very similar to that conducted in the lab. The on-line study involved 150 Web users and served confirmatory purposes. Unlike the preliminary study where the aesthetic judgements of participants were collated via an on-line study only, the additional lab-based study reported here allowed us to meet the actual users, observe their aesthetic behaviours and interview them. A subjective approach is employed here, because we acknowledge that the aesthetic opinions of Web users are particularly important for discriminating between Web designs. Once again we use adjectives from Lavie and Tractinsky [2004]’s bi-dimensional framework to describe perceived Web aesthetics. Furthermore, we take into account some new adjectives which were not previously investigated in the preliminary case. The chapter is divided into three main sections. In the first section we present the lab-based study and in the second section we present the on-line study. We discuss the results from these two studies as we go along. We also provide a brief comparison of the rating strategies adopted by the participants for the aesthetic judgements performed in the two sets of studies. The third section contains a content analysis of the feedback comments given by the participants, especially those from the on-line study where we had a greater response. In general, we observe that there are many factors which influence the aesthetic behaviours of Web users, and these factors are consistent across studies.

4.1 Lab-based Study

The aim of this study was to investigate how users judge the visual quality of Web pages. We were interested in understanding what informs users about the visual quality of Web pages when they have to judge based on certain design dimensions such as *clean*, *pleasing*, *fascinating*, *creative* and *aesthetic* as defined in Lavie and Tractinsky [2004]’s bi-dimensional framework. The factors responsible for the aesthetic preferences of the participants would be used to inform a framework which will support a more objective approach to Web aesthetic measurement. The rest of the section describes the experimental setup and results.

4.1.1 Participants

Thirty-two (32) participants, 25 males and 7 females were recruited for the study from the School of Computer Science and its immediate environs. Two persons (males) had invalid responses. In the first case the participant did not answer all the questions on the paper-based questionnaire. In the second case the respondent was unable to complete the study at one go. As a result, both sets of data were not included in the final analysis. Consequently, there were 30 participants with valid responses, 23 males and 7 females with ages ranging from 16 to 41 and over. Twenty-six (26) were undergraduate and postgraduate students from Computing and Life Sciences departments, while 4 were professionals with Nursing, Teaching, Veterinary Medicine and Engineering as their backgrounds. All the participants were frequent Web users. One person (male) reported a mild case of colour-blindness. Interviews before and after the task confirmed that the impairment he claimed did not affect the purpose of the experiment. Moreover, the inclusion or removal of his data did not significantly influence the standard deviations for the participants’ aesthetic ratings, hence, his data was included. There were 16 Whites (British), 5 Blacks (British/African/Caribbean), 3 Asians, 2 Chinese and 4 others (2 Arabics, 1 German, 1 Iraqi). See Appendix B.1 for more information.

4.1.2 Stimuli

Fifty (50) homepages were used for the study. This allowed for the investigation of a wide variety of Web designs. As much as we wanted the Web pages to be representative, we did not also want to over burden the participants with very

long study sessions, and this is why we could not use more than 50 Web pages. Homepages were used because they represent gateways to Websites. In agreement with Pandir and Knight [2006], we judged that the use of visual aesthetics may be more crucial for homepages. The Web pages were randomly selected from the top 100 Websites in the United Kingdom (UK) as ranked by Alexa¹. We also used randomly selected Web pages from the winners and nominees list for the Webby Awards² under the best visual aesthetic design and welcome page categories for years 2005 to 2009. The psychic science random number generator³ was used to generate unique random numbers to aid the Web page selection process.

For selections from Alexa, where a random number corresponded to the rank position of a Website which was unsuitable for general viewing (e.g pornographic Website as pre-warned by Alexa), the associated homepage was not selected. The homepage belonging to another Website was picked based on the next generated random number. Bank Websites were also excluded as it was difficult to retrieve all their associated Cascading Style Sheets (CSS) for re-rendering, and to avoid any security issues. All the Web pages from Alexa were downloaded on the 10th of November, 2009, while the Web pages from the Webby Award's Website were downloaded on the 23rd of November 2009 and then merged together to form a pool. The 50 Web pages were stored locally and presented with their interactive features to the participants. This was achieved by re-rendering the Web pages using the HTML `<iframe>` tags. The attributes of the tags were adjusted to ensure that the Web pages rendered exactly as they would have on the Web.

We could not upload the Web pages due to ethical issues like those surrounding phishing. Phishing is an attempt to steal personal information (e.g passwords) from vulnerable electronic communication users by pretending to be a legitimate Website for example. Uploading our stored pages would mean duplicating the original Web pages on-line and this raised suspicion on one occasion during the formative stages of our work. Furthermore, the dynamic nature of the Web constrained us from using live Web pages, as content may change across participants. The Web pages represented news, sports, personal, education, blogs, search, government, social networking, e-commerce and leisure genres. Screenshots of the Web pages and their respective Web addresses can be found in Appendix B.2.

¹<http://www.alexa.com/topsites/countries/GB>

²<http://webbyawards.com/>

³<http://www.psychicscience.org/random.aspx>

4.1.3 Lab Setting

The study took place at the Web Ergonomics Lab (WEL) based at the School of Computer Science, University of Manchester, United Kingdom. Standard DELL desktop PCs with 17 inch monitors were used. The screen resolutions were set to 1280 X 1024. Both user lab suites were artificially lit to good standards.

4.1.4 Task and procedure

Participants were first asked to read an information sheet (B.3.1) outlining the aim of the study and experiment procedure. On agreeing to participate, a consent form (B.3.2) was signed, and a demographic form filled out (B.3.3). Each participant was made to sit in a comfortable position in front of a desktop computer. The task was to judge the visual quality of 50 homepages. Participants were shown a homepage for 4 seconds, and were free to scroll up or down to view the whole Web page as they would normally do when browsing. However, they were not allowed to navigate away from the homepage. This was to ensure stimulus uniformity, as the Web is very dynamic. After 4 seconds, another page was shown instructing participants to rate the Web page they had just seen based on the 5 design dimensions under investigation. A 7-point Likert scale was used, and the scores were written on a paper questionnaire (B.3.4). After rating a Web page, participants then clicked the next button. This made another homepage appear for 4 seconds as before, after which a page with instructions to rate followed. The viewing time was set to 4 seconds because we were interested in visceral responses. First impressions have been shown to play an important role in efforts that seek to understand the aesthetic preferences of Web users [Lindgaard et al., 2006]. The viewing time was short enough to allow initial judgements to be elicited, and long enough for Web pages with flash content or dense graphics to load. Previous studies report viewing times ranging from 50 milliseconds [Lindgaard et al., 2006; Tractinsky et al., 2006] up to 7 seconds [Michailidou et al., 2008] or more for gathering visceral responses. The Web pages were ordered in two different ways to counter balance any position effects, and participants had to rate twice.

The judgements of the participants were made based on Lavie and Tractinsky [2004] *classical* and *expressive* Web aesthetic dimensions, and the adjectives *clean*, *pleasing* and *fascinating*, *creative* were selected to represent the two dimensions respectively. Participants then gave an overall score under the term

beautiful/aesthetic. A close examination of Lavie and Tractinsky’s Web aesthetic dimensions will reveal that some of the terminologies are very much related. For example, the following pairs of terms from their framework are synonyms: clean and clear, original and creative. We speculated that this may come across to participants, and could lead to unwanted duplications. Hence, we chose a subset of terms that were semantically disparate to an extent for our research. Their framework has also been criticized for the inclusion of the term ‘aesthetic’, firstly as a design dimension of aesthetics [Lindgaard et al., 2006], and secondly under the classical dimension only [Moshagen and Thielsch, 2010]. Consequently, we gathered the overall judgements of the participants under the term ‘aesthetic’, rather than use it as one of the design dimensions. Also, the word ‘beautiful’ was used alongside the term ‘aesthetic’ in the questionnaire to aid people who may not be familiar with the word aesthetics. As we had users with differing backgrounds in mind, we wanted to keep the terminologies as simple as possible, hence, we did not make use of a more technical design dimension like ‘symmetry’. Qualitative data were gathered after the experiment, and detailed think aloud sessions were also performed for some of the participants. Experiment sessions lasted between 30 minutes and one hour depending on the participants judgement speed, and after task discussions. The participants were paid £10 for giving their time.

4.1.5 Results

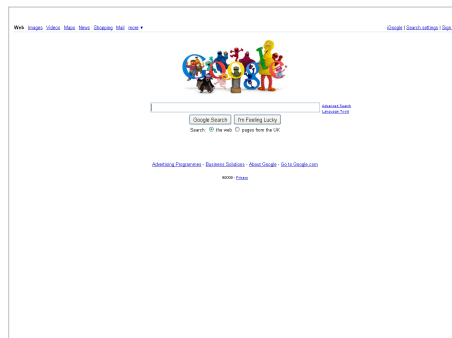
Means and standard deviations (SDs) were computed for the homepages based on the participants’ ratings, given the 5 design dimensions. Table 4.1 shows the mean scores for the Web pages. The higher the mean score, the higher the page ranking for the dimension in question. For example, the cleanest homepage was ID46, while the most cluttered was ID30. In general, if a homepage was given a high score for one design dimension, it was likely to get similar scores across the other dimensions and vice versa, suggesting a positive relationship between the design dimensions. This outcome lends some support to Hassenzahl [2004]’s observation that “evaluative constructs tend to correlate”. In other words, if end users perceive a product to be good, they tend to reward other aspects (e.g desirability) of the product in the same positive fashion. Furthermore, lower SD values achieved for clean and aesthetic design dimensions show that participants agreed more on these aspects. Agreement among participants was less on the creative dimension. We would expect such, as this is a more subjective construct.

Table 4.1: Participants' aesthetic ratings for the lab-based study

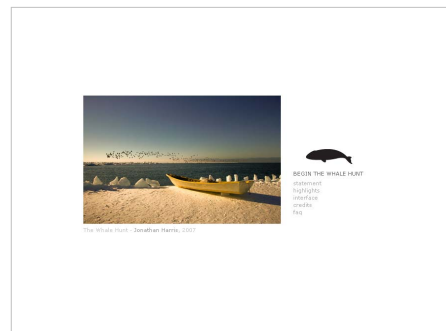
Web page	PageID	Clean		Pleasing		Fascinating		Creative		Aesthetic	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Adbash	ID1	5.42	1.00	4.53	1.24	3.83	1.43	4.03	1.51	4.15	1.29
Amazon	ID2	4.45	1.62	5.48	1.05	5.43	1.09	5.05	1.20	5.23	1.06
Answers.com	ID3	4.25	1.38	4.67	1.21	4.20	1.42	4.20	1.37	4.35	1.11
Argos	ID4	3.57	1.90	4.52	1.42	4.58	1.31	4.35	1.46	4.35	1.27
Ask Jeeves	ID5	6.37	0.84	5.35	1.37	4.63	1.37	4.37	1.54	5.05	1.25
Asos	ID6	5.12	1.21	5.43	1.01	5.05	0.99	5.15	1.08	5.27	1.00
Autotrader	ID7	3.83	1.40	4.55	1.15	4.48	1.26	4.47	1.07	4.45	1.06
BBC	ID8	4.33	1.63	5.30	1.13	5.42	1.20	5.22	1.29	5.17	0.94
Bebo	ID9	5.85	0.87	5.18	1.03	4.77	0.98	4.78	0.97	5.07	0.86
Big Fat Institute	ID10	3.87	1.44	4.07	1.19	3.83	1.14	4.02	1.18	3.88	1.06
Bing	ID11	6.25	0.76	5.77	1.20	5.37	1.27	5.38	1.36	5.62	1.17
Directgov	ID12	3.43	1.44	3.48	1.34	3.10	1.09	3.33	1.10	3.33	1.18
Ebay	ID13	4.43	1.48	5.35	0.90	5.23	0.96	5.13	1.07	5.12	0.83
Ezine Articles	ID14	2.27	1.35	2.72	1.14	2.55	1.12	2.92	1.11	2.60	1.08
Facebook	ID15	6.10	0.71	5.38	1.16	4.78	1.14	4.63	1.40	5.00	1.27
Flickr	ID16	5.53	0.69	5.52	0.81	4.95	0.91	5.12	0.91	5.32	0.68
Full Sail University	ID17	5.13	1.19	5.53	1.00	5.65	0.99	5.72	1.17	5.43	1.04
Good Things by Orange	ID18	5.82	0.91	5.85	1.25	5.45	1.28	5.80	1.17	5.55	1.01
Google	ID19	6.68	0.64	5.78	0.97	5.25	1.11	5.07	1.28	5.65	1.02
Gumtree	ID20	3.28	1.64	3.68	1.29	3.52	1.50	3.53	1.35	3.53	1.29
Hello Sour Sally	ID21	5.72	1.36	5.28	1.62	5.23	1.59	5.57	1.44	5.20	1.37
IMDb	ID22	3.42	1.52	4.08	1.36	4.58	1.29	4.15	1.15	4.12	1.10
Jonathan Yuen	ID23	6.13	1.27	4.45	1.62	3.72	1.80	4.12	1.73	4.32	1.62
Last Fm	ID24	5.05	0.69	5.23	0.77	4.98	1.00	4.83	0.96	4.93	0.68
Linkedin	ID25	5.62	0.78	4.53	0.90	3.82	0.89	3.77	1.01	4.20	0.84
Live Journal	ID26	4.00	1.28	4.33	0.96	4.02	0.97	4.07	0.98	4.13	0.93
Marks and Spencer	ID27	5.72	0.65	5.67	0.89	5.33	1.19	5.30	1.09	5.62	0.68
Megavideo	ID28	4.92	1.14	5.12	0.95	4.83	0.95	4.55	1.08	4.75	0.96
Microsoft	ID29	5.47	0.87	5.28	0.90	4.82	1.00	4.97	1.04	5.15	0.92
Money Saving Expert.com	ID30	2.13	1.51	2.92	1.25	3.18	1.45	3.25	1.41	2.75	1.14
Mozilla	ID31	5.80	0.88	5.52	1.13	5.03	1.11	5.07	1.22	5.40	1.05
MSN	ID32	3.72	1.79	4.37	1.25	4.48	1.37	4.38	1.32	4.40	1.32
Pantagonia	ID33	5.22	1.14	5.28	1.00	5.17	0.98	5.02	0.88	5.12	0.86
Play.com	ID34	3.72	1.44	4.97	1.20	5.05	1.25	4.90	1.05	4.80	0.93
Rapidshare	ID35	5.92	1.12	4.32	1.32	3.43	1.05	3.32	0.94	4.00	0.96
Rightmove	ID36	3.63	1.44	3.98	1.32	4.00	1.29	4.17	1.01	4.03	1.16
Royalmail	ID37	6.10	0.67	5.05	1.03	4.33	1.08	4.48	1.11	5.02	0.87
Solar System Exploration	ID38	4.03	1.49	5.08	1.08	5.37	1.31	4.83	1.04	4.87	1.05
Target.com	ID39	4.25	1.48	4.93	1.16	4.85	1.18	4.87	1.15	4.75	1.19
Tesco	ID40	3.97	1.55	4.80	1.16	4.62	1.29	4.55	1.26	4.60	1.21
Twitter	ID41	5.97	0.95	5.60	0.89	4.97	1.02	4.90	1.30	5.33	0.99
Veer	ID42	5.52	0.66	5.10	1.02	4.40	1.04	4.53	1.02	4.90	0.88
Villa San Michelle	ID43	6.30	0.74	6.13	1.06	5.63	0.93	5.58	1.18	6.12	0.86
Virgin Media	ID44	3.20	1.60	4.17	1.33	4.37	1.17	4.40	1.29	4.17	1.30
We Feel Fine	ID45	5.75	1.26	5.25	1.48	4.90	1.48	4.93	1.52	5.33	1.30
Whalehunt	ID46	6.57	0.80	5.63	1.36	4.82	1.47	4.52	1.63	5.33	1.19
Wikipedia	ID47	5.35	1.36	4.83	1.40	4.45	1.35	4.45	1.30	4.62	1.27
Wordpress	ID48	4.58	1.16	4.58	0.94	4.47	0.96	4.62	0.88	4.63	0.76
Yahoo	ID49	4.20	1.62	4.83	1.15	4.75	0.99	4.65	1.18	4.68	1.09
Yell	ID50	5.00	0.92	4.67	0.92	4.08	1.03	4.20	1.09	4.43	0.94

Clean - Cluttered

Clean homepages were found to have a simple and less dense compositional layout as in Figure 4.1, while cluttered homepages had a complex and more dense layout as shown in Figure 4.2. The cleanest Web pages tended to have very little information on them, as if to invite the user to engage with the site, while the most cluttered Web pages presented too much information at once. Cluttered homepages were characterised by heavy text presence and/or segmentation of the layout. We also observed that clean homepages tended to have one main image, while their cluttered counterparts had several images on the welcome page.

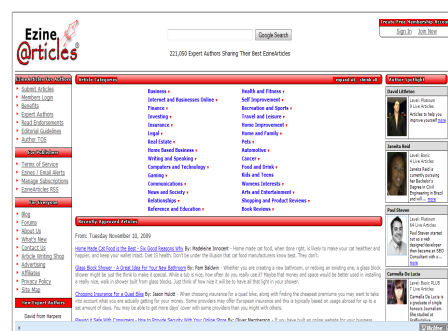


(a) ID19



(b) ID46

Figure 4.1: Clean homepages from the lab-based study.



(a) ID14



(b) ID30

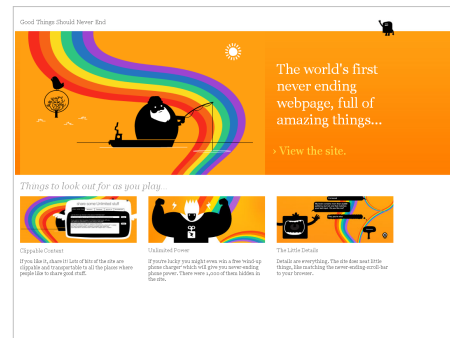
Figure 4.2: Cluttered homepages from the lab-based study.

Pleasing - Displeasing

It was particularly difficult to understand what moderated users' aesthetic preferences when rating how pleasing a homepage was, considering the best homepages in this category (see Figure 4.3). The top five welcome pages on the pleasing dimension seemed to possess varying positive aesthetic characteristics like moderate text and image quantity, animations, moderate segmentation etc. It therefore seems that the adjective 'pleasing' represents a more general design dimension. However, homepages with too much information like those in Figure 4.4 came across as displeasing, as was the case with the previous design dimension.



(a) ID43



(b) ID18

Figure 4.3: Pleasing homepages from the lab-based study.



(a) ID13



(b) ID14

Figure 4.4: Displeasing homepages from the lab-based study.

Fascinating homepages were those that aroused the curiosity of the user from the outset (Figure 4.5). Web pages with moderate to heavy animations came across as fascinating to most of the participants that were recruited. Both pages in Figure 4.5 made use of heavy animations. On the other hand, homepages without animations, which also had an overly simple or cluttered outlook came across as boring to the study participants (see Figure 4.6). Furthermore, we found that the main image used on fascinating welcome pages was also critical, and carefully crafted to maintain interest. We found their images to be very captivating.

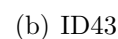
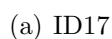


Figure 4.5: Fascinating hompages from the lab-based study.

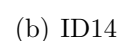
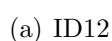
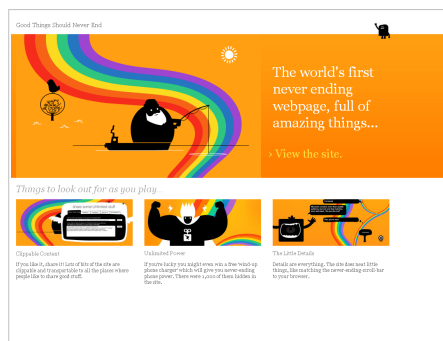


Figure 4.6: Boring homepages from the lab-based study.

Creative - Basic

Homepages with animations were also perceived to be creative. The best homepages in this category (see Figure 4.7) employed heavy use of animations like in the ‘fascinating’ dimension. However, we observed that the use of animations more readily predicts the creativity level on a Web page compared with its ability to fascinate the user. The standard deviations reported in Table 4.1 also suggest that the creative design dimension is more subjective than its fascinating counterpart. Again, homepages without moving graphics, which also had an overly simple or cluttered outlook were judged as basic homepages (Figure 4.8).



(a) ID18

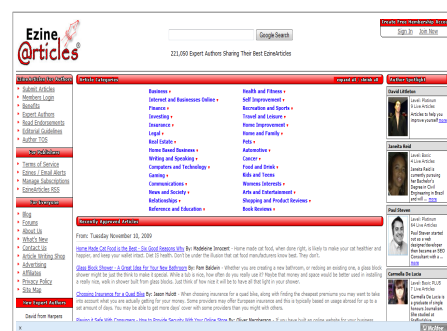


(b) ID17

Figure 4.7: Creative homepages from the lab-based study.



(a) ID30



(b) ID14

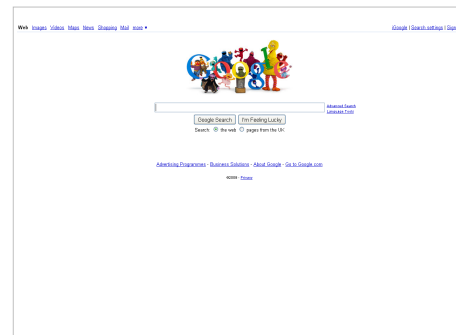
Figure 4.8: Basic homepages from the lab-based study.

Aesthetic - Unaesthetic

The overall ratings for the homepages were collected under the term, ‘aesthetic/beautiful’. Figure 4.9 shows homepages with a combination of characteristics that could influence the subjective aesthetic judgements of Web users. These include simplicity, good use of colour and images. This was expected, as participants were asked to give a general rating under this category. In Figure 4.10, mostly cluttered and text-based homepages were identified as being unaesthetic. In general, the participants seemed to appreciate moderation in design. This was observed across all the design dimensions investigated in this study.



(a) ID43

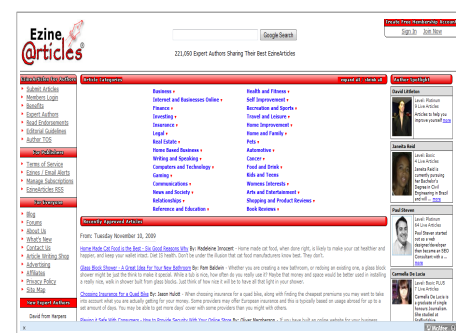


(b) ID19

Figure 4.9: Aesthetic homepages from the lab-based study.



(a) ID30



(b) ID14

Figure 4.10: Unaesthetic homepages from the lab-based study.

How Well do the Design Dimensions Relate with Web Aesthetics?

A Pearson correlation analysis was performed between the four design dimensions and the overall term ‘aesthetic’ using the mean ratings given by the participants. The scatterplot in Figure 4.11 and associated Pearson correlation matrix in Table 4.2 show that visual cleanness had the least positive correlation with the term ‘aesthetic’, suggesting the term ‘clean’ to be most unlike the other design dimensions examined here. While the aesthetic dimension, ‘pleasing’ had the highest positive correlation with the term ‘aesthetic’. We had speculated that the participants may have perceived the term ‘pleasing’ to be a general design dimension like ‘aesthetic’. Recall that the participants were asked to give an overall visual quality score under the term ‘aesthetic’/‘beautiful’. In general, all the design dimensions showed significant positive relationships with overall aesthetics.

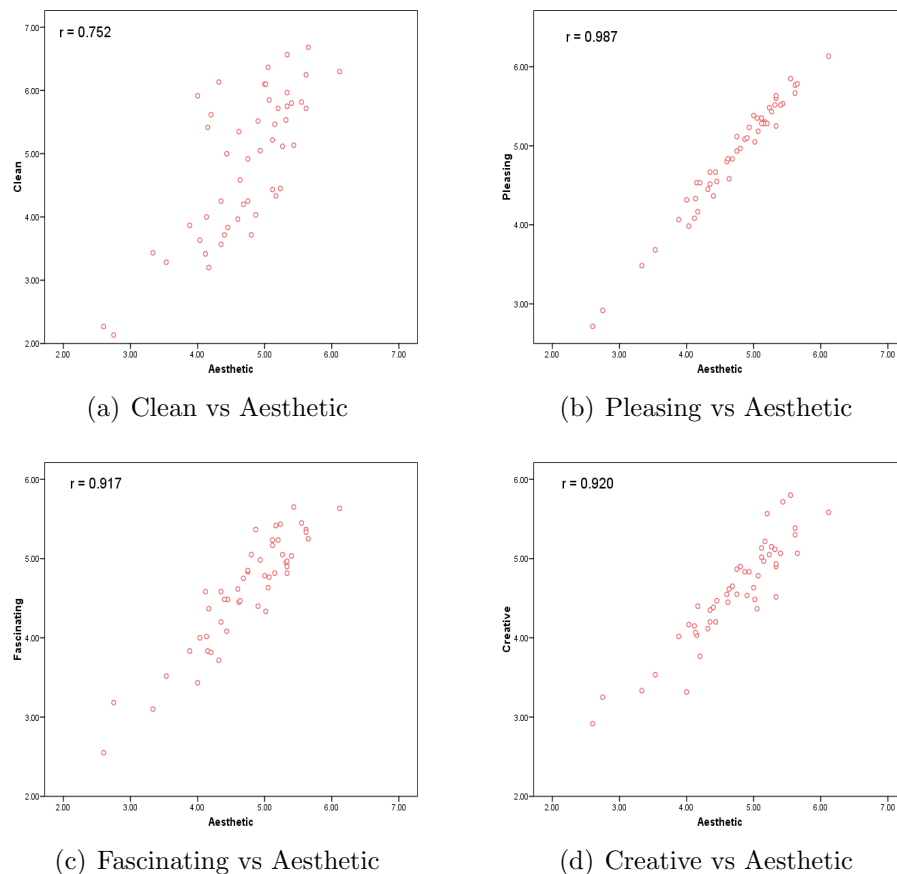


Figure 4.11: Scatter plots showing the relationship between the design dimensions investigated and the overall term ‘aesthetic’ in the lab-based study.

Table 4.2: Correlation for the aesthetic dimensions in the lab-based study.

r	Clean	Pleasing	Fascinating	Creative	Aesthetic	Familiarity
Clean	1.000	0.781** (p = 0.000)	0.471** (p = 0.001)	0.513** (p = 0.000)	0.752** (p = 0.000)	-0.122 (p = 0.397)
Pleasing		1.000	0.898** (p = 0.000)	0.891** (p = 0.000)	0.987** (p = 0.000)	0.078 (p = 0.591)
Fascinating			1.000	0.958** (p = 0.000)	0.917** (p = 0.000)	0.160 (p = 0.266)
Creative				1.000	0.920** (p = 0.000)	0.037 (p = 0.799)
Aesthetic					1.000	0.074 (p = 0.610)
Familiarity						1.000

Correlations** are significant at the 0.01 level (2-tailed)

As expected the design dimension clean had a strong relationship with pleasing and aesthetic dimensions which all come under the classical aesthetic arm of Lavie and Tractinsky [2004]’s bi-dimensional framework. It also exhibited a more moderate correlation with the expressive aesthetic dimensions fascinating and creative. This further validates Lavie and Tractinsky [2004]’s work. Interestingly, all the design dimensions except clean had very strong positive correlations between them, further highlighting the uniqueness of the clean design dimension. It is mostly characterized by moderation and simplicity. However, when moderation is overdone it could lead to boring or dull visual designs. This explains its moderate relationships with more sophisticated and visible aspects of design aesthetics. We also observe from Table 4.2 that familiarity did not influence the aesthetic ratings given by the participants in any significant way.

In Table 4.3 we present a summary of the prominent indicator Web page properties associated with each design dimension. These indicator features were selected after critical anecdotal inspection of Web pages in the top and bottom positions under each design category. We acknowledge that as is the case with all user studies there may be other subtle subjective factors responsible for moderating the aesthetic choices of the participants along these dimensions. For example,

there is the issue of cultural dependency and its influence on aesthetic choices. Different colours mean different things in different cultures and these could taint aesthetic judgements [Cyr et al., 2010]. However, we do not investigate this issue further in this research thesis. The indicator physical properties highlighted here came across rather strongly. Further empirical studies were conducted in subsequent sections to provide more evidence for these outcomes.

Table 4.3: Key indicator Web page characteristics for the design dimensions

Design Dimension	Web Page Properties
Clean	One main image, mostly white coloured background, low text count, and a less dense layout with little/no segmentation
Pleasing	A combination of characteristics - Bold images, good colour use, low text count, less dense layout and animations
Fascinating	Moderate to heavy animations
Creative	Heavy animations
Aesthetic	A combination of characteristics - Bold images, good colour use, low text count, less dense layout and animations

4.2 On-line Study

To further validate findings from the lab-based study, an on-line experiment was designed. It was a replica of the lab study, with slight modifications to suit the Web medium. The study was targeted at a much larger demography and it was undertaken at the participants' own time and convenience. A smaller chunk of Web pages were evaluated as a result, and the study participants were not paid.

4.2.1 Participants

A total of 257 people visited our experiment Website. However, only 154 people completed the entire study. Out of the 154 participants who completed the study, four (3 males and 1 female) answered 'Yes' to the colour blindness question in the demographics section. As the study was conducted on-line, we did not have an opportunity to meet the participants involved to ascertain the nature or severity of the visual impairment claimed, hence their data was excluded from the analysis.

This brought the final number of participants to 150. There were equal numbers of male and female participants, 75 each. The participants were frequent Web users, except two who used the Web occasionally. Forty-nine (49) of the participants did not have English as their first language, while 101 were native speakers. Participants were recruited via mailing lists within the University of Manchester, as well as from the larger research community. For example, an invitation was sent to the mailing list belonging to the Association for Computing Machinery (ACM) Special Interest Group on Hypertext, Hypermedia and the Web (SIGWEB) which has members from all over the globe. For more information see Appendix B.4.

4.2.2 Stimuli

Twenty-five (25) homepages were selected from the 50 used in the lab-based study. The selection was performed by arranging all 50 homepages based on their mean aesthetic scores (from lab-based) in descending order, and then choosing pages in even numbered positions. Due to ethical issues surrounding phishing, we could not upload the live pages for the on-line study. Instead, screenshots of the respective homepages were displayed in colour to the participants. Each participant viewed 24 out of 25 homepages randomly selected from the pool of Web pages due to a technical fault in the experiment source code. The withheld page varied for each participant, because of the randomization process. Hence, there were no biases due to this fault. Screenshots of the Web pages, their study identification (ID) number, and respective Web addresses can be found in Appendix B.5

4.2.3 Task and procedure

The welcome page of the experiment's Website conveyed the aim of the study and instructions. There was also a consent section, and participants were expected to click the 'I agree' button only if they wished to participate. The task was to look at homepages selected randomly from a pool of 25 Web pages and rate them with respect to their visual quality along five design dimensions. The participants were asked to look at a Web page for 4 seconds, after which another Web page appeared for them to rate the homepage they had just seen. Since the homepages were randomised, there was no need for the study participants to rate twice. The same 7-point scale and design dimensions used in the lab case were employed.

4.2.4 Results

Means and standard deviations were computed for each of the 25 homepages based on the participants' ratings, given the 5 design dimensions. Table 4.4 shows the mean scores. Once again, the higher the mean score, the higher the Web page ranking for the design dimension. As was the case in the lab-based study, if a homepage was given a high rating for one design dimension, it was likely to get a high rating across the other design dimensions and vice versa, suggesting a positive relationship between the design dimensions investigated here.

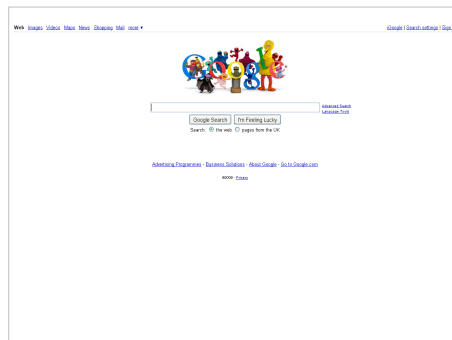
Table 4.4: Participants' aesthetic ratings for the on-line study

Web page	PageID	Clean		Pleasing		Fascinating		Creative		Aesthetic		Familiarity	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Answers.com	ID1	4.32	1.58	4.36	1.41	4.19	1.34	4.12	1.21	4.12	1.24	3.08	2.01
Askjeeves	ID2	6.29	1.11	5.33	1.23	4.33	1.56	4.39	1.61	4.91	1.30	3.81	1.99
Asos	ID3	4.80	1.43	5.00	1.28	4.64	1.35	4.84	1.12	4.84	1.24	2.86	2.19
Bigfat University	ID4	3.83	1.59	4.02	1.33	4.11	1.40	4.08	1.37	3.87	1.21	1.57	1.25
Directgov	ID5	3.76	1.61	4.01	1.45	3.78	1.50	3.88	1.37	3.77	1.35	3.50	2.20
Ezine Articles	ID6	2.38	1.53	2.58	1.39	2.71	1.57	2.77	1.38	2.43	1.31	1.71	1.43
Facebook	ID7	5.89	1.06	5.12	1.22	4.28	1.44	4.21	1.48	4.72	1.26	6.10	1.62
Fullsail University	ID8	4.50	1.60	4.67	1.49	4.59	1.56	4.93	1.51	4.48	1.53	1.57	1.28
Google	ID9	6.41	1.13	5.81	1.16	4.82	1.43	4.77	1.76	5.40	1.21	6.77	0.78
Hello Sour Sally	ID10	6.39	0.84	5.15	1.56	4.75	1.75	4.76	2.00	4.95	1.56	1.49	1.17
Jonathan	ID11	6.41	0.83	4.75	1.63	4.03	1.95	4.36	1.98	4.57	1.68	1.48	1.26
Livejournal	ID12	3.99	1.37	4.25	1.19	4.06	1.29	4.19	1.09	4.03	1.24	2.29	1.87
Marks and Spencer	ID13	4.97	1.29	5.06	1.15	4.75	1.23	4.81	1.15	4.88	1.08	3.45	2.18
Microsoft	ID14	5.17	1.28	5.03	1.26	4.49	1.35	4.64	1.20	4.76	1.28	4.25	1.94
Pantagonia	ID15	5.41	1.17	5.38	1.11	4.97	1.17	4.89	1.19	5.05	1.07	1.87	1.59
Play.com	ID16	3.49	1.62	4.34	1.37	4.35	1.26	4.20	1.31	4.03	1.35	3.54	2.36
Rightmove	ID17	3.54	1.50	3.91	1.50	4.09	1.34	4.12	1.27	3.71	1.33	2.80	2.00
Target.com	ID18	3.40	1.53	4.13	1.24	4.23	1.17	4.21	1.16	3.88	1.13	2.54	1.90
Tesco	ID19	3.41	1.62	4.16	1.31	4.04	1.34	3.96	1.30	3.80	1.25	3.78	2.17
Twitter	ID20	5.68	1.28	5.25	1.17	4.64	1.44	4.50	1.57	4.99	1.23	4.29	2.18
Veer	ID21	5.54	0.92	5.29	1.00	4.87	1.27	5.04	1.22	5.10	1.15	1.52	1.26
Virgin Media	ID22	2.76	1.46	3.66	1.27	4.14	1.35	4.04	1.19	3.55	1.29	3.02	1.87
Whalehunt	ID23	6.37	1.18	5.55	1.46	5.06	1.60	4.94	1.78	5.47	1.48	1.51	1.16
Wordpress	ID24	4.44	1.39	4.78	1.19	4.51	1.36	4.62	1.18	4.53	1.25	2.74	1.95
Yell	ID25	4.60	1.39	4.02	1.32	3.60	1.42	3.71	1.34	3.80	1.25	2.89	1.90

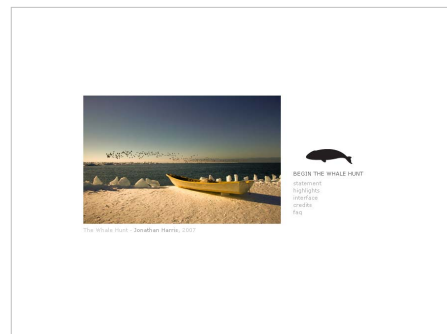
Figures 4.12 and 4.13 show pages in the top and bottom positions across the design dimensions. The positive relationship between the five design dimensions meant that these homepages maintained similar rankings across the dimensions. Furthermore, the low SD values in the clean dimension also lend support to an earlier fact that this design dimension is less subjective in nature. In other words, the participants found it easier to agree on what visual designs are clean, compared with what designs were creative as we noticed higher SD values.

The Best Web pages

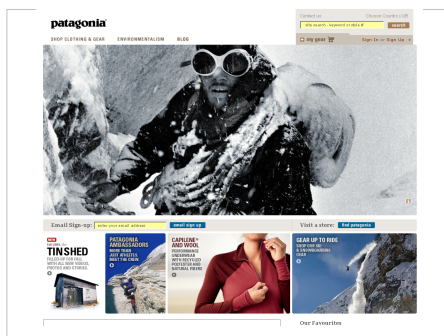
As was the case in the lab-based study, we observe in Figure 4.12 that Web pages with moderate visual content came across as being aesthetic overall. For example, the Google homepage which is the cleanest homepage here, also topped the chart as the cleanest homepage in the lab-based study. As the participants in the on-line study were only exposed to screenshots of the Web pages, we also notice that Web pages with captivating images were ranked as pleasing, fascinating or creative. This was the case for ID15, ID21 and ID23. In the lab study, the use of animations was a moderating factor for these latter dimensions.



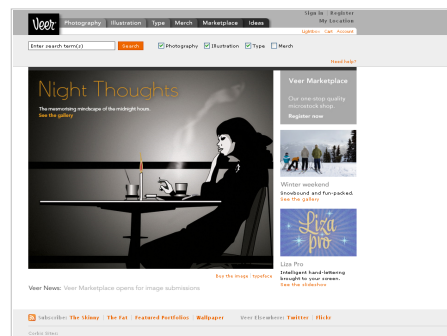
(a) ID9



(b) ID23



(c) ID15

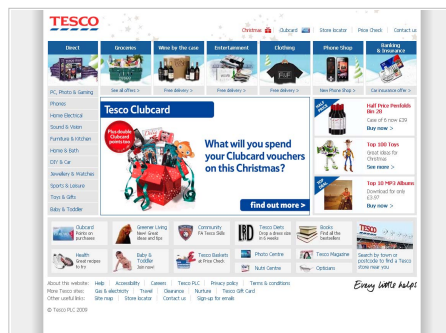


(d) ID21

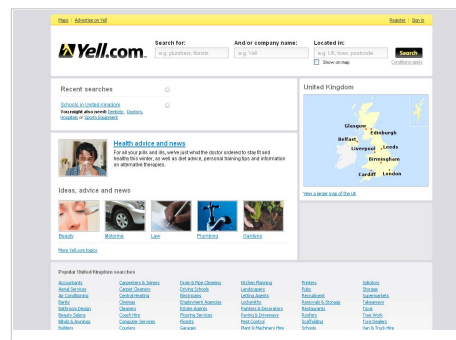
Figure 4.12: The best homepages from the on-line study.

The Bottom Web pages

One outstanding characteristic of the homepages in the bottom position across all five dimensions investigated was clutter. Homepages which had too much information or segmentation on them ranked poorly. A similar scenario was observed in the lab-based studies. This lends support to the fact that moderation in design is more appealing, at least among the participants we recruited for both studies.



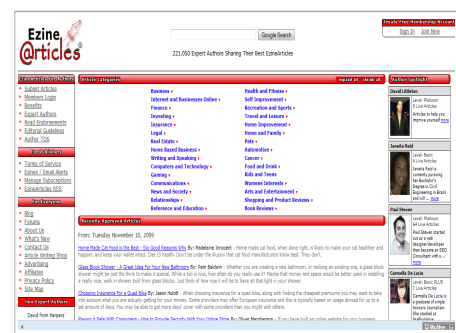
(a) ID19



(b) ID25



(c) ID22



(d) ID6

Figure 4.13: The bottom homepages from the on-line study.

How Well do the Design Dimensions Relate with Web Aesthetics?

As we did in the lab-based study, a Pearson correlation analysis was performed between the four design dimensions and the overall term ‘aesthetic’, using the mean ratings given by the participants. The scatterplot in Figure 4.14 and Table 4.5 show that visual cleanness had the least positive correlation with the term ‘aesthetic’, while ‘pleasing’ had the highest positive correlation with the term ‘aesthetic’. In general, all the design dimensions showed significant positive relationships with overall aesthetics. The same was the case in the lab-based study. The associated Pearson correlation matrix is shown in Table 4.5. The correlations also show that there were no effects of previous knowledge of the homepages on the ratings given, as no significant relationships were observed.

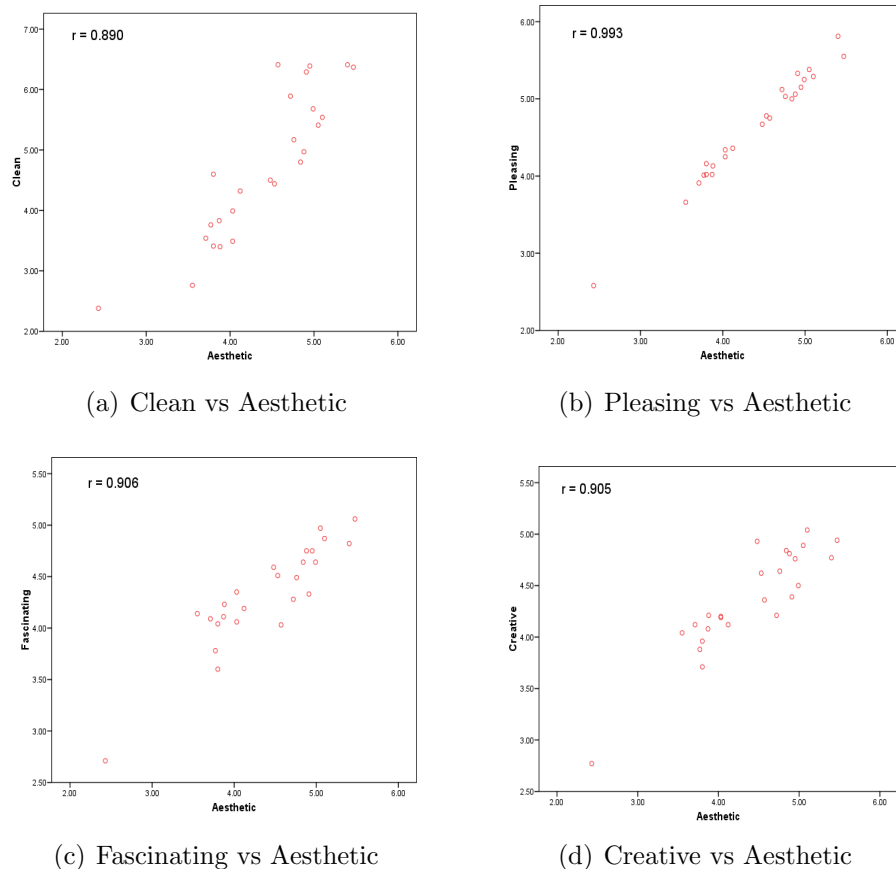


Figure 4.14: Scatter plots showing the relationship between the design dimensions investigated and the overall term ‘aesthetic’ in the on-line study.

Table 4.5: Correlation for the aesthetic dimensions in the on-line study.

r	Clean	Pleasing	Fascinating	Creative	Aesthetic	Familiarity
Clean	1.000	0.891** (p = 0.000)	0.644** (p = 0.001)	0.672** (p = 0.000)	0.890** (p = 0.000)	0.184 (p = 0.379)
Pleasing		1.000	0.886** (p = 0.000)	0.877** (p = 0.000)	0.993** (p = 0.000)	0.293 (p = 0.156)
Fascinating			1.000	0.964** (p = 0.000)	0.906** (p = 0.000)	0.090 (p = 0.670)
Creative				1.000	0.905** (p = 0.000)	-0.005 (p = 0.980)
Aesthetic					1.000	0.211 (p = 0.311)
Familiarity						1.000

Correlations** are significant at the 0.01 level (2-tailed)

Comparison of Aesthetic Ratings from Both Studies

Mean ratings from the lab-based and on-line studies were compared using an independent samples T-test with equal variances. Mean ratings for the 25 Web pages investigated in the on-line study, and the same 25 homepages from the lab-based study were used for the comparative analysis. Table 4.6 shows the p-values for each homepage based on the different design dimensions investigated. For 75% of the cases, p-values were greater than 0.05, so for those cases we accept the null hypothesis which says that the aesthetic judgements from both populations have no difference. In otherwords, the participants ratings in both studies spanned similar magnitudes. For the remaining 25% (the underlined cases), we observed some differences. We had expected slight differences arising from the use of screenshots in the on-line study. In particular, we expected these differences to show up in the participants' ratings of how fascinating or creative a Web page was. The reason being that, in the lab-based study we observed that the use of animations was a key moderator for ratings along these two design dimensions.

Table 4.6: P-values from t-test to compare aesthetic ratings from both studies.

Web page	Clean	Pleasing	Fascinating	Creative	Aesthetic
Answers.com	0.828	0.266	0.960	0.761	0.342
Askjeeves	0.730	0.926	0.329	0.931	0.593
Asos	0.260	0.083	0.121	0.161	0.077
Bigfat University	0.919	0.861	0.310	0.826	0.952
Directgov	0.311	0.067	<u>0.020</u>	<u>0.040</u>	0.102
Ezine Articles	0.699	0.621	0.591	0.597	0.511
Facebook	0.301	0.288	0.075	0.149	0.266
Fullsail University	<u>0.043</u>	<u>0.003</u>	<u>0.000</u>	<u>0.008</u>	<u>0.001</u>
Google	0.204	0.912	0.126	0.377	0.287
Hello Sour Sally	<u>0.000</u>	0.669	0.162	<u>0.038</u>	0.418
Jonathan	0.139	0.357	0.422	0.535	0.459
Livejournal	0.980	0.725	0.859	0.566	0.657
Marks and Spencer	<u>0.002</u>	<u>0.007</u>	<u>0.019</u>	<u>0.035</u>	<u>0.000</u>
Microsoft	0.230	0.303	0.215	0.164	0.114
Pantagonia	0.404	0.644	0.398	0.575	0.746
Play.com	0.486	<u>0.021</u>	<u>0.006</u>	<u>0.006</u>	<u>0.003</u>
Rightmove	0.763	0.816	0.750	0.855	0.216
Target.com	<u>0.006</u>	<u>0.001</u>	<u>0.009</u>	<u>0.006</u>	<u>0.000</u>
Tesco	0.089	<u>0.014</u>	<u>0.032</u>	<u>0.026</u>	<u>0.002</u>
Twitter	0.245	0.125	0.233	0.199	0.157
Veer	0.906	0.340	0.058	<u>0.035</u>	0.381
Virgin Media	0.142	<u>0.049</u>	0.386	0.140	<u>0.019</u>
Whalehunt	0.394	0.772	0.451	0.234	0.631
Wordpress	0.592	0.402	0.857	0.995	0.678
Yell	0.135	<u>0.012</u>	0.080	0.065	<u>0.010</u>

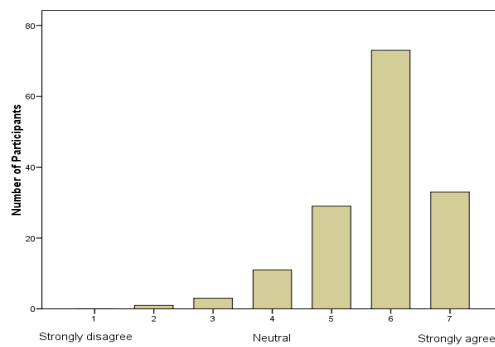
Table 4.6 shows many underlined cases for the two dimensions in question. For those cases, participants in the lab-based study gave higher scores compared to their on-line counterparts who appeared to be more conservative with the scores. However, the similar correlation matrices in Figures 4.11 and 4.14 show that these differences did not influence our overall results in any confounding way. On the whole, we obtained similar results for both studies. There were no surprises. For example, a Web page which was judged as being cluttered in the lab-based study did not suddenly receive a high score for cleanness in the on-line one.

4.3 Feedback

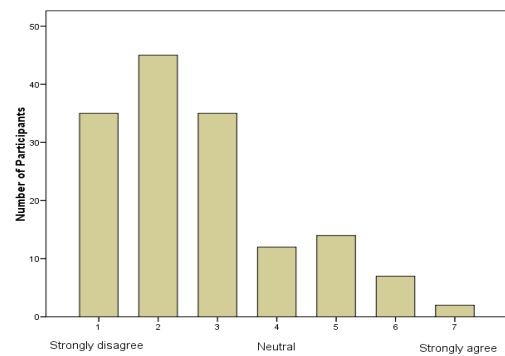
In this section we provide a brief analysis of the comments we recieved from the participants. These were gathered during the after task discussions in the lab study, and from the written comments left in the on-line study.

Attitudinal Responses

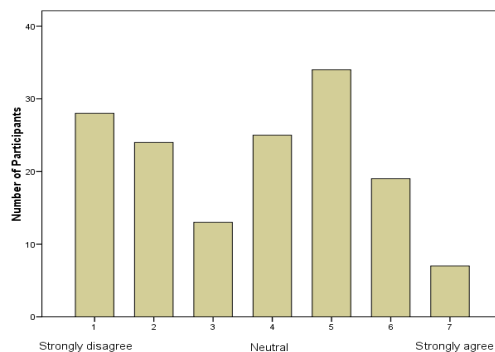
Selected factors which moderated the aesthetic judgements of Web users in the lab-based study (see B 3.5) were further investigated in the on-line study. The factors which were extracted and examined include images/graphics, text quantity, use of animations, simplicity, structure, frequency of page use/familiarity, use of colour and meaningfulness. Figure 4.15 shows the responses of participants.



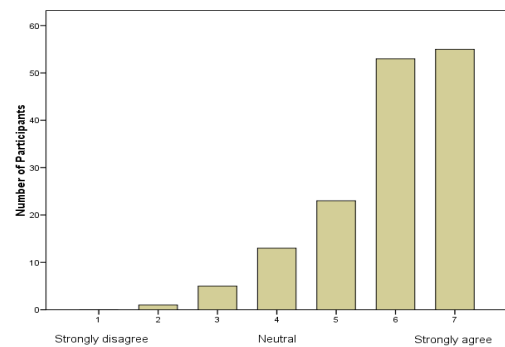
(a) S1: I find Web pages with images or graphics to be visually pleasing.



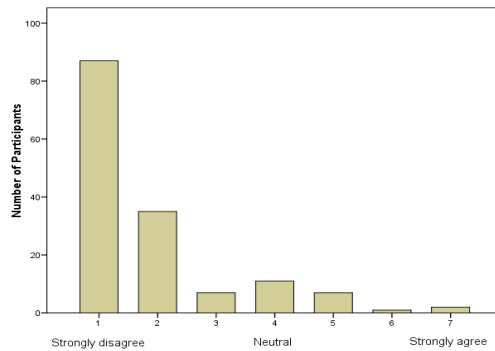
(b) S2: I find Web pages with a lot of text or writing to be visually pleasing.



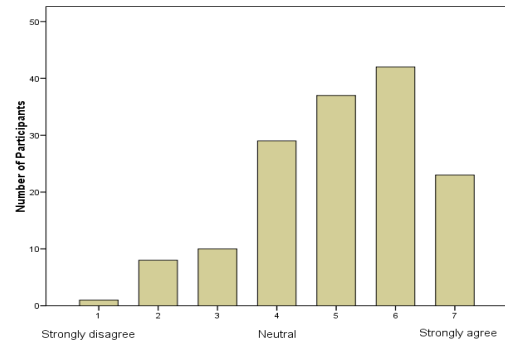
(c) S3: I find Web pages with animations or moving images/graphics to be visually pleasing.



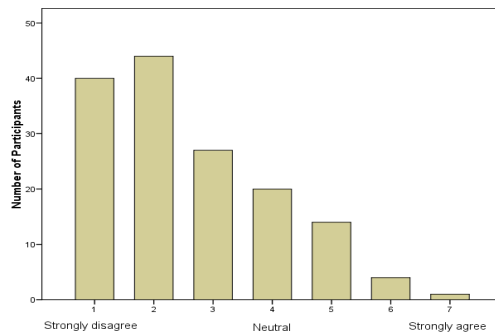
(d) S4: I find simple Web pages to be visually pleasing.



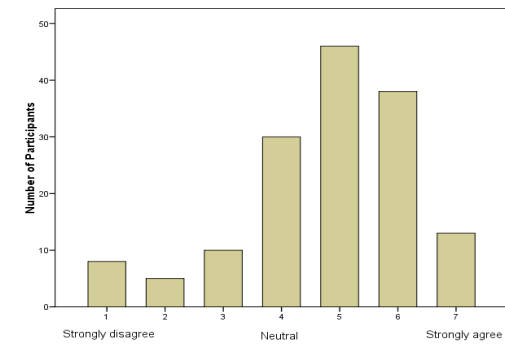
(e) S5: I find **poorly** structured Web pages to be visually pleasing.



(f) S6: I find Web pages I like to use to be visually pleasing.



(g) S7: I find Web pages with **no** use of colour to be visually pleasing.



(h) S8: I find Web pages that are meaningful to be visually pleasing.

Figure 4.15: Attitudinal responses of participants to statements on Web aesthetics

The results meet our expectations, except for the animation case. Participants seemed to be divided on whether or not the use of animations on a Web page increases aesthetic pleasure (see sub-graph (c)). Consequently, the use of animations on Websites should be done in a moderate fashion.

Content Analysis

Using a similar methodology described in Lindgaard and Dudek [2003], but with slight modifications we performed a content analysis on the subjective feedback comments given by the participants who took part in the on-line study. As a last question in the study, the participants were expected to answer the following: *How will you describe a visually pleasing or beautiful Web page in your own words?*. Unlike the rest of the study, this last question allowed the participants

to express their opinions in a fully subjective fashion. Participants' responses can be found in Appendix B.7. Their comments were classified in two ways: i) Based on the Web design features which were explicitly mentioned, whether on a positive or negative note. We were interested in any Web design features that could influence aesthetic preference. Furthermore, only properties that could be manipulated by a designer were considered ii) Based on the participant's overall perception of aesthetics, using the three categories: appearance, function or both.

The Moderating Role of Web Design Features

In our case, an exact match approach was adopted for the classification. Consequently, there was no need for negotiations as there were no ambiguities to resolve as in Lindgaard and Dudek [2003], and one expert judge was sufficient. Only Web design features which were explicitly mentioned by the participants were elicited. Where a participant's comment did not explicitly refer to any Web design features, the statement was not classified. Let's consider valid comments given by the first three participants in response to the question - *How will you describe a visually pleasing or beautiful Web page in your own words?*

- p1 - Clean and easy to find the information/links that you want. Use of pictures with labels to help to find appropriate links.
- p3 - Simple, uncluttered, small images for things like buttons and menus, larger images for whatever visual information is being presented on the page.
- p5 - Clean, good balance of colours, text in a clean font only where needed, no adverts, not too many links/panels, minimalistic, and does its job well, and nothing else.

The respective Web design features elicited were:

- p1 - Links, Images and Labels
- p3 - Images, Buttons and Menus
- P5 - Colours, Text, Font, Adverts and Links

Figure 4.16 gives a summary of the Web design features elicited, while Table B.15 in the Appendix B.7 contains a full analysis of the participants' statements.

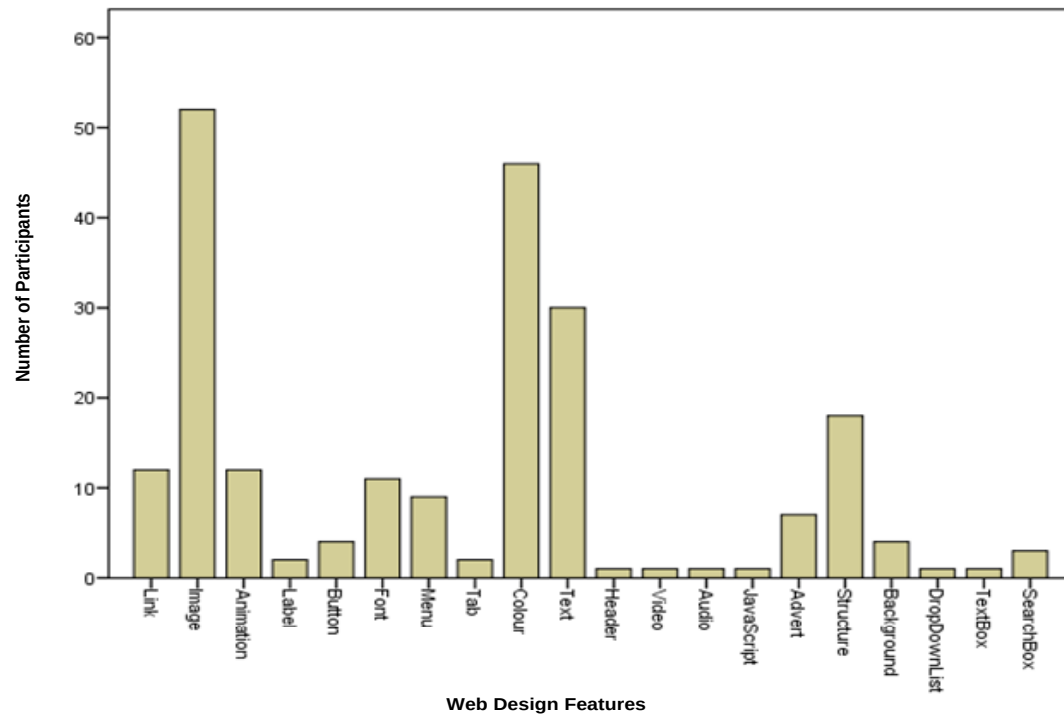


Figure 4.16: Content analysis on participants' feedback comments.

As in Figure 4.16, the use of images, colour and text quantity emerged the top three design features which influenced the participants' reported aesthetic choices the most. This information is used in Chapter 6 where we learn multiple regression functions for predicting the aesthetic preferences of Web users.

Aesthetic Perception

The participants' comments were also classified based on their reported perception of the concept of aesthetics. Three categories were used: appearance, function or both. The general literature on the scope of visual aesthetics contains arguments about these classification. In HCI domains, researchers wonder whether aesthetics should be perceived viscerally i.e solely on appearance or interaction [Overbeeke and Wensveen, 2004]. Let's consider again valid comments given by the first three participants in response to the question - *How will you*

describe a visually pleasing or beautiful Web page in your own words?, and classify their reported perceptions. Once again responses from participants that were either vague or ambiguous (e.g p17 - It can not be explained. Depends on individuals or p29 - Not too much and not too little) were not classified.

- p1 - Clean and easy to find the information/links that you want. Use of pictures with labels to help to find appropriate links.
- p3 - Simple, uncluttered, small images for things like buttons and menus, larger images for whatever visual information is being presented on the page.
- p5 - Clean, good balance of colours, text in a clean font only where needed, no adverts, not too many links/panels, minimalistic, and does its job well, and nothing else.

The respective Web design features elicited were:

- p1 - Participant is after both appearance and functionality
- p3 - Participant is after appearance or presentation mainly
- P5 - Participant is after both appearance and functionality

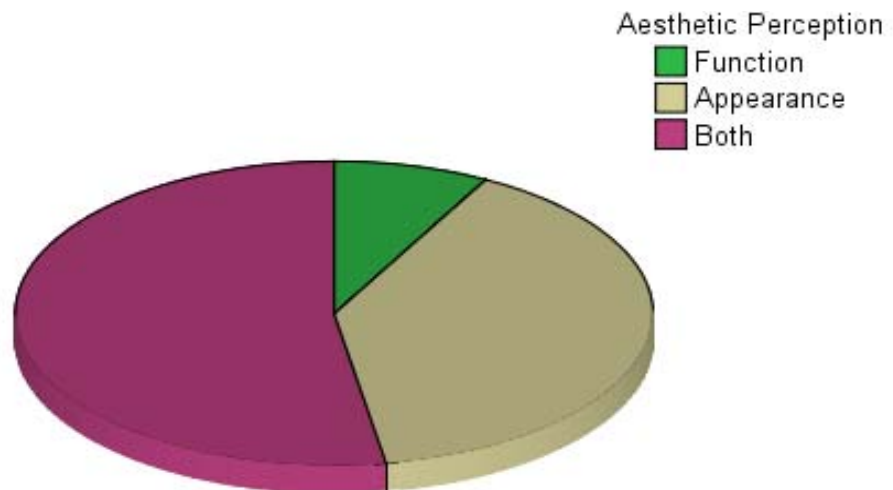


Figure 4.17: Aesthetic perceptions gathered from the participants' comments.

Figure 4.17 shows that incorporating both dimensions seems to be the ideal in most cases. The same was reported in a study conducted by Hsu [2011].

4.4 Summary

The subjective aesthetic judgements of Web users were investigated in two studies, a lab-based and an on-line study. Our findings confirm that there are several factors which influence the way users judge the visual quality of Web pages. For each of the visual design dimensions investigated, there were certain indicator properties possessed by Web pages which users relied upon to make their aesthetic judgements, and these properties varied depending on the design dimension being evaluated. For example, a less-dense compositional structure was important for rating a Web page as being clean, while the use of animations was more important for rating a Web page as being fascinating or creative. The indicator properties will be used for defining more objective metrics for Web aesthetics in Chapter 6 where we learn multiple regression functions for predicting Web users preferences. The next chapter describes technical and manual accessibility audits conducted on a cross-section of Web pages from the current chapter. This would enable us to investigate the interplay between Web aesthetics and accessibility. Information on the key factors which moderate this relationship will also be built into our predictor tool described in Chapter 6.

Chapter 5

Web Accessibility Audits

This chapter reports two sets of studies conducted to investigate the accessibility of homepages whose aesthetic quality had already been determined in Chapter 4. The first study is a technical evaluation where we employ 4 automated checkers for accessibility testing, while the second is a manual audit involving 11 Web accessibility experts. In the technical evaluation, the accessibility level of all 50 homepages was assessed. A correlation analysis was then performed to investigate the relationship between Web aesthetics and accessibility in general. For the manual audits, a method for measuring barriers of accessibility (MAMBO) was used to examine the accessibility of a cross-section of the 50 homepages. MAMBO is a variant of the Barrier Walkthrough (BW) method proposed by Brajnik [2008c]. Unlike the technical evaluation, we were interested in accessibility barriers which could affect people with visual impairments (i.e. blindness, low-vision and colour-blindness). The manual audits were also more thorough.

5.1 Automated Accessibility Testing

The four automated accessibility checkers used for testing include: EvalAccess 2.0, AChecker, TAW and Cynthia Says. These tools were chosen because they represent publicly available accessibility testing software. The following is a brief description of the four accessibility checkers used in this first study:

EvalAccess Version 2.0: EvalAccess is an accessibility tool developed by the Laboratory of Human Computer Interaction for Special Needs at the University of the Basque Country, Spain. EvalAccess is based on WCAG 1.0. It has been

developed as a Web service to facilitate incorporation into other applications. It supports the evaluation of Web pages from their URLs or HTML mark-up. Unlike some tools, it supports the evaluation of multiple Web pages (Website). EvalAccess presents results as either errors or warnings. Errors represent accessibility problems detected under any of the three priority levels, while warnings are those which require manual inspection to ascertain whether or not they are true accessibility barriers. For more information see <http://sipt07.si.ehu.es/evalaccess2/>.

TAW: TAW consists of a number of tools used for testing Websites for accessibility conformance. TAW is currently capable of testing for compliance using both WCAG 1.0 and 2.0. In addition, it can test the mobile Web for compliance to accessibility guidelines. When testing based on WCAG 1.0, the tool gives two sets of results, ‘automatic’ and ‘human review’ for each priority level. The first reflects the number of problems that the tool can detect, while the second reflects those which require human inspection. For evaluations based on WCAG 2.0, results are presented as ‘problems’, ‘warnings’ and ‘not reviewed’. The first requires corrections, the second may require human inspection, while the third category definitely requires human inspection, as the criteria cannot be tested by a machine in the first place. TAW is multi-lingual. For more information on the TAW accessibility testing tool please visit: <http://www.tawdis.net/>.

AChecker: AChecker was developed by the Adaptive Technology Resource Centre (ATRC) at the University of Toronto, Canada. It supports the following accessibility guidelines: Stanca Act (Italy), Section 508, BITV 1.0 (Germany), WCAG 1.0 and WCAG 2.0 (International). AChecker inspects single HTML pages for conformance. Web developers can also benefit from its Web service Application Programming Interface(API). Evaluation results are classed as *known problems*: those AChecker knows are definitely accessibility barriers; *likely problems*: those which AChecker has identified as probable accessibility barriers, but requires human decision to ascertain whether they are true accessibility barriers, and *potential problems*: those which AChecker cannot identify or classify. For more information on this tool please see: <http://achecker.ca/checker/index.php>.

Cynthia Says: Cynthia Says is a free Web-based tool which uses the Section 508 standards or WCAG 1.0 as a basis for accessibility testing. Only one Web

page from a site can be examined per minute. Unlike the other tools described here, its results are boolean in nature (pass or fail) with no numerical summary of the accessibility issues found. As such, the human evaluator is saddled with the responsibility of manually counting the accessibility issues highlighted by the tool whenever a numerical analysis is required. In our formative study (Chapter 3), Cynthia Says was used for accessibility testing. Re-using the tool here will provide some form of validation or further evidence methodology-wise. For more information on this testing software please visit: <http://www.cynthiasays.com/>.

5.1.1 Stimuli

The same 50 homepages used for the studies on aesthetic perception (Chapter 4) were investigated. Screenshots of the Web pages, their study identification (ID) number and respective Web addresses can be found in Appendix B.2.

5.1.2 Task and procedure

The 50 homepages were first uploaded to the Web Ergonomics Lab (WEL) server, and their respective URLs were keyed into the form spaces provided by the tools. All four tools were made to test based on WCAG 1.0. The reason being that most of the existing accessibility checkers are configured to test using WCAG 1.0. Very few accessibility testing and repair tools have upgraded to WCAG 2.0. Moreover, WCAG 2.0 is designed to require a more user-centered testing process [Caldwell et al., 2008]. With Cynthia Says, we analyzed the results in two ways: i) We count each instance of failure to come up with the total number of failures for each Web page. This is to make the results comparable with other tools which provide numerical data. ii) We also count each guideline violated, as we did in the preliminary study described in Chapter 3. This is to enable us to uncover any contributing factors associated with our initial approach. For TAW, we focused on the numeric results obtained for automated testing, and did not take the figures associated with ‘human review’ requests into consideration. In every case, we add up the number of accessibility issues identified progressively to determine the conformance level standing as described in WCAG 1.0: “Conformance Level “A”: all Priority 1 checkpoints are satisfied; Conformance Level “Double-A”: all Priority 1 and 2 checkpoints are satisfied; Conformance Level “Triple-A”: all Priority 1, 2, and 3 checkpoints are satisfied ” [Chisholm et al., 1999].

5.1.3 Results

Table 5.1 shows Pearson correlation coefficients for the relationship between the aesthetic dimensions of all 50 Web pages, and the number of accessibility checkpoints failed under the three conformance levels A, AA and AAA.

Table 5.1: Correlation between aesthetics and accessibility failures

		Level A	Level AA	Level AAA
EvalAccess 2.0				
	Clean	- 0.156 ($p=0.278$)	- 0.177 ($p=0.219$)	- 0.184 ($p=0.200$)
	Pleasing	- 0.110 ($p=0.448$)	- 0.093 ($p=0.519$)	- 0.088 ($p=0.545$)
	Fascinating	- 0.056 ($p=0.699$)	0.014 ($p=0.926$)	0.022 ($p=0.877$)
	Creative	- 0.068 ($p=0.637$)	- 0.070 ($p=0.627$)	- 0.071 ($p=0.626$)
	Aesthetic	- 0.106 ($p=0.462$)	- 0.079 ($p=0.585$)	- 0.078 ($p=0.589$)
AChecker				
	Clean	- 0.259 ($p=0.069$)	- 0.244 ($p=0.088$)	- 0.179 ($p=0.213$)
	Pleasing	- 0.095 ($p=0.511$)	- 0.112 ($p=0.438$)	- 0.088 ($p=0.542$)
	Fascinating	0.015 ($p=0.719$)	- 0.014 ($p=0.922$)	0.016 ($p=0.911$)
	Creative	- 0.018 ($p=0.903$)	- 0.049 ($p=0.738$)	- 0.046 ($p=0.753$)
	Aesthetic	- 0.088 ($p=0.544$)	- 0.113 ($p=0.434$)	- 0.080 ($p=0.581$)
TAW				
	Clean	- 0.237 ($p=0.097$)	- 0.283* ($p=0.047$)	- 0.279* ($p=0.049$)
	Pleasing	- 0.191 ($p=0.183$)	- 0.125 ($p=0.387$)	- 0.117 ($p=0.419$)
	Fascinating	- 0.122 ($p=0.398$)	0.016 ($p=0.910$)	0.023 ($p=0.876$)
	Creative	- 0.125 ($p=0.387$)	- 0.097 ($p=0.502$)	- 0.096 ($p=0.509$)
	Aesthetic	- 0.186 ($p=0.197$)	- 0.150 ($p=0.299$)	- 0.144 ($p=0.319$)
Cynthia Says				
	Clean	- 0.235 ($p=0.105$)	- 0.356* ($p=0.012$)	- 0.386* ($p=0.006$)
	Pleasing	- 0.156 ($p=0.284$)	- 0.163 ($p=0.262$)	- 0.170 ($p=0.242$)
	Fascinating	- 0.077 ($p=0.597$)	- 0.018 ($p=0.903$)	0.001 ($p=0.997$)
	Creative	- 0.085 ($p=0.560$)	- 0.044 ($p=0.766$)	- 0.038 ($p=0.797$)
	Aesthetic	- 0.151 ($p=0.301$)	- 0.150 ($p=0.304$)	- 0.152 ($p=0.296$)

*-Significant at the 0.05 level (2-tailed).

From Table 5.1, we observe that all except 7 of the coefficients are negative across tools. This suggests that the more aesthetic the Web page, the fewer the accessibility failures for each conformance level in question. However, only 4 of these correlations (those with *) are significant at the 0.05 level. The significant relationships can be found under TAW and Cynthia Says for ‘clean’ versus accessibility failures, level AA and AAA. Also, when the results from Cynthia Says were analyzed based on the number of guidelines failed (an approach described in Chapter 3), we still observed significant relationships for ‘clean’ versus Level AA failures ($r = -0.310$, $p = 0.030$) and ‘clean’ versus Level AAA failures ($r = -0.320$, $p = 0.025$). Hence, our data from these two tools suggest cleanness to be one design dimension significantly related with accessibility. So, the cleaner the Web page, the fewer the accessibility barriers present, and the more likely it is that the said Web page would be accessible from a technical perspective.

Furthermore, we observe that the design dimension, ‘clean’ had the highest coefficients (low *p-values*) across tools. Although, automated accessibility checkers have their challenges in the area of accuracy (e.g false positives) and agreement between tools. It is important to note from the tool descriptions that the developers of these automated checkers try to keep machine testable accessibility issues and those requiring human review separate. As such, the tools attempt to evaluate accessibility issues which their creators imagine are machine testable from the outset. Consequently, the data for the correlation between visual cleanness and accessibility here does indicate a relationship technically speaking.

In our formative study (Chapter 3), we observed significant relationships between the design dimensions, ‘clean’, ‘clear’, ‘organised’ and the number of accessibility failures a Web page had. We concluded there that the three design dimensions ‘clean’, ‘clear’, ‘organised’ were very much related, and represented less subjective design aspects known as ‘classical aesthetics’ [Lavie and Tractinsky, 2004]. Although, Lavie and Tractinsky’s framework also groups the design dimensions ‘clean’, ‘pleasing’ and ‘aesthetic’ under classical aesthetics, we had shown in Chapter 4 that ‘clean’ was unlike the other two (pleasing and aesthetic). Hence, its relationship with accessibility here. To further validate these findings, a manual audit which examines the accessibility levels of a cross-section of homepages from this first study is reported next. The audit focuses on accessibility issues capable of affecting people with visual impairments. Results from the audit will then be correlated with aesthetic ratings for the selected homepages.

5.2 Barrier Walkthrough Study

The Barrier Walkthrough (BW) method is an accessibility evaluation technique adapted from heuristic evaluations widely used in usability engineering [Brajnik, 2006]. The heuristics used as checkpoints in the usability case are replaced with *barriers* in the BW method. An *accessibility barrier* prevents persons with disabilities from achieving set goals when interacting with a Web page. Barriers are derived from known accessibility issues specified in Web design guidelines and can be described in terms of i) user category, ii) assistive technology used, iii) goal/task being hindered and iv) features of a Web page that trigger the barrier in question. Consequently, the BW method allows an evaluator to identify accessibility issues in a context specific manner. To effectively apply the BW method an evaluator must: i) define of the user category (e.g users with visual impairments, users with cognitive disabilities, mobile device users etc.), ii) define user goals (e.g casual browsing, e-shopping etc.), iii) check the Web page in question for accessibility barriers and iv) determine the severity of each barrier found on the Web page. Figure 5.1 shows an example of an accessibility barrier.

barrier	users cannot perceive nor understand the information conveyed by an information rich image (e.g. a diagram, a histogram)
defect	an image that does not have accompanying text (as an alt attribute, content of the OBJECT tag, as running text close to the picture or as a linked separate page)
users affected	blind users of screen readers, users of small devices
consequences	users try to look around for more explanations, they spend substantial time and effort; effectiveness, productivity, satisfaction are severely affected

Figure 5.1: An example of an accessibility barrier [Brajnik, 2006]

The severity of a barrier is determined by the extent to which it impedes the user's *effectiveness*: ability to achieve a given task (ISO 9241); *productivity*: the extent to which resources such as time, effort and attention are used to achieve a given level of effectiveness; *satisfaction*: pleasure of use; and *safety*: both personal and financial. The persistence of the barrier is also taken into account when rating the severity. The severity level of a barrier is classified as *minor*: if the user can cope, and only productivity and satisfaction are affected; *significant*: if

the user has to operate in a trial-and-error mode, and effectiveness, productivity, satisfaction and safety are affected; or *critical*: if it causes the user to give up on the task, and effectiveness, productivity, satisfaction and safety are also affected. According to Brajnik [2006], the BW method is believed to be educative for novice accessibility evaluators. It is also effective in identifying severe accessibility issues and reducing false positives in the evaluation process. However, like many other heuristic methods it has an evaluator effect [Brajnik et al., 2011; Yesilada et al., 2009]. For more details on the BW methodology please visit <http://sole.dimi.uniud.it/~giorgio.brajnik/projects/bw/bw.html>.

5.3 Participants

Nineteen (19) judges were contacted by e-mail. They were people who work in the accessibility area, and belong to research groups across academia and industry that focus on inclusive design. Seventeen (17) of them volunteered to do the study, but 12 judges carried out the accessibility audits and returned their completed evaluation results. Others sent in their apologies. One (1) out of the 12 had invalid questionnaire responses, hence the associated data was not used. There were 8 males and 3 females with ages ranging from 26 to 50 years (Mean = 36.2 and SD = 7.76). All the judges were fluent in English language except one who had intermediate skills. The judges had experience working in the accessibility area for a number of years ranging from 1 to 15 (Mean = 7.5 and SD = 4.76). None of the evaluators were beginners to Web accessibility as a discipline. Our judges rated themselves as having intermediate or expert skills in the area. Six (6) rated themselves as intermediate, while 5 rated themselves as experts. Four (4) of the judges had worked as Web accessibility consultants in the past. The judges evaluated one or more Web pages depending on how much time they were willing to spare for the manual accessibility auditing exercise.

5.4 Stimuli

Sixteen (16) out of 50 homepages which had previously been rated on their aesthetic quality in Chapter 4 were selected for the accessibility study. Ten (10) pages were first chosen by arranging all 50 homepages in descending order of their overall aesthetic quality, and choosing every fifth page. The selected pages

therefore spanned the best, average and worst pages in terms of aesthetic quality. Six (6) extra pages were then added. These were pages which were consistently in the top or bottom positions under the visual design categories (i.e clean, pleasing, fascinating, creative and aesthetic) previously investigated. This was to enable us to report findings on the interplay between various Web design dimensions and accessibility. Table 5.2 contains the Web pages, their study IDs and URLs.

Table 5.2: Web pages, together with their study IDs and Web addresses

Page Name	PageID	Web Addresses
Villa San Michelle	ID1	http://www.villasanmichele.com/web/ovil/villa_san_michele.jsp
Google UK	ID2	http://www.google.co.uk/
Good things-Orange	ID3	http://awards.goodthingsshouldneverend.com/
Full Sail University	ID4	http://www.fullsail.edu/
Whalehunt	ID5	http://thewhalehunt.org/
BBC	ID6	http://www.bbc.co.uk/
Askjeeves	ID7	http://uk.ask.com/?o=312&l=dir
Solar System-NASA	ID8	http://solarsystem.nasa.gov/index.cfm
Wordpress	ID9	http://wordpress.com/
MSN	ID10	http://uk.msn.com/
Virgin Media	ID11	http://www.virginmedia.com/
Rapidshare	ID12	http://www.rapidshare.com/
Gumtree	ID13	http://www.gumtree.com/
Directgov	ID14	http://direct.gov.uk/en/index.htm
Money Saving Expert.com	ID15	http://www.moneysavingexpert.com/
Ezine Articles	ID16	http://ezinearticles.com/

5.5 Task and Procedure

On agreeing to participate, the judges were assigned a number and sent the study materials by e-mail. The study pack comprised a Participant Information Sheet (PIS), demographic information sheet, Web page(s) to be evaluated, barrier checklist spreadsheet(s) and a post-evaluation questionnaire(s). See Appendix C for study materials. The judges were asked to read the PIS which outlined the purpose of the study and instructions. They were also required to fill a demographic form. Each judge was assigned a Web page(s) to evaluate. The following user categories were selected for investigation after discussions between 4 of the judges: **Blind:** people who cannot see and have to use screen readers to access information on the Web; **Low-vision:** people who see partially and require screen magnifiers, accessibility features offered by operating systems, and maybe screen readers to access information on the Web and **Colour-blind:** people who

cannot distinguish between certain colours. The user categories chosen were restricted to people with visual impairments, because they constitute a large part of people with disabilities who have access to the Web [Mankoff et al., 2005]. Other disability types were not considered, because we did not want to overburden the judges. Manual accessibility audits are very time consuming. The evaluators were asked to imagine that the user goal was browsing or information search. The evaluators judged the Web pages independently, and in their personal work environment. They were expected to go through a pre-defined barrier checklist and say whether the listed barriers were present on a Web page, bearing in mind the affected disabled user group. If a barrier was present they were expected to state the impact, persistence and severity of the barrier found as follows:

Impact

- 3 - The barrier will definitely make a user with the stated visual impairment give up on their task.
- 2 - The barrier will make a user with the stated visual impairment adopt a trial-and-error strategy.
- 1 - A user with the stated visual impairment can cope or still get around with the barrier in question.

Persistence

- 3 - The barrier will show up continuously when a user is carrying out a task.
- 2 - The barrier shows up often.
- 1 - The barrier appears once and rarely shows up again.

Severity

Impact and persistence were combined to obtain severity levels as in Table 5.3:

Table 5.3: Severity table

Impact	Persistence	Severity
1	1	minor
1	2	minor
1	3	significant
2	1	significant
2	2	significant
2	3	critical
3	1	critical
3	2	critical
3	3	critical

A post-evaluation form was filled at the end. It captured the time taken for the evaluations, the judges' confidence in auditing the Web page(s), the effort required and their productivity levels while carrying out the accessibility audits. The completed accessibility audits were then e-mailed back to the investigator.

We did not employ user-testing, another effective manual accessibility evaluation technique for the following reasons: It is expensive [Mankoff et al., 2005]; It is also difficult to find people with disabilities of the same degree, who also have the same level of computing expertise [Kelly et al., 2005; Petrie et al., 2006]; A person with disabilities may have more than one disability. As a result, such a person may be affected by multiple Web accessibility barriers which an evaluator may not be able to account for [Petrie et al., 2006; Vigo et al., 2007]; People with disabilities have different assistive technologies and personal adaptations. An evaluator may not be able to create the same environment [Petrie et al., 2006]; The user's ability to use the assistive technologies available is another issue [Kelly et al., 2005; Sloan et al., 2006]. We reckoned that the level of subjectivity would be greater if user-testing was employed, compared with the use of Web accessibility experts. It is important to note, however, that no one evaluation method can identify all the accessibility issues on a Website [Mankoff et al., 2005; Rowan et al., 2000]. Hybrid approaches are agreed to be the most effective. In particular, expert reviews have been shown to be very effective when multiple evaluators are involved, and a combination of techniques are used [Mankoff et al., 2005]. We employed 11 experts, and they made use of various tools and techniques.

5.6 Results

We received 37 valid BW reports for the 16 Web pages investigated. Further descriptions of the study outcomes are discussed in subsequent sub-sections.

5.6.1 Web page distribution among judges

Table 5.4 shows the distribution of Web pages among the 11 judges who had valid responses. Each Web page was assigned to at least 2 judges in a random fashion. The invalid data received from one of the judges left 2 Web pages with evaluation results from a lone judge. We did not consider this a major issue as all the judges were well-versed in the area. The affected pages were ID4 and ID10. While more

than one judge per Web page is encouraged, an associated downside is increased disagreements or subjectivity in the evaluation results [Brajnik et al., 2011].

Table 5.4: Web page distribution among judges who took part in the audits

Web page	PageID	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11
Villa San Michelle	ID1	✓		✓								
Google UK	ID2	✓								✓	✓	
Good things by Orange	ID3	✓	✓		✓							
Full Sail University	ID4	✓										
Whalehunt	ID5	✓				✓	✓					
BBC	ID6	✓						✓	✓			
Askjeeves	ID7	✓						✓	✓			
Solar System Exploration by NASA	ID8	✓		✓								
Wordpress	ID9	✓										✓
MSN	ID10	✓										
Virgin Media	ID11	✓									✓	
Rapidshare	ID12	✓		✓								
Gumtree	ID13	✓				✓	✓					
Directgov	ID14	✓		✓								
Money Saving expert.com	ID15	✓			✓					✓		
Ezine Articles	ID16	✓		✓								

5.6.2 Tools/techniques used in the evaluation by judges

The judges made use of a number of Web accessibility evaluation tools and techniques. Table 5.5 shows that Firebug was the most popular tool used. It was closely followed by the Firefox accessibility extension/toolbar and accessibility evaluation tools like WAVE and EVALACCESS 2.0. While visual inspection of the HTML source code and use of browser features (e.g enabling or disabling JavaScript, turning images on or off) were the most popular techniques used.

Table 5.5: Tools/techniques used by judges to aid the evaluation process

Tools/techniques	URLs	Judge Number
Firebug	http://getfirebug.com/	J3 J8 J9 J11
Firefox accessibility extension/toolbar	https://addons.mozilla.org/en-US/firefox/addon/accessibility-evaluation-toolb/	J3 J5 J10
WAVE	http://wave.webaim.org/	J1 J2 J3
EvalAccess 2.0	http://sipt07.si.ehu.es/evalaccess2/index.html	J1 J8 J9
Web Developer Toolbar	http://webdeveloptoolbar.com/	J3 J8
AChecker	http://achecker.ca/checker/index.php	J2
TAW	http://www.tawdis.net/	J1
Juicy Studio Accessibility Toolbar	http://juicystudio.com/	J3
Firevox	http://www.firevox.clcworld.net/	J7
Colour Contrast Analyser - Juicy studio	http://juicystudio.com/services/luminositycontrastratio.php	J8
W3C Markup Validation Service	http://validator.w3.org/	J9
VoiceOver on Safari		J8
WebAnyWhere on Firefox		J8
MacOS Universal Access		J8
Color Oracle		J8
JAWS 9.0 Demo Version		J9
JAWS 11.0		J6 J10
Visual inspection of source code		J1 J2 J5 J7
Using browser features (E.g Firefox , IE)		J1 J2 J6 J9

5.6.3 Subjective ratings on the evaluation process

Table 5.6 shows the mean and standard deviations (numbers in bracket) for confidence levels of the evaluators, effort required to perform the evaluations and level of productivity on a 5-point scale (1-very low to 5-very high).

Table 5.6: Subjective ratings on the manual audit process

Web Page	PageID	Number of Evaluations	Time Taken (mins)	Evaluator's Confidence	Effort Required	Productivity Level
Villa San Michelle	ID1	2	42.5 (3.5)	3.5 (0.7)	2.5 (0.7)	4.0 (0.0)
Google UK	ID2	3	156.7 (179.5)	4.3 (1.2)	2.3 (1.5)	4.0 (1.0)
Good things by Orange	ID3	3	30.0 (15.0)	3.0 (1.0)	3.0 (1.0)	4.0 (0.0)
Full Sail University	ID4	1	40.0 (n/a)	3.0 (n/a)	2.0 (n/a)	4.0 (n/a)
Whalehunt	ID5	3	18.0 (13.1)	3.3 (0.6)	2.0 (1.0)	3.7 (1.2)
BBC	ID6	3	48.3 (10.4)	4.3 (0.6)	2.7 (0.6)	3.7 (0.6)
Askjeeves	ID7	3	63.3 (25.2)	3.3 (0.6)	3.7 (0.6)	3.0 (1.0)
Solar System Exploration by NASA	ID8	2	42.5 (10.6)	4.5 (0.7)	3.0 (0.0)	5.0 (0.0)
Wordpress	ID9	2	32.5 (3.5)	3.5 (0.7)	2.5 (0.7)	4.0 (0.0)
MSN	ID10	1	50.0 (n/a)	3.0 (n/a)	3.0 (n/a)	4.0 (n/a)
Virgin Media	ID11	2	90.0 (42.4)	3.5 (0.7)	4.0 (1.4)	3.5 (0.7)
Rapidshare	ID12	2	17.5 (3.5)	5.0 (0.0)	1.0 (0.0)	5.0 (0.0)
Gumtree	ID13	3	21.0 (16.8)	2.7 (0.6)	3.0 (0.0)	3.3 (0.6)
Directgov	ID14	2	20.0 (0.0)	5.0 (0.0)	2.0 (0.0)	5.0 (0.0)
Money Saving Expert.com	ID15	3	228.3 (321.9)	2.7 (0.6)	4.0 (1.0)	3.3 (1.2)
Ezine Articles	ID16	2	50 (7.1)	4.5 (0.7)	2.5 (0.7)	4.0 (0.0)

The shortest mean evaluation time of 17.5 minutes was recorded for ID12 which had a very simple design layout. While ID15 previously rated as being cluttered took the judges the longest to evaluate, with an average time of 228.3 minutes. Furthermore, the judges who evaluated ID12 reported a high mean confidence (5.0), low mean effort (1.0) and high mean productivity levels (5.0). While the judges for ID15 had a low mean confidence (2.7), high mean effort (4.0) and low productivity levels (3.3). In general, the judges were more confident, quicker and productive when rating simple Web pages, compared to complex ones. A correlation analysis showing trends in the evaluation is presented in section 5.6.5.

5.6.4 Barriers found based on average severity ratings

Figure 5.2 shows accessibility barriers found on the Web pages. The highest number of barriers were found on ID11 which was a rather cluttered Web page, while the least numbers were found on ID5 and ID12 which were much simpler.

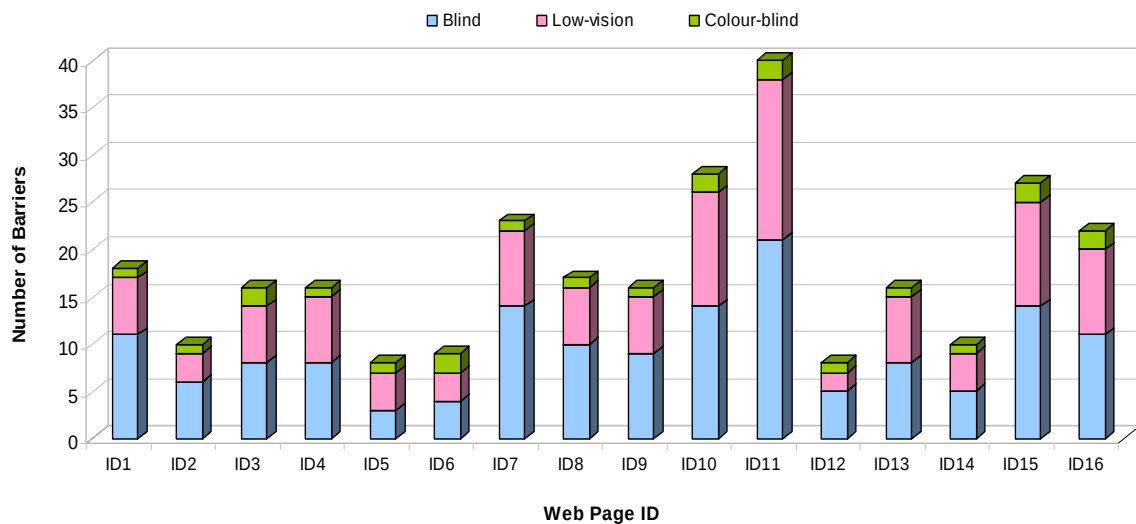


Figure 5.2: Summary of accessibility barriers found on the Web pages

Table 5.7 gives a more detailed description of the nature of the accessibility barriers found. A tick in the table means the said barrier was given an average severity rating of at least 1 by the judges who rated the Web page in question. As we can see in Table 5.7, ‘spaced titles’, ‘ASCII art’ and ‘pages without titles’ were the 3 accessibility barriers capable of affecting people with blindness that were not found on any of the examined Web pages. ‘Widely formatted forms’ were not found on any page examined for barriers which could affect people with low-vision. The most common barrier found which could affect persons with blindness across the Web pages was ‘generic or ambiguous links’, while ‘insufficient visual contrast’ was the most common barrier found which could affect people with low-vision and colour-blindness. In general, more barriers were found capable of affecting people with blindness, followed by low-vision and then colour-blindness.

Table 5.7: Barriers found on the Web pages based on average severity ratings

Barriers	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8	ID9	ID10	ID11	ID12	ID13	ID14	ID15	ID16
BLIND																
Rich images lacking equivalent text			✓				✓		✓	✓	✓		✓		✓	
Video with no captions						✓				✓	✓				✓	
Color is necessary to understand information			✓							✓	✓		✓			
Inaccessible frames										✓	✓					
Moving content	✓		✓	✓						✓	✓		✓			
Image maps with no text																✓
Functional images embedded in the background				✓							✓				✓	
Functional images lacking text										✓	✓	✓			✓	
Generic/ambiguous links			✓		✓		✓	✓	✓	✓	✓	✓			✓	
Dynamic menus in JavaScript	✓						✓				✓				✓	
Mouse events	✓						✓	✓			✓				✓	
Opaque objects	✓		✓	✓			✓						✓			
Keyboard traps								✓			✓					
ASCII art	✓			✓												
Spaced titles																
Too many links						✓		✓	✓	✓	✓		✓	✓	✓	✓
Form with redirect											✓					
Non separated links										✓			✓	✓		
New windows								✓			✓			✓		
Forms with no LABEL tags				✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Forms that are badly linearized							✓				✓					
Too short timings																
Data tables with no structural relationships						✓					✓					
Data tables with no summary											✓					
Layout tables	✓	✓			✓		✓	✓		✓		✓				✓
Page without titles																
Frame without title										✓	✓		✓			
Language markup	✓	✓		✓			✓	✓				✓			✓	✓
No page headings	✓	✓	✓		✓		✓	✓	✓						✓	✓
Images used as titles	✓			✓					✓					✓		✓
No keyboard shortcuts	✓	✓					✓	✓	✓				✓			✓
Skip links not implemented	✓	✓	✓				✓	✓	✓	✓				✓		✓
Text-only page											✓					✓
Window without browser controls							✓									
Dynamic changes			✓	✓			✓	✓		✓	✓				✓	

Barriers Cont.	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8	ID9	ID10	ID11	ID12	ID13	ID14	ID15	ID16
LOW-VISION																
Rich images that are badly positioned			✓							✓	✓		✓		✓	
Rich images included in the page background									✓		✓		✓		✓	
Color is necessary to understand information		✓	✓		✓					✓	✓				✓	
Insufficient visual contrast	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Inaccessible frames										✓	✓		✓			
Moving content	✓		✓	✓						✓	✓					
Image maps																✓
Functional images embedded in the background				✓							✓				✓	
Functional images lacking text										✓	✓				✓	
Too long tooltips										✓						✓
Dynamic menus in JavaScript	✓						✓				✓					
Internal links are missing							✓				✓					✓
Too long lines of text								✓	✓	✓	✓	✓	✓	✓	✓	✓
Too many links						✓					✓					✓
Form with redirect											✓					
Widely formatted forms																
Overlapping windows											✓					
Too short timings																
Images used as titles	✓			✓					✓	✓				✓	✓	✓
No keyboard shortcuts		✓					✓	✓	✓							✓
Text cannot be resized	✓		✓	✓	✓			✓								
Inflexible page layout	✓		✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	
Missing layout clues																
Skip links not implemented		✓			✓		✓	✓	✓	✓			✓	✓		✓
Window without browser controls							✓									
Sortable data table							✓				✓					
Dynamic changes				✓			✓			✓	✓				✓	
COLOUR-BLIND																
Color is necessary to understand information		✓	✓			✓		✓		✓	✓			✓	✓	✓
Insufficient visual contrast	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TOTAL	18	10	16	16	8	9	23	17	16	28	40	8	16	10	27	22

Table 5.8: Correlation between aesthetics, barriers and subjective quantities

r	Clean	Pleasing	Fascinating	Creative	Aesthetic	Barriers	Time	Confidence	Effort	Productivity
Pearson's coefficient										
Clean	1.000	0.868 ^a (p = 0.000)	0.637 ^a (p = 0.008)	0.594 ^b (p = 0.015)	0.835 ^a (p = 0.000)	-0.501 ^b (p = 0.048)	-0.246 (p = 0.359)	0.033 (p = 0.905)	-0.417 (p = 0.108)	0.047 (p = 0.861)
Pleasing		1.000	0.930 ^a (p = 0.000)	0.898 ^a (p = 0.000)	0.994 ^a (p = 0.000)	-0.342 (p = 0.195)	-0.228 (p = 0.397)	-0.118 (p = 0.663)	-0.184 (p = 0.495)	-0.011 (p = 0.967)
Fascinating			1.000	0.972 ^a (p = 0.000)	0.947 ^a (p = 0.000)	-0.158 (p = 0.559)	-0.120 (p = 0.658)	-0.218 (p = 0.417)	0.011 (p = 0.967)	-0.049 (p = 0.856)
Creative				1.000	0.921 ^a (p = 0.000)	-0.129 (p = 0.635)	-0.137 (p = 0.612)	-0.266 (p = 0.319)	0.008 (p = 0.978)	-0.065 (p = 0.812)
Aesthetic					1.000	-0.294 (p = 0.269)	-0.218 (p = 0.417)	-0.139 (p = 0.609)	-0.163 (p = 0.547)	-0.022 (p = 0.935)
Barriers						1.000	0.378 (p = 0.148)	-0.433 (p = 0.094)	0.783 ^a (p = 0.000)	-0.439 (p = 0.089)
Time							1.000	-0.220 (p = 0.414)	0.517 ^b (p = 0.040)	-0.378 (p = 0.149)
Confidence								1.000	-0.547 ^b (p = 0.028)	0.740 ^a (p = 0.001)
Effort									1.000	-0.655 ^a (p = 0.006)
Productivity										1.000

a - significant at the 0.01 level (2-tailed) and b - significant at the 0.05 level (2-tailed).

r continued	Clean	Pleasing	Fascinating	Creative	Aesthetic	Barriers	Time	Confidence	Effort	Productivity
Spearman's rho										
Clean	1.000	0.850 ^a (p = 0.000)	0.603 ^b (p = 0.013)	0.529 ^b (p = 0.035)	0.806 ^a (p = 0.000)	-0.507 ^b (p = 0.045)	-0.242 (p = 0.367)	0.101 (p = 0.710)	-0.459 (p = 0.073)	0.120 (p = 0.657)
Pleasing		1.000	0.900 ^a (p = 0.000)	0.859 ^a (p = 0.000)	0.988 ^a (p = 0.000)	-0.280 (p = 0.293)	-0.096 (p = 0.724)	-0.129 (p = 0.633)	-0.197 (p = 0.465)	0.051 (p = 0.851)
Fascinating			1.000	0.944 ^a (p = 0.000)	0.926 ^a (p = 0.000)	-0.150 (p = 0.580)	-0.015 (p = 0.957)	-0.214 (p = 0.427)	-0.063 (p = 0.818)	0.042 (p = 0.878)
Creative				1.000 (p = 0.000)	0.900 ^a (p = 0.000)	-0.199 (p = 0.460)	-0.063 (p = 0.816)	-0.148 (p = 0.583)	-0.088 (p = 0.746)	0.125 (p = 0.645)
Aesthetic					1.000	-0.258 (p = 0.334)	-0.022 (p = 0.935)	-0.119 (p = 0.661)	-0.188 (p = 0.486)	0.045 (p = 0.869)
Barriers						1.000	0.685 ^a (p = 0.03)	-0.368 (p = 0.161)	0.771 ^a (p = 0.000)	-0.344 (p = 0.192)
Time							1.000	-0.174 (p = 0.519)	0.623 ^a (p = 0.010)	-0.428 (p = 0.098)
Confidence								1.000	-0.490 (p = 0.054)	0.656 ^a (p = 0.006)
Effort									1.000	-0.607 ^b (p = 0.013)
Productivity										1.000

a - significant at the 0.01 level (2-tailed) and b - significant at the 0.05 level (2-tailed).

5.6.5 Correlation analysis: aesthetics versus barriers

A correlation analysis was performed between the aesthetic dimensions (ratings obtained from the lab-based study in Chapter 4), the number of accessibility barriers found and other subjective ratings given by the judges. Table 5.8 shows the results for the Pearson and Spearman's correlation tests. Although all the aesthetic dimensions showed negative relationships with the number of barriers found on the examined homepages, only visual cleanliness had a moderate significant negative correlation with the number of barriers found (both Pearson and Spearman's coefficient). So, the cleaner the homepage, the fewer the accessibility barriers. We believe that this is due to the small number of HTML elements required to build visually clean Web pages. A Web page with a simple HTML code base is more likely to have fewer accessibility issues, because the Web designer typically has fewer bytes of code to mind. Furthermore, the number of barriers found on a Web page was positively related with the time (Spearman's coefficient only) and effort (both Pearson and Spearman's coefficient) required to perform the accessibility audits. The time taken for the evaluations was positively related with the effort required (both Pearson and Spearman's coefficient). The judges' confidence was negatively related with effort required (Pearson's coefficient only) and positively related with productivity (both Pearson and Spearman's coefficient). Finally, effort required to do the evaluations was negatively related with productivity (both Pearson and Spearman's coefficient).

5.6.6 Accessibility indexes

The Accessibility Indexes (AIs) of the Web pages were calculated for the 3 disability groups BLind (BL), Low-Vision (LV) and Colour-Blind (CB) as follows:

- First, a severity matrix is obtained by tabulating the barriers by user types and severity. Each element of the matrix M gives the proportion of sampled barriers associated with the disability d and severity s .
- A confidence interval matrix M can then be generated by computing 95% confidence interval around each proportion $M_{d,s}$. Tables C.1 to C.16 in Appendix C show the severity and confidence intervals for proportions matrices obtained from the BW reports for each Web page. The Adjusted Wald Method (AWM) was used to determine the confidence intervals. AWM is

the best method for datasets which comprise of small sample sizes, since the generated confidence interval is a function of the sample size [Lewis and Sauro, 2006; Sauro and Lewis, 2005].

- Next, we determine the barrier density factor F of the Web page as follows: $F = k \left(\frac{\text{Number of barriers}}{\text{Number of bytes}} \right)$, which can be interpreted as the probability that k bytes of the HTML code of a Web page causes a barrier. If M is the severity matrix, then $F \cdot M_{d,s}$ is the probability that k bytes of code causes a barrier for disability d with severity s . The scale factor k is used to tune the values produced by MAMBO. For our case, $k = 50$.
- We then calculate the Raw Accessibility Index (AI_r) for a Web page by combining the disability type score (D_d) and barrier density factor F :

$$AI_r = \prod_d [1 - (F \cdot D_d)]^2$$

- If we combine the density factor F with the confidence interval severity matrix M , we obtain F ; after using appropriate weights to balance different severity levels we get the Weighted Accessibility Index (AI_w) for a Web page. Since it is based on confidence intervals, it is itself an interval ($\underline{AI_w}, \overline{AI_w}$) defined as:

$$\begin{aligned} \text{let } \underline{H_d} &= \frac{f_{d,1}}{w_1} + \frac{f_{d,2}}{w_2} + f_{d,3} \\ \text{and } \overline{H_d} &= \frac{\bar{f}_{d,1}}{w_1} + \frac{\bar{f}_{d,2}}{w_2} + \bar{f}_{d,3} \\ \text{then } \underline{AI_w} &= \prod_d \left(1 - F \cdot \min\{1, \overline{H_d}\} \right)^2 \\ \overline{AI_w} &= \prod_d \left(1 - F \cdot \min\{1, \underline{H_d}\} \right)^2 \end{aligned}$$

Without the weights w_s , we have the Unweighted Accessibility Index (AI_u) which is still an interval ($\underline{AI_u}, \overline{AI_u}$) (see [Brajnik, 2008c] and [Brajnik and Lomuscio, 2007] for more details on the methodology for calculating AIs).

Accessibility Index (AI) with Varied HTML Sizes

Table 5.9 contains the AIs for the 16 Web pages examined. The higher the AI, the more accessible the Web page and vice versa. Contrary to our previous findings in subsections 5.6.4 and 5.6.5, the results here show Web pages with little HTML content (e.g ID3 and ID5) to have lower AIs, while Web pages with a lot of content (e.g ID6, ID7, ID9, ID10, ID11, ID15 and ID16) have higher AIs. It seems then that when two Web pages vary largely in terms of their HTML file size, AIs may be biased in favour of Web page with more content. These results suggest Web pages with smaller HTML content to be less accessible to people with visual impairments, given the pages we examined here. This can easily be traced to the weighting given to the HTML size in the equation used for calculating AIs here. From the table, we also observe some AI confidence interval overlaps. For example, ID6, ID7 and ID9 all span the same confidence interval range. When two AI intervals overlap, no sound comparison can be made between the Web pages in question [Brajnik, 2008c; Brajnik and Lomuscio, 2007].

Both effects (HTML size weighting and AI confidence intervals overlap) can be attributed to the magnitude of the barrier density factor F . For the overlap problem, F contributes to the variability or the range spanned by AI. The smaller it is, the wider the range spanned by AI. F can therefore be tuned by choosing a suitable scale factor k [Brajnik, 2008c; Brajnik and Lomuscio, 2007]. We could not use a k value smaller than 50 because of the second problem (i.e. the HTML file size). With the HTML size problem, the AI of a Web page with larger content tends to 1 for small k values. Recall the formula for calculating the barrier density factor: $F = k \left(\frac{\text{Number of barriers}}{\text{Number of bytes}} \right)$. Dividing the number of barriers found on a Web page by a very large content size, and multiplying by a small scale factor k gives a small F which tends to 0. When this small F value is plugged into the formula for calculating AI, the result tends to 1. Consequently, it may be more useful to compare Web pages with similar HTML size and no AI overlaps. From Table 5.9 we observe that ID3 and ID5 have only 614.4 bytes between them, and no overlaps in their AIs. Therefore, we can soundly say that ID5 is more accessible than ID3. In terms of their aesthetic quality, ID5 was preferred for its visual cleanness, while ID3 was preferred on the expressive dimension and other aesthetic aspects. We cannot say much about the accessibility rankings of other Web pages because of the aforementioned problems. Consequently, no sound correlation analysis can

be performed between the accessibility (based on AIs) of the Web pages and their aesthetic quality. We had hoped that the analysis will provide further evidence on the interplay between Web aesthetics and accessibility. Although the BW method provides an effective approach for identifying and quantifying the severity of barriers, the associated AI metric needs to be further refined to check the occurrence of AI interval overlaps and cope with HTML size variability.

Figure 5.3 shows the associated boxplots for the AIs. We see that AI_r has more variability than the other two indexes (i.e AI_u and AI_w). Also, AI_u is slightly more spread and lower than AI_w , because all the barriers weigh the same. The small range of AI_w is due to the small variability of critical barriers which weigh alot [Brajnik, 2008c; Brajnik and Lomuscio, 2007]. ID3 and ID5 are outliers.

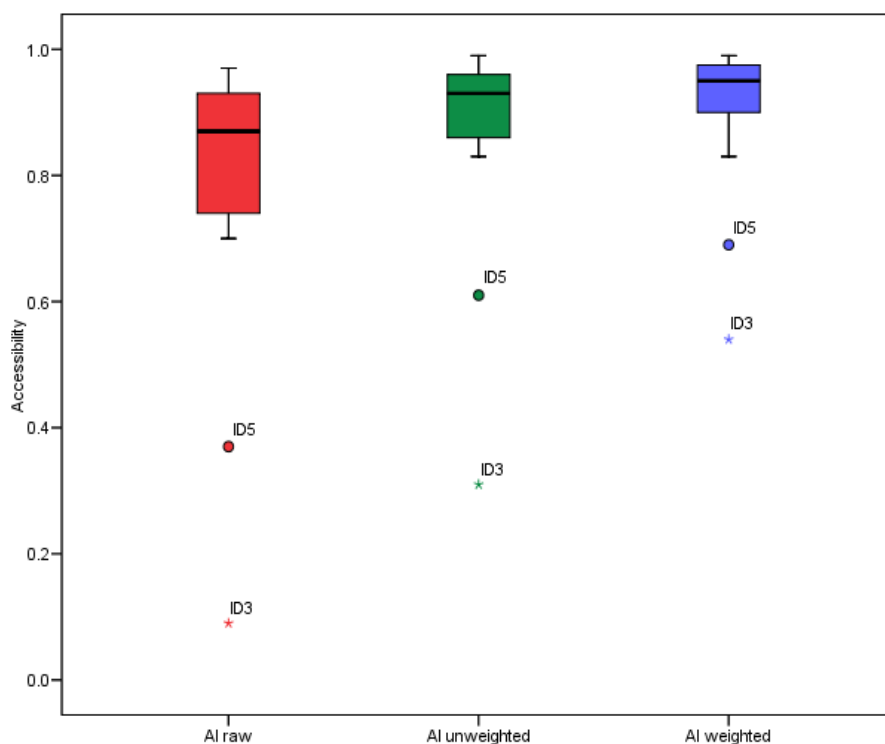


Figure 5.3: Boxplots for the AIs. Note that the boxplots for AI_u and AI_w are computed on the basis of the midpoints of the confidence intervals.

Figure 5.4 also shows that there is a very strong linear correlation between AI_r and AI_w (Pearson's coefficient of 0.995). Therefore, a linear model can be used to predict AI_w from AI_r using the equation $y = 0.5143x + 0.4987$.

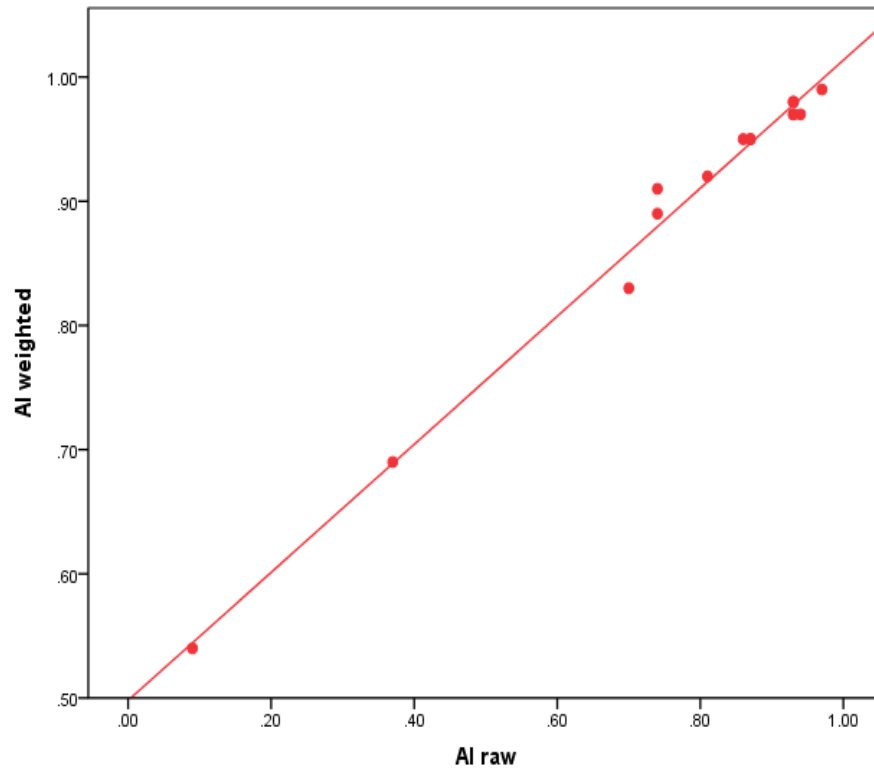


Figure 5.4: Scatter plots of AI_r against midpoints of AI_w

Accessibility Index (AI) with Standardized HTML Sizes

In a further analysis, we examined the effect of the number and severity of barriers found on a Web page using the same AI formula. To achieve this, more weighting was given to the barriers found by standardizing the HTML sizes. The mean HTML sizes for the Web pages were used in the investigation instead. Table 5.10 has the results of the analysis. As expected, the table shows ID11 to be the most inaccessible Web page due to low values observed for all three accessibility indexes [$AI_r=0.82$; $AI_u=(0.83,0.92)$; $AI_w=(0.85,0.96)$]. The said Web page also had the highest number of barriers (40 of them) in section 5.6.4. While a Web page like ID5 with very little HTML content ID5 and fewer barriers (8 of them) was considered more accessible [$AI_r=0.96$; $AI_u=(0.96,0.99)$; $AI_w=(0.97,1.00)$].

Table 5.10: Accessibility indexes with fixed HTML sizes

<i>PageID</i>	<i>AlrBL</i>	<i>AlrLV</i>	<i>AlrCB</i>	<i>Alr</i>	<i>AluBL</i>	<i>AluLV</i>	<i>AluCB</i>	<i>Alu</i>	<i>AluBL</i>	<i>AluLV</i>	<i>AluCB</i>	<i>AlwBL</i>	<i>AlwLV</i>	<i>AlwCB</i>	<i>Alw</i>
ID1	0.98	0.98	0.97	0.93	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.94, 0.98)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.95, 0.99)
ID2	0.98	0.98	0.98	0.94	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.95, 0.98)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.98, 1.00)	(0.96, 1.00)
ID3	0.98	0.98	0.98	0.93	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.94, 0.98)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.98, 1.00)	(0.95, 1.00)
ID4	0.98	0.98	0.97	0.93	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.94, 0.98)	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.94, 0.98)
ID5	0.99	0.99	0.98	0.96	(0.99, 0.99)	(0.99, 1.00)	(0.99, 1.00)	(0.96, 0.99)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.97, 1.00)
ID6	0.98	0.98	0.98	0.95	(0.99, 0.99)	(0.99, 1.00)	(0.99, 1.00)	(0.96, 0.99)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.96, 1.00)
ID7	0.96	0.96	0.95	0.87	(0.96, 0.98)	(0.96, 0.98)	(0.96, 0.99)	(0.89, 0.95)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.97, 1.00)	(0.96, 1.00)	(0.92, 0.99)
ID8	0.97	0.97	0.97	0.91	(0.97, 0.99)	(0.97, 0.99)	(0.97, 0.99)	(0.92, 0.98)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.97, 1.00)	(0.93, 0.99)
ID9	0.98	0.98	0.97	0.93	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.94, 0.98)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.98, 1.00)	(0.96, 1.00)
ID10	0.96	0.96	0.95	0.87	(0.96, 0.98)	(0.96, 0.98)	(0.96, 0.99)	(0.89, 0.95)	(0.96, 0.99)	(0.96, 0.99)	(0.96, 0.99)	(0.96, 0.99)	(0.97, 0.99)	(0.96, 1.00)	(0.89, 0.97)
ID11	0.94	0.94	0.93	0.82	(0.94, 0.97)	(0.94, 0.97)	(0.94, 0.98)	(0.83, 0.92)	(0.95, 0.98)	(0.95, 0.98)	(0.95, 0.98)	(0.95, 0.98)	(0.95, 0.99)	(0.94, 0.99)	(0.85, 0.96)
ID12	0.99	0.99	0.98	0.96	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.96, 0.99)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.96, 1.00)
ID13	0.98	0.98	0.97	0.93	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.94, 0.98)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.95, 0.99)
ID14	0.98	0.98	0.98	0.94	(0.98, 0.99)	(0.98, 0.99)	(0.98, 1.00)	(0.95, 0.98)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.99, 1.00)	(0.98, 1.00)	(0.96, 1.00)
ID15	0.96	0.96	0.95	0.87	(0.96, 0.98)	(0.96, 0.98)	(0.96, 0.99)	(0.89, 0.95)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.98, 1.00)	(0.96, 1.00)	(0.92, 0.99)
ID16	0.96	0.96	0.95	0.87	(0.96, 0.98)	(0.96, 0.98)	(0.96, 0.99)	(0.89, 0.96)	(0.96, 0.99)	(0.96, 0.99)	(0.96, 0.99)	(0.96, 0.99)	(0.96, 0.99)	(0.96, 1.00)	(0.89, 0.98)

Although, we still observe some overlaps in the confidence intervals for AI_u and AI_w , this analysis is consistent with our findings in section 5.6.4 and 5.6.5. It further validates our speculations about HTML sizing bias in the AI formula. Figure 5.5 shows the associated boxplots for AIs with standardized HTML sizing. As before, we see that AI_r has more variability than the other two indexes (i.e AI_u and AI_w). Also, AI_u is slightly more spread and lower than AI_w , because all the barriers weigh the same. The small range of AI_w is due to the small variability of critical barriers which weigh alot [Brajnik, 2008c; Brajnik and Lomuscio, 2007]. ID11 is now an outlier for AI_w .

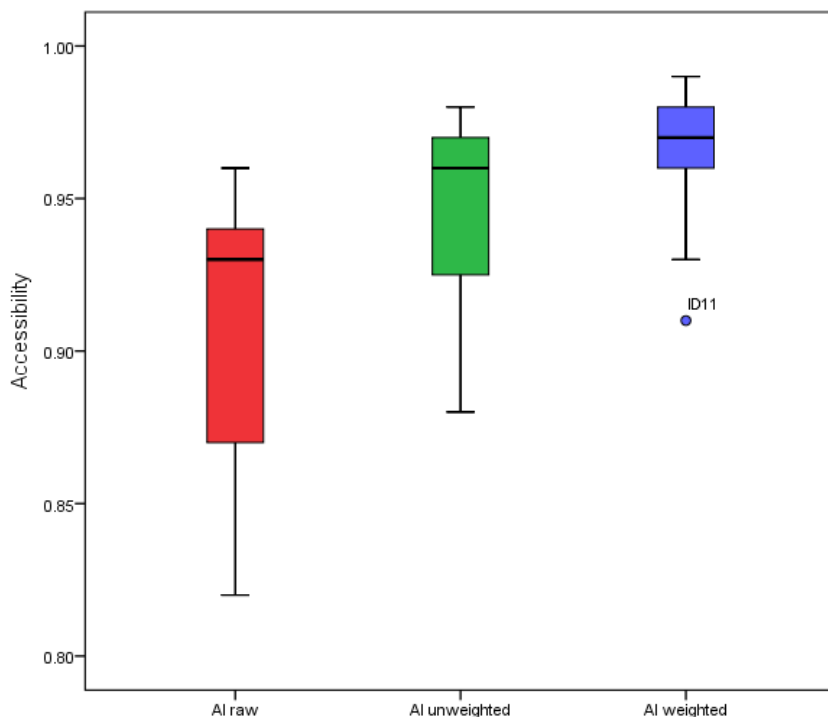
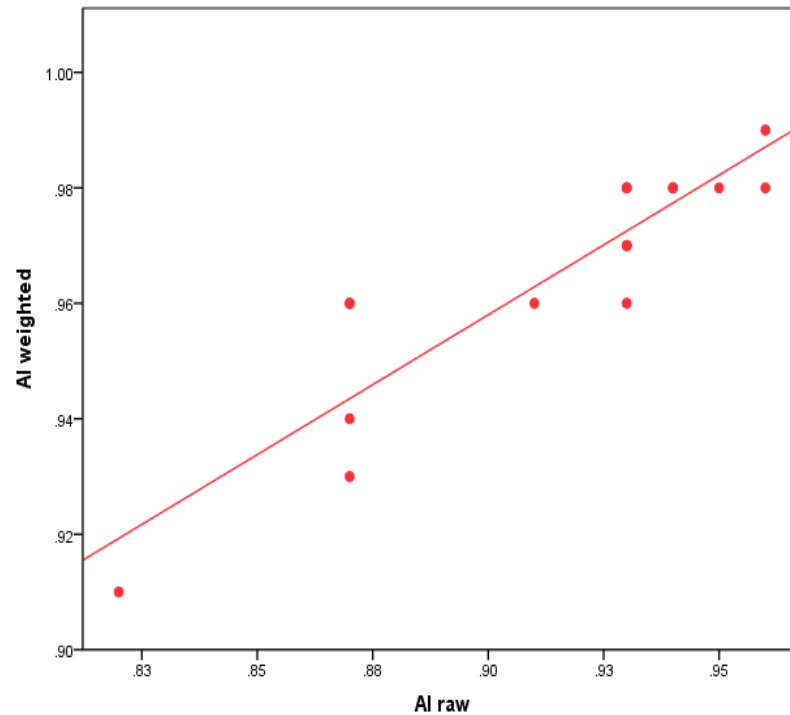


Figure 5.5: Boxplots for the AIs. Note that the boxplots for AI_u and AI_w are computed on the basis of the midpoints of the confidence intervals.

As before, Figure 5.6 shows that there is a very strong linear correlation between AI_r and AI_w (Pearson's coefficient of 0.911). Therefore, a linear model can be used to predict AI_w from AI_r using the equation $y = 0.484x + 0.522$.

Figure 5.6: Scatter plots of AI_r against midpoints of AI_w

5.6.7 Correlation analysis: aesthetics versus indexes

Here, we examine the relationship between the aesthetic quality of Web pages and their accessibility as measured by the AI metric (with standardized HTML sizes). For the accessibility scores, the mid-points of the intervals were used for AI_u and AI_w . Table 5.11 has the results of the Pearson and Spearman correlation tests conducted. Recall, that the higher the AI, the more accessible the Web page is. As before, we observe significant positive correlations between the design dimension ‘clean’ and accessibility [Pearson: ($AI_r = 0.539$; $AI_w = 0.539$)] and [Spearman: ($AI_r = 0.559$; $AI_u = 0.519$; $AI_w = 0.573$)]. Although the other dimensions do not show strong correlations with accessibility, it is important to note that they are all positive. Perhaps, given more data those relationships may become clearer and stronger. We also see an agreement here between our findings in section 5.6.4, and the relationship between barriers and the AI scores. The results show a strong negative relationship (both Pearson and Spearman) between the number of barriers found and AI of a Webpage. In other words, the higher the number of barriers found, the lower the AI score for a Web page and vice versa.

Table 5.11: Correlation between aesthetics, barriers and accessibility indexes

r	Clean	Pleasing	Fascinating	Creative	Aesthetic	Barriers	AIr	AIu	AIw
Pearson's coefficient									
Clean	1.000	0.868 ^a (p = 0.000)	0.637 ^a (p = 0.008)	0.594 ^b (p = 0.015)	0.835 ^a (p = 0.000)	-0.501 ^b (p = 0.048)	0.539 ^b (p = 0.031)	0.493 (p = 0.052)	0.539 ^b (p = 0.031)
Pleasing		1.000	0.930 ^a (p = 0.000)	0.898 ^a (p = 0.000)	0.994 ^a (p = 0.000)	-0.342 (p = 0.195)	0.429 (p = 0.098)	0.386 (p = 0.140)	0.380 (p = 0.146)
Fascinating			1.000	0.972 ^a (p = 0.000)	0.947 ^a (p = 0.000)	-0.158 (p = 0.559)	0.266 (p = 0.319)	0.229 (p = 0.393)	0.190 (p = 0.480)
Creative				1.000	0.921 ^a (p = 0.000)	-0.129 (p = 0.635)	0.253 (p = 0.345)	0.217 (p = 0.419)	0.179 (p = 0.507)
Aesthetic					1.000	-0.294 (p = 0.269)	0.394 (p = 0.131)	0.350 (p = 0.183)	0.329 (p = 0.213)
Barriers						1.000	-0.962 ^a (p = 0.000)	-0.980 ^a (p = 0.000)	-0.911 ^a (p = 0.000)
AIr							1.000	0.992 ^a (p = 0.000)	0.911 ^a (p = 0.000)
AIu								1.000	0.906 ^a (p = 0.000)
AIw									1.000

a - significant at the 0.01 level (2-tailed) and b - significant at the 0.05 level (2-tailed).

r continued	Clean	Pleasing	Fascinating	Creative	Aesthetic	Barriers	AIr	AIu	AIw
Spearman's rho									
Clean	1.000	0.850 ^a (p = 0.000)	0.603 ^b (p = 0.013)	0.529 ^b (p = 0.035)	0.806 ^a (p = 0.000)	-0.507 ^b (p = 0.045)	0.559 ^b (p = 0.024)	0.519 ^b (p = 0.040)	0.573 ^b (p = 0.020)
Pleasing		1.000	0.900 ^a (p = 0.000)	0.859 ^a (p = 0.000)	0.988 ^a (p = 0.000)	-0.280 (p = 0.293)	0.357 (p = 0.175)	0.332 (p = 0.209)	0.399 (p = 0.126)
Fascinating			1.000	0.944 ^a (p = 0.000)	0.926 ^a (p = 0.000)	-0.150 (p = 0.580)	0.211 (p = 0.433)	0.203 (p = 0.451)	0.172 (p = 0.524)
Creative				1.000	0.900 ^a (p = 0.000)	-0.199 (p = 0.460)	0.247 (p = 0.356)	0.249 (p = 0.351)	0.263 (p = 0.324)
Aesthetic					1.000	-0.258 (p = 0.334)	0.336 (p = 0.203)	0.319 (p = 0.229)	0.353 (p = 0.179)
Barriers						1.000	-0.976 ^a (p = 0.000)	-0.978 ^a (p = 0.000)	-0.897 ^a (p = 0.000)
AIr							1.000	0.993 ^a (p = 0.000)	0.907 ^a (p = 0.000)
AIu								1.000	0.893 ^a (p = 0.000)
AIw									1.000

a - significant at the 0.01 level (2-tailed) and b - significant at the 0.05 level (2-tailed).

The only design dimension which shows significant relationships (in a positive fashion) with accessibility in these studies is visual *cleanness*. Visually clean Web pages have better accessibility indexes, and fewer accessibility barriers. This outcome can be traced to the small number of HTML content (e.g. images, links, text, scripts) required to build visually clean Web pages. A Web page with a simple HTML code base is more likely to have fewer accessibility issues, because the Web designer typically has fewer bytes of code to mind. A similar situation is reported in a study by [Lopes et al., 2010]. In that study, the authors found a correlation between accessibility and Web page complexity (i.e number of HTML elements). Web pages with fewer HTML elements (simpler Web pages) had better accessibility quality. It may be this simplicity that the design community struggles with or mis-understands sometimes. It is commonly believed that accessible Websites are boring, because of the perceived minimalistic undertone to their designs [Petrie et al., 2004; Regan, 2004]. Many Web designers fail to see simplicity as an aesthetic notion [Karvonen, 2000]. Our findings do not seem to fully support a closely related study where highly accessible Websites were also shown to have complex visual designs [Petrie et al., 2004]. Simple Web designs had fewer accessibility issues in our case. Expressive designs which would naturally come across as being more complex and sophisticated showed no significant relationships with accessibility. However, this does not rule out the possibility of creating fancy and yet accessible Web pages. Our data in this thesis only shows this to be less the case presently. Expressive designs may not necessarily be a barrier to accessibility, however the relationship between classical aesthetic dimensions and functionality is more consistently established across studies.

5.6.8 Quality assessment

It is also important that we evaluate the effectiveness of the BW method here. One way of doing this is through a reliability test. Reliability is the extent to which independent accessibility audits produce the same results [Brajnik, 2008b]. One way of measuring reliability is by the coefficient of variation (*cv*). It is defined as $\frac{SD}{M}$, where SD is the standard deviation and M is the mean of the number of correctly identified barriers. The smaller the *cv* value, the more reliable the audit results. Whenever the *cv* value exceeds 1, it depicts low reliability as SD is greater than M. Similar quality assessment measures are used in [Brajnik, 2008b; Brajnik et al., 2011; Yesilada et al., 2009]. The *cv* value here measures the variation

between the barrier severity ratings given by different judges for barriers on the same Web page, and for different disability types. It is represented by the triple (barrier type, disability category, page). Since this value can be influenced by the number of evaluators, we performed the reliability tests with the same number of judges per page. Two judges were chosen per page. For Web pages which had evaluations from more than two judges, two sets of audits were randomly chosen. ID4 and ID10 had lone evaluations due to invalid questionnaire responses from the second judge who was assigned the Web pages in question, hence no reliability checks could be performed. The results for the QA are shown in Table 5.12.

Table 5.12: Coefficient of variation (cv) among judges for the Web pages evaluated both at the page level and between the three disability types investigated - Blind (BL), Low-Vision (LV) and Colour-Blind (CB)

PageID	Page	BL	LV	CB
ID1	0.21	0.26	0.16	0.24
ID2	0.23	0.29	0.10	0.70
ID3	0.21	0.22	0.17	0.70
ID4	n/a	n/a	n/a	n/a
ID5	0.13	0.12	0.15	0.00
ID6	0.15	0.06	0.17	1.40
ID7	0.27	0.32	0.17	0.70
ID8	0.17	0.18	0.14	0.35
ID9	0.26	0.25	0.22	0.70
ID10	n/a	n/a	n/a	n/a
ID11	0.50	0.47	0.55	0.35
ID12	0.11	0.13	0.05	0.70
ID13	0.29	0.29	0.29	0.14
ID14	0.22	0.20	0.21	0.70
ID15	0.47	0.49	0.46	0.24
ID16	0.27	0.18	0.30	1.40

At the page level, we observe moderate variations between the independent accessibility audits performed by the judges. The highest variation between judges was observed for ID11. The Web page in question had the highest number of barriers with an average severity rating of at least 1. Accordingly, we would

expect greater variances in the opinions of the judges involved. When split between disability types, the results show reasonable variations for the blind and low-vision categories. The cv values are rather high for colour-blindness on some of the homepages. This is because the BW method specifies only two types of barriers capable of affecting people with colour-blindness, which are ‘color is necessary to understand information’ and ‘insufficient visual contrast’. Whenever the judges disagreed on the barrier severity ratings for this user category, the effect was greater. Going by the page level reliability scores, the accessibility audits are reproducible among judges. This also boosts our confidence on the audits performed on ID4 and ID10, as the lone judge with valid questionnaire responses also helped in evaluating other Web pages.

In one study [Brajnik et al., 2011] where the role of expertise in Web accessibility evaluations was investigated, the authors found that a lone expert judge was capable of identifying 70% of the problems on a Website. With 2 judges 94% of the problems were covered and 3 judges covered all. While more than one expert judge per Web page is encouraged, they also found that the reproducibility of the accessibility evaluations reduce as the judge numbers assigned to a page increases. This is due to the increased subjectivity arising from the many different opinions. Although the authors point out that not all of their study outcomes are generalizable as they either apply to the experts they employed or the Websites evaluated, their findings give us an idea of the effects of expertise on our own studies, especially as we employed some of the experts that they used.

5.7 Summary

The interplay between Web aesthetics and accessibility has been examined here. Our results show only one aesthetic dimension, *clean* to be significantly related with accessibility. Clean Web designs were characterised by simplicity and minimalism. They had fewer accessibility barriers compared with the other aesthetic dimensions. Our data suggests this design dimension to be a suitable proxy measure for accessibility as far as people with visual impairments are concerned. This lends further support to the existing relationship between classical aesthetic aspects and functionality, in this case accessibility. The next chapter describes a tool which uses the findings from the empirical studies in Chapters 4 and 5 to predict the accessibility of Web pages based on the clarity of their visual designs.

Chapter 6

Predicting Web Content Quality

This chapter describes the development of the EIVAA tool. The tool is built on findings from the studies conducted in Chapters 4 and 5. In Chapter 4 we demonstrated how users classify Web designs based on aesthetic quality. We were also able to elicit some of the Web design features which moderate their aesthetic preferences. Those features would be used here to inform the EIVAA framework on aesthetics prediction. In Chapter 5 we showed how aesthetic aspects of Web pages relate with their accessibility. We found one aspect of visual designs, ‘clean-ness’ to be closely related with accessibility. Insights from the relationship will also be used here to inform accessibility status predictions. The EIVAA tool has been designed to be part of a larger framework known as the Accessibility Tools Framework (ACTF), which is in turn part of the Eclipse project. In the rest of the chapter we give a brief overview of ACTF and explain where the EIVAA tool fits within this larger framework. We also describe the statistical models on which the EIVAA tool is based, together with an algorithm which explains how the tool operates. We conclude with a discussion on the performance, as well as limitations of the statistical models when tested on the original training data.

6.1 Accessibility Tools Framework

The Accessibility Tools Framework (ACTF) ¹ is an open source project which brings together software tools developed within the Web accessibility community. It provides a platform on which Web developers with interests in accessibility can build, test, share and reuse their software. Examples of software housed within

¹Accessibility Tools Framework (ACTF) - <http://www.eclipse.org/actf/>

this framework includes: Web content validation tools, usability problem simulators, visual complexity simulators, assistive technology simulators among others [Asakawa and Paciello, 2007]. The EIVAA tool will also be housed within this framework. The diagram in Figure 6.1 is an overview of the ACTF project.

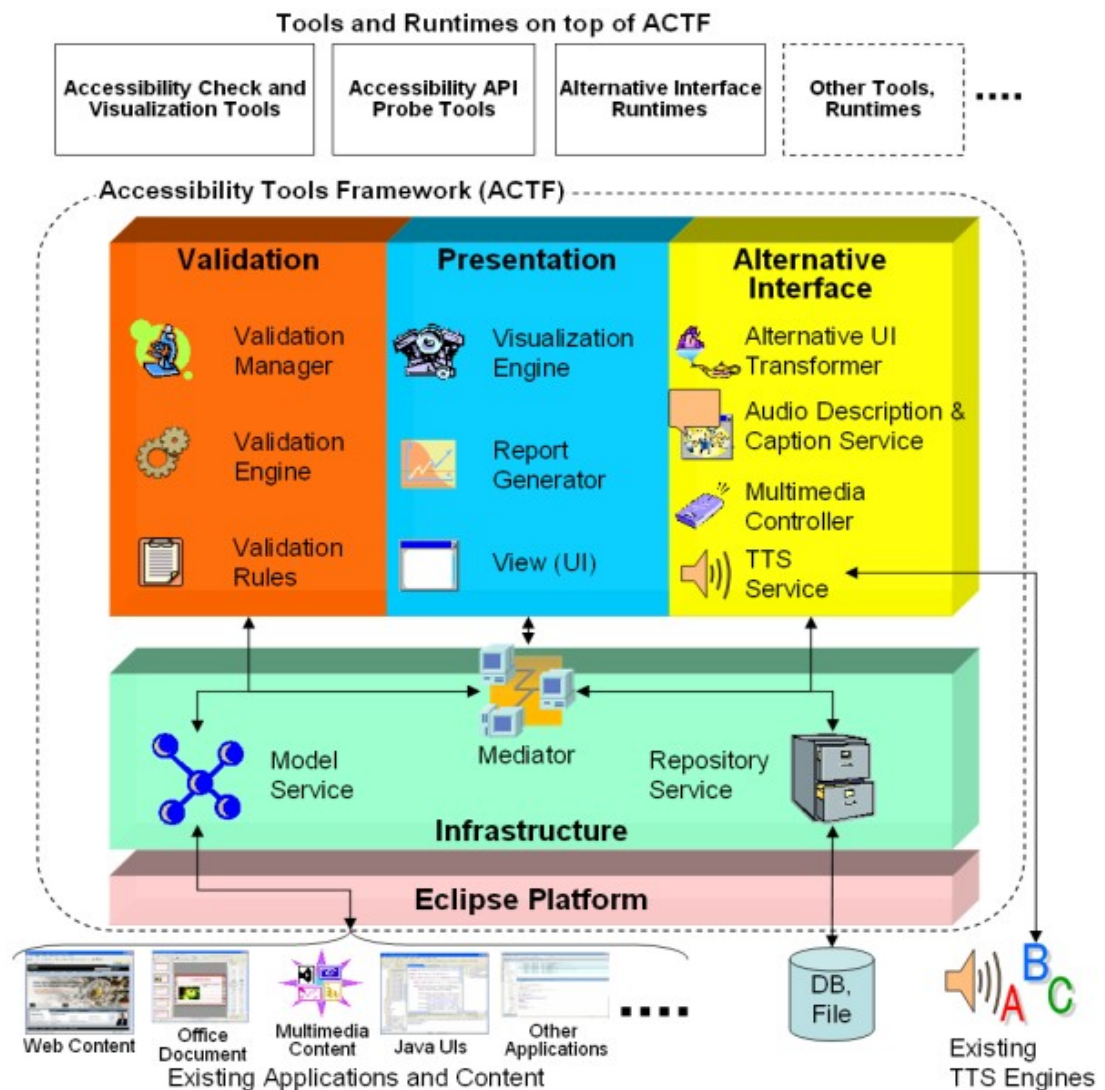


Figure 6.1: An overview of ACTF [Asakawa and Paciello, 2007]

The ACTF project is made up of four major components, and these work together to support the development of accessible Web content. They include:

- **Validation Part:** This component provides support features for building and managing validation rules for Web content and related applications.
- **Presentation Part:** This component provides support features for the following: a) visual representation analyzers. These analyzers highlight in a visual fashion usability and/or accessibility issues capable of affecting people with visual impairments; b) usability simulators. A usability simulator is capable of providing feedback to Web developers on how people with various types of disabilities and/or in poor environmental conditions perceive Web content. This is achieved by mimicking vision in these scenarios. The presentation component also handles report generation and views.
- **Alternative Interface Part:** This part provides features which facilitate the rendering of Web content in a more accessible way without altering the original content. This also covers the use of audio descriptions and captions for multimedia content, as well as the provision of shortcut keys and control features which allow the user to be in charge of their Web experience.
- **Infrastructure Part:** This part manages the aforementioned components. It also provides access to required plugins and/or applications some of which may be external to Eclipse [Asakawa and Paciello, 2007].

The EIVAA tool comes under both presentation and validation components of the ACTF project. The tool aims to predict the aesthetic quality of a Web page by evaluating the page's visual features (presentation), and then using that information to provide a proxy measure of the page's accessibility (validation).

6.2 The EIVAA Tool

The EIVAA tool represents a novel attempt to predict functionality from appearance in the context of the Web. Although existing studies establish links between appearance and pragmatic qualities of Websites such as performance and usability, none of these studies go on to exploit these relationships as we propose. In this section, we describe the feature selection process for the EIVAA tool, and the development and testing of the statistical models on which the tool is based.

6.2.1 Feature selection

In Chapter 4 we successfully elicited some of the prominent Web design elements which moderate the aesthetic preferences of users. These include: images, text quantity, good use of hyperlinks, colour, structure and animations. All except two of these features will be used in a regression analysis aimed at generating statistical models capable of predicting aesthetic quality and accessibility status. We do not investigate colour as it is complex to automatically extract colour information and perform Website rankings based on them. Colour perception can be influenced by several factors (e.g brightness, saturation, lighting conditions or the computer monitor used in viewing), most of which are difficult to control [Lindgaard, 2007]. Although there are studies on colour preferences and their impact on Web user behaviours (e.g [Bonnardel et al., 2011; Cyr et al., 2010]), the aforementioned challenges make it difficult to conduct studies that totally reflect reality. For example, experiments are designed around a set of colours or employ a single colour per Web page (e.g [Bonnardel et al., 2011]). In reality Websites make use of colour combinations which these authors also acknowledge. However, we agree that colour plays a significant role in aesthetic preferences. Moreover, there are existing tools which capture colour information for Web accessibility evaluation purposes. Consequently, this information could be re-used. Examples include: Colour Contrast Analyser², Colour Check³ and ColorSelector⁴.

The second feature which we did not investigate further was the structure of a Web page. We concluded that structure was a rather subjective construct to programmatically detect, given EIVAA's set task which is more objective in nature. Moreover, Web pages present us with a huge variety of layout designs, and ranking Web pages in an objective fashion using their layout design is not as straightforward. As such, we will focus on the remaining visual cues (i.e images, text quantity, hyperlink usage and animations or moving graphics). These aspects of Web visual designs were interpreted as being programmatically detectable and measurable using the following features or HTML elements:

- Images: These refer to the static graphic content on the page. To programmatically detect images we count the number of HTML image tags (img) used. The data gathered in Chapter 4 revealed that Web users perceive

²<http://www.paciellogroup.com/resources/contrast-analyser.html>

³<http://www.etre.com/tools/colourcheck/>

⁴<http://www.fujitsu.com/global/accessibility/assistance/cs/>

that images contribute positively to the aesthetic quality of Web pages. However, our qualitative data also showed that when excessive images were employed on Web pages, those pages came across as cluttered.

- Text: This represents the words displayed in the browser. A function was written to count words on a Web page. The function comprised regular expression patterns which filter off HTML tags, leaving behind the actual words. Participants unanimously agreed that too much text puts them off.
- Links: Hyperlinks facilitate traveling on the Web. They are used to connect two Web pages together or to connect one section of a Web page to another section on the same Web page. The `< a >` tag is used to specify hyperlinks on a Web document. For more information on hyperlinks see <http://www.w3schools.com/html/default.asp>. One may wonder how hyperlinks impact aesthetic preference. Since hyperlinks form the basis of the Web, it is easy to see why users are particular about their usage. It seems this relates more to functional aesthetics or the “beauty in use” notion [Overbeeke and Wensveen, 2004] . Participants were particular about the number of links. Too many links came across as displeasing to the participants we recruited for the studies reported in Chapter 4.
- Script: “The script tag is used to define a client-side script, such as a JavaScript. JavaScript is commonly used for image manipulation, form validation and dynamic changes of content”. As such, it allows Web professionals to create more interactive and beautiful Websites. For more information on this please see <http://www.w3schools.com/html/default.asp>.
- Object: “The object tag supports Plug-Ins. It can be used to embed multimedia such as audio, video, Java applets, ActiveX, PDF, and Flash in Web pages”. The use of objects in HTML adds more creativity to a Web page and moves it away from the text-based ones. For more information on this please see <http://www.w3schools.com/html/default.asp>.
- Embed: “The embed tag defines a container for an external application or interactive content (a plug-in)”. This allows Web developers to create fascinating and creative Websites. For more information on this HTML element please see <http://www.w3schools.com/html/default.asp>.

The number of scripts, objects and embedded content on a Web page is used here to model motion in the Web interface. Animation came across as a prominent characteristic of expressive designs in the lab study reported in Chapter 4.

6.2.2 Multiple regression models

Multiple regression models are used to predict the value of a criterion y , for given values of predictor variables $x_1, x_2, \dots, x_k$. The multiple regression equation of y on $x_1, x_2, x_3, \dots, x_k$ is given in equation 6.1.

$$y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + \dots + b_k x_k \quad (6.1)$$

where b_0 is a constant and $b_1, b_2, b_3, \dots, b_k$ are the regression coefficients for the different predictor variables $x_1, x_2, x_3, \dots, x_k$. We use regression models to predict Web aesthetic quality (clean, pleasing, fascinating, creative and overall aesthetics), given programmatically detectable Web design features such as image count, text quantity and so on. We employ the stepwise regression method, because it allows us to extract the minimum set of predictors for the criterion variable of interest [Brace et al., 2006]. This method suits our framework which only makes proxy evaluations with the smallest set of Web design features. This kind of information is useful for Web professionals who are looking to make quick and rough estimations regarding Web content quality. In every case, we checked for the multicollinearity problem, and satisfied this constraint. A tolerance of less than 0.20 or 0.10 and/or a VIF of 5 or 10 and above indicates a multicollinearity problem [Obrien, 2007]. Furthermore, we re-scaled the amount of text found on a Web page by dividing the word count by 10 before performing the regression analysis. We observed that the word count far exceeded the other features, leading to an out-of-scale regression coefficient for the predictor variable ‘Words’.

Model for Predicting ‘Clean - Cluttered’ Aesthetic Dimension

A significant model (model 2) emerged, $F_{(2,47)} = 26.438, p < 0.0005$; Adjusted R square = .509. The significant variables were Words (Beta = -.591 $p < 0.0005$) and Images (Beta = -.240 $p = 0.035$). The model, regression coefficients, histogram and normal P-P plots are shown in Figures 6.2 and 6.3 respectively.

Model Summary ^c									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.695 ^a	.482	.472	.82291	.482	44.739	1	48	.000
2	.728 ^b	.529	.509	.79296	.047	4.694	1	47	.035

a. Predictors: (Constant), Words

b. Predictors: (Constant), Words, Images

c. Dependent Variable: Clean

Coefficients ^a											
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	5.518	.153		36.185	.000					
	Words	-.008	.001	-.695	-6.689	.000	-.695	-.695	-.695	1.000	1.000
2	(Constant)	5.643	.158		35.759	.000					
	Words	-.007	.001	-.591	-5.322	.000	-.695	-.613	-.533	.813	1.230
	Images	-.008	.003	-.240	-2.167	.035	-.496	-.301	-.217	.813	1.230

a. Dependent Variable: Clean

Figure 6.2: Models and coefficients of regression for dependent variable: clean.

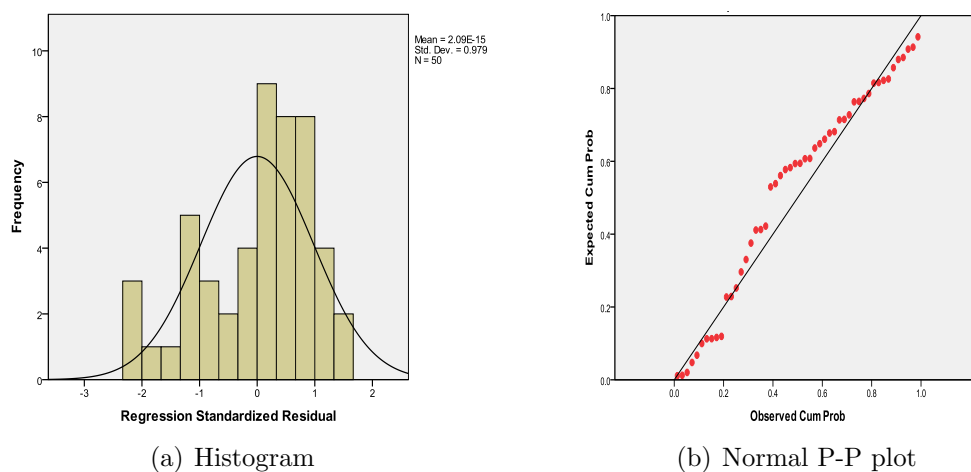


Figure 6.3: Histogram and Normal P-P Plot for dependent variable: clean.

This model (model 2) accounts for about 51% of the variance in the cleanliness ratings, which is good. Therefore, the number of images and amount of words

could be used as a minimum set of features required to predict the level of visual cleanness on a Web page. Our qualitative data suggests this as well. Web pages with minimal images and text came across as being clean, while those with too many images or large amount of text came across as being cluttered. The regression function for predicting cleanness is given in equation 6.2.

$$Clean = 5.643 - (0.007 * Words) - (0.008 * Images) \quad (6.2)$$

The other predictor variables were not significant in this model. They include: the amount of embedded content, hyperlinks, scripts and objects.

Model for Predicting ‘Pleasing - Displeasing’ Aesthetic Dimension

A significant model (model 2) also emerged, $F_{(2,47)} = 13.347, p < 0.0005$; Adjusted R square = .335. The significant variables which emerged were Words (Beta = -.624 $p < 0.0005$) and Scripts (Beta = .264 $p = 0.035$). The regression coefficients and plots are shown in Figures 6.4 and 6.5 respectively.

Model Summary ^c									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.546 ^a	.298	.284	.61466	.298	20.419	1	48	.000
2	.602 ^b	.362	.335	.59225	.064	4.701	1	47	.035

a. Predictors: (Constant), Words

b. Predictors: (Constant), Words, Scripts

c. Dependent Variable: Pleasing

Coefficients ^a											
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	5.215	.114		45.782	.000					
	Words	-.004	.001	-.546	-4.519	.000	-.546	-.546	-.546	1.000	1.000
2	(Constant)	5.012	.144		34.758	.000					
	Words	-.005	.001	-.624	-5.121	.000	-.546	-.598	-.596	.913	1.095
	Scripts	.016	.007	.264	2.168	.035	.080	.302	.253	.913	1.095

a. Dependent Variable: Pleasing

Figure 6.4: Models and coefficients of regression for dependent variable: pleasing.

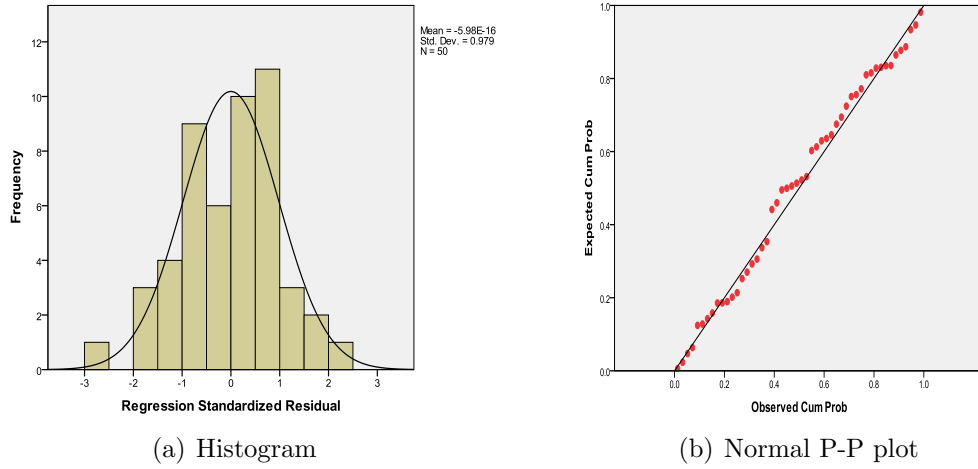


Figure 6.5: Histogram and Normal P-P Plot for dependent variable: pleasing.

Therefore, the number of words and amount of scripts used is the least set of Web design features required to predict how pleasing a Web page would be. This model accounts for only 33.5% of the variance in the pleasantness ratings given by the participants, which is fair. As such, it is not as strong as the previous model for predicting cleanness. From our observations, it was particularly difficult to elicit factors which moderated the participants ratings for this aesthetic dimension. The regression function for predicting pleasantness is given in equation 6.3.

$$Pleasing = 5.012 - (0.005 * Words) + (0.016 * Scripts) \quad (6.3)$$

The other predictor variables were excluded, as they were not significant in the model. They include: number of images, embedded content, links and objects.

Model for Predicting ‘Fascinating - Boring’ Aesthetic Dimension

A significant model (model 2) also emerged for predicting how fascinating a Web page would be given our training data set, $F_{(2,47)} = 7.128, p = 0.002$; Adjusted R square = .200. Significant variables were Words (Beta = -.440 $p = 0.002$) and Scripts (Beta = .367 $p = 0.009$) like in the previous case. Once again, the text quantity and number of scripts constitute the least set of Web design features

required to predict how fascinating a Web page would be. The regression coefficients and plots are shown in Figures 6.6 and 6.7 respectively:

Model Summary ^c									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.331 ^a	.110	.091	.66464	.110	5.926	1	48	.019
2	.482 ^b	.233	.200	.62361	.123	7.524	1	47	.009

a. Predictors: (Constant), Words

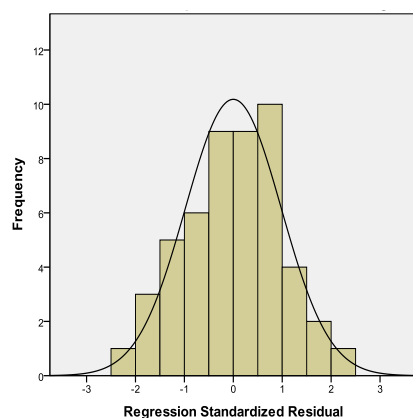
b. Predictors: (Constant), Words, Scripts

c. Dependent Variable: Fascinating

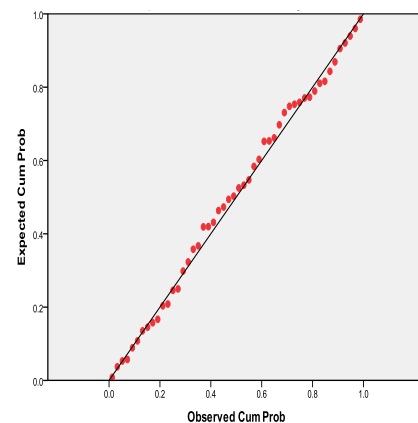
Coefficients ^a										
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	4.789	.123		38.878	.000				
	Words	-.002	.001	-.331	-2.434	.019	-.331	-.331	-.331	1.000
2	(Constant)	4.519	.152		29.759	.000				
	Words	-.003	.001	-.440	-3.288	.002	-.331	-.432	-.420	.913
	Scripts	.021	.008	.367	2.743	.009	.237	.371	.350	.913

a. Dependent Variable: Fascinating

Figure 6.6: Models and coefficients of regression for dependent variable: fascinating.



(a) Histogram



(b) Normal plot

Figure 6.7: Histogram and Normal P-P Plot for dependent variable: fascinating.

This model accounts for only 20% of the variance in the participants' ratings. As such, it is not as strong a model as the previous two models we have discussed. The associated regression function is given in equation 6.4.

$$Fascinating = 4.519 - (0.003 * Words) + (0.021 * Scripts) \quad (6.4)$$

Other predictors were excluded from the model, as they were not significant.

Model for Predicting 'Creative - Basic' Aesthetic Dimension

A significant model (model 2) also emerged for predicting how creative a Web page would be, $F_{(2,47)} = 6.510, p = 0.003$; Adjusted R square = .184. Significant variables were Words (Beta = -.385 $p = 0.005$) and Embed (Beta = .296 $p = 0.027$). Data from Chapter 4 suggests that heavy use of animations influenced the participants' ratings along this design dimension, hence it is interesting to see embedded content emerge as a predictor variable here. The regression coefficients and plots are shown in Figures 6.8 and 6.9:

Model Summary ^c									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.360 ^a	.130	.112	.60613	.130	7.159	1	48	.010
2	.466 ^b	.217	.184	.58108	.087	5.229	1	47	.027

a. Predictors: (Constant), Words

b. Predictors: (Constant), Words, Embed

c. Dependent Variable: Creative

Coefficients ^a											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	4.779	.112		42.541	.000					
	Words	-.002	.001	-.360	-2.676	.010	-.360	-.360	-.360	1.000	1.000
2	(Constant)	4.693	.114		41.166	.000					
	Words	-.003	.001	-.385	-2.973	.005	-.360	-.398	-.384	.993	1.007
	Embed	.275	.120	.296	2.287	.027	.264	.316	.295	.993	1.007

a. Dependent Variable: Creative

Figure 6.8: Models and coefficients of regression for dependent variable: creative.

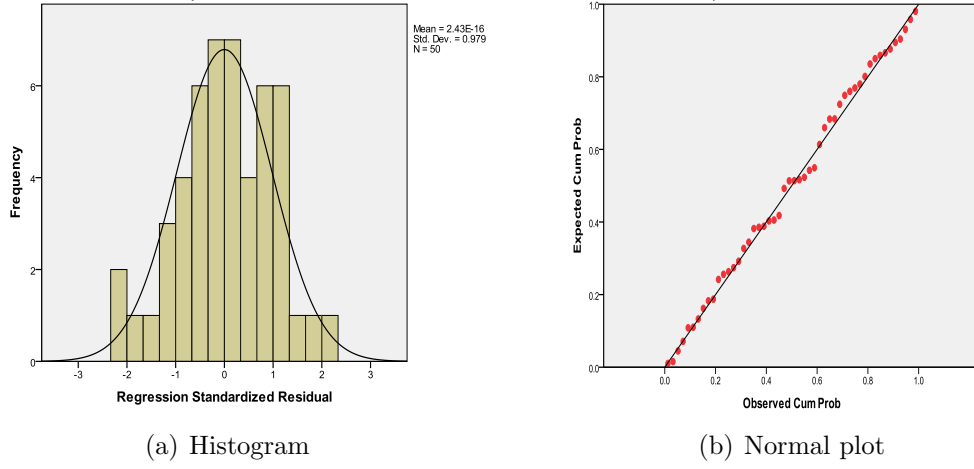


Figure 6.9: Histogram and Normal P-P Plot for dependent variable: creative.

This model accounts for only 18.4% of the variance in the level of creativity ratings. As such, it is not a very strong model compared with the others. The resulting regression function is given in equation 6.5.

$$Creative = 4.693 - (0.003 * Words) + (0.275 * Embed) \quad (6.5)$$

The other predictor variables were excluded from the model, as they were not significant. They include: number of images, scripts, links and objects.

Model for Predicting ‘Aesthetic - Unaesthetic’ Dimension

We also had a significant model (model 2) for predicting how aesthetic a Web page would be, $F_{(2,47)} = 12.113, p < 0.0005$; Adjusted R square = .312. Significant variables were Words (Beta = -.603 $p < 0.0005$) and Scripts (Beta = .266 $p = 0.037$). Therefore, the number of words and scripts is the least set of Web design features required to predict how aesthetic a Web page would be. The resulting regression function for predicting overall aesthetics is given by:

$$Aesthetic = 4.831 - (0.004 * Words) + (0.015 * Scripts) \quad (6.6)$$

This model accounts for 31.2% of the variance in the level of aesthetic ratings. This makes the current model better than the previous two models for predicting

fascination and creativity levels on a Web page. The regression coefficients and plots are shown in Figures 6.10 and 6.11 respectively.

Model Summary ^c									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.525 ^a	.276	.260	.61844	.276	18.255	1	48	.000
2	.583 ^b	.340	.312	.59646	.065	4.602	1	47	.037

a. Predictors: (Constant), Words

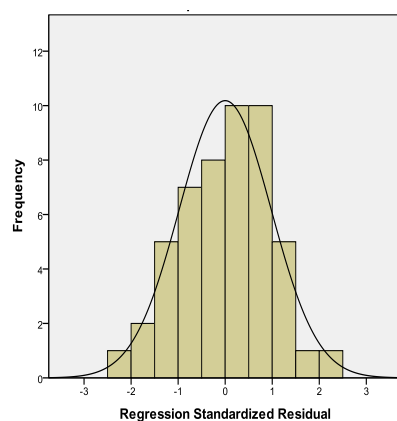
b. Predictors: (Constant), Words, Scripts

c. Dependent Variable: Aesthetic

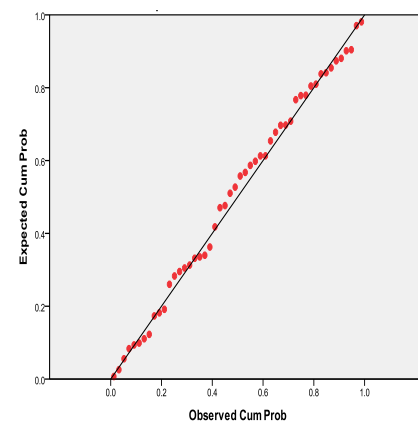
Coefficients ^a											
		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
							B	Std. Error	Beta	t	Sig.
1	(Constant)	5.033	.115		43.913	.000					
	Words	-.004	.001	-.525	-4.273	.000	-.525	-.525	-.525	1.000	1.000
2	(Constant)	4.831	.145		33.263	.000					
	Words	-.004	.001	-.603	-4.866	.000	-.525	-.579	-.577	.913	1.095
	Scripts	.015	.007	.266	2.145	.037	.088	.299	.254	.913	1.095

a. Dependent Variable: Aesthetic

Figure 6.10: Models and coefficients of regression for dependent variable: aesthetic.



(a) Histogram



(b) Normal plot

Figure 6.11: Histogram and Normal P-P plot for dependent variable: aesthetic.

6.2.3 Aesthetic prediction algorithm

The programming sequence for the EIVAA tool is presented in Algorithm 1:

Algorithm 1 Algorithm for predicting aesthetic quality and accessibility status

```

start
retrieve source code
preprocess HTML
get required HTML tags count (img, script, embed etc)
calculate and print cleanness score from regression equation
calculate and print pleasantness score from regression equation
calculate and print fascination score from regression equation
calculate and print creativity score from regression equation
calculate and print aesthetics score from regression equation
if cleanness score  $\leq 2.9$  then
    print likely low accessibility
    else if cleanness score  $\geq 3.0$  and  $\leq 4.9$  then
        print likely moderate accessibility
    else
        print likely high accessibility
    end
end
end

end

```

6.2.4 Testing regression models on training data

The five statistical models were tested on the training data set from the lab study in Chapter 4. This allowed us to evaluate the prediction performance of the EIVAA tool before conducting a further evaluation on a new set of homepages.

Predicting Cleanness

All 50 homepages were examined by the EIVAA tool for their visual cleanness. Figure 6.12 shows that the cleanness ratings from the tool mimics those of Web users. Recall that this model accounts for about 51% of the variances, which is why it performs well from the outset. If we consider the top and bottom peaks

in the chart or figure, we will observe that the cleanness ratings from the Web users span a wider range than those from the tool. Also, the ratings given by the users seem to be mostly higher than those of the tool. These outcomes can be traced to the constant in the regression function on which the tool is based. The model for predicting cleanness has a constant with the value 5.643. This value determines the range which the cleanness scores generated by the EIVAA tool can span. It also detects the highest possible cleanness rating a homepage can achieve. A scaling factor could easily be used to raise the possible rating up to 7 which was the maximum obtainable score in the lab-based study if need be.

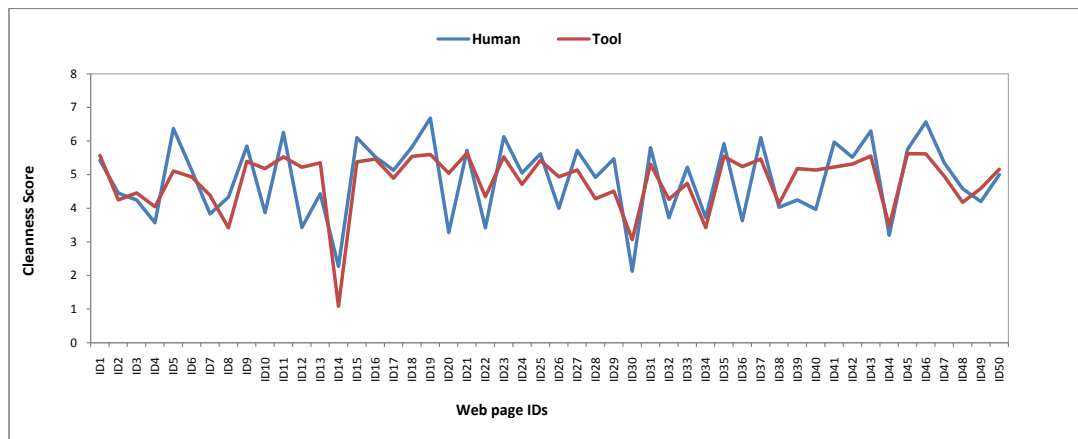


Figure 6.12: Human vs. EIVAA predictions on training data: clean.

Predicting Pleasantness

Unlike the cleanness case, the superimposed ratings of homepage pleasantness ratings generated by the EIVAA tool and those of its human counterparts are less closely knit. In Figure 6.13 we observe fewer cases of synchronized pleasantness scores. Once again, the ratings from the tool span a smaller range for the same reasons given in the cleanness case. Recall that the pleasantness model explains only 33.5% of the variances, which is why it performs in this manner. In the lab study involving actual Web users, it was also challenging to characterise pleasing visual designs. In other words, it was not exactly clear what moderated the participants' pleasantness ratings, as there seemed to be a combination of factors. It is not very suprising that this comes across in the performance of the EIVAA tool, as its models were generated from the ratings given by these users.

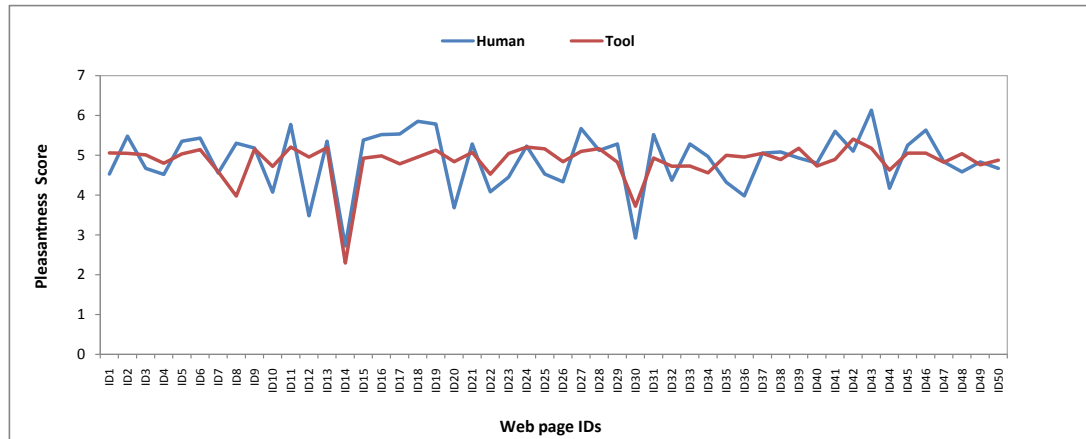


Figure 6.13: Human vs. EIVAA predictions on training data: pleasing.

Predicting Fascination

Figure 6.14 shows a superimposed chart of Web page fascination predictions performed by the EIVAA tool and ratings given by actual end-users. As was with the other two design dimensions, we observe that the ratings from the tool span a smaller range than those of the users. The model from which EIVAA makes these fascination level predictions accounts for only 20% of the variance, which is why the ratings of the tool deviate more from those of users than we observed in the previous two models. Predicting fascination in an automated fashion seems to be complex, given the level of subjectivity we also observed among Web users.

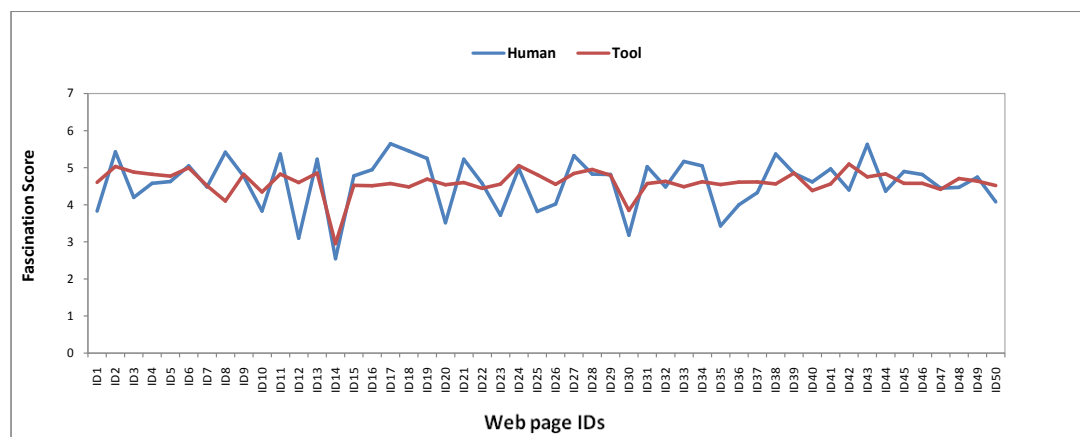


Figure 6.14: Human vs. EIVAA predictions on training data: fascinating.

Predicting Creativity

In Figure 6.15 we see a graph of EIVAA predictions on creativity and ratings previously given by Web users. The EIVAA creativity model explains only 18.4% of the variance which is why we see a huge difference in both aesthetic ratings.

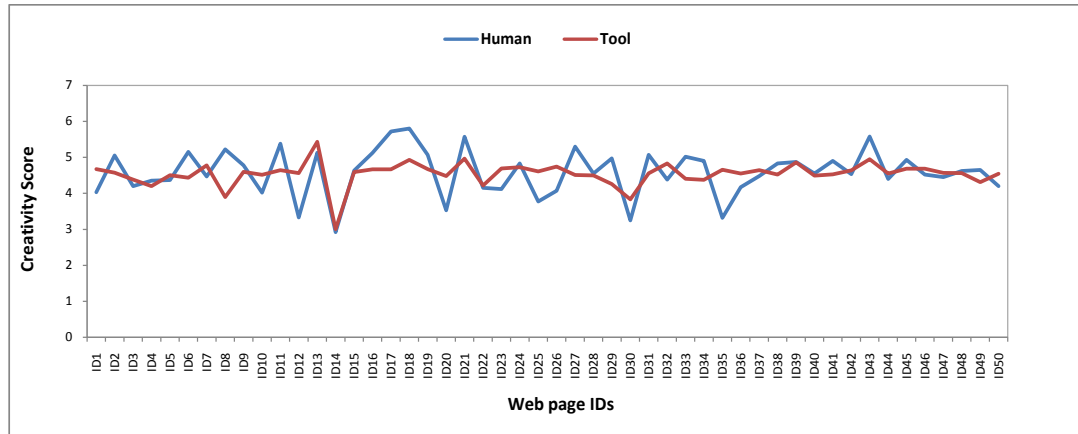


Figure 6.15: Human vs. EIVAA predictions on training data: creative.

Predicting Aesthetic Quality

EIVAA predictions on overall aesthetic quality and those of its human counterparts is shown in Figure 6.16. As the EIVAA aesthetic model accounts for

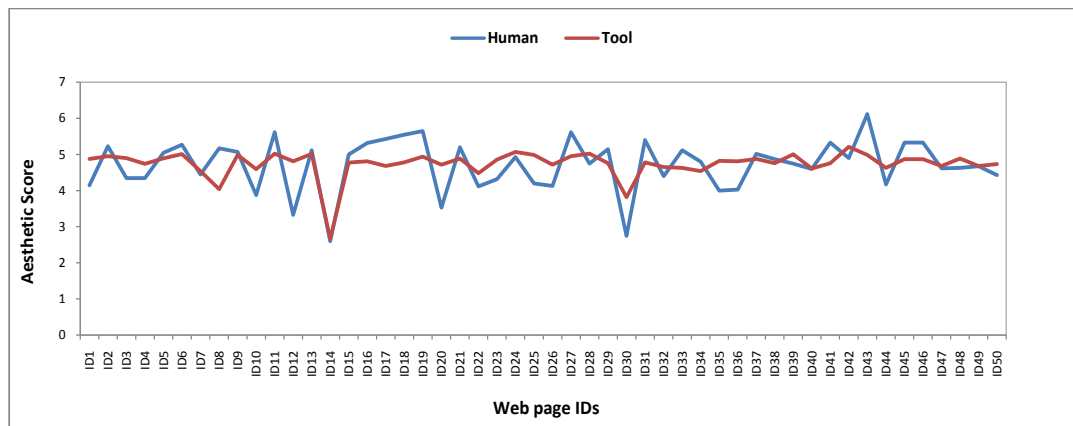


Figure 6.16: Human vs. EIVAA predictions on training data: aesthetic.

31.5% of the variance, we notice a few more synchronized aesthetic scores compared to the fascination and creativity case. Again, the scores generated from the tool span a smaller range for similar reasons explained before.

The models for predicting cleanness, pleasantness and overall aesthetic value account for more of their associated variances, and these three design dimensions originally belong to the classical wing of Lavie and Tractinsky [2004]’s bi-dimensional aesthetics framework. The models for predicting fascination and creativity levels account for less of their variances, and they belong to the expressive wing of the aforementioned framework. We had earlier mentioned that the latter class of designs were more subjective. As such, some of the unexplained variances may be due to personal differences among individuals. Since the EIVAA tool was trained on aesthetic ratings given by Web users, it also struggles in areas where there was greater disagreement among its human counterparts. This is why we see weak synchronization in the aesthetic predictions done by the EIVAA tool and users, especially along the expressive dimension. Of the five models generated, the strongest was that of cleanness as it explained approximately 51% of the variance. Accordingly, we observed low standard deviations on the cleanness ratings given by Web users in Chapter 4, suggesting that there was more agreement between participants along this dimension, and it came across here.

6.3 Summary

In this chapter, we have presented the EIVAA framework, along with the statistical models on which it is built. We also carried out an initial test of the framework’s predictive capabilities on our training data set. Our data shows that the EIVAA tool is able to predict visual cleanness better than the other dimensions, using image and word count on a Web page as predictors. We observed that the cleanness level predictions of the EIVAA tool closely mimicked the ratings given by users. However, we recorded tool-human rating deviations along the other design dimensions, especially for expressive aspects. It may be the case that the features we used here to characterise the affected design dimensions (which are more subjective) were not sufficient. As such, the associated models could not explain more of the variances. In the next chapter we evaluate the performance of the EIVAA tool on new test data. We also use a more quantitative evaluation approach to compare the predictions from the EIVAA tool with that of users.

Chapter 7

An Evaluation of the EIVAA Framework

This chapter reports a performance evaluation conducted for the EIVAA framework developed in Chapter 6. The intent of the chapter is to compare the predictive capabilities of the EIVAA tool with aesthetic judgements performed by its human counterparts on a task which involves evaluating the visual quality of Web pages along five design dimensions. The chapter is divided into three main sections as follows: section i) describes an on-line study where Web users were asked to evaluate a set of homepages based on their visual aesthetic quality. The Web pages used here are different from the ones used in previous chapters of this thesis; section ii) demonstrates the use of the regression models (built into the EIVAA tool) to make predictions on the same set of Web pages used in (i) above. This new prediction scenario allows us to examine the robustness of the statistical models on which the EIVAA framework is built; section iii) presents a comparison between the ratings done by Web users in (i) and the EIVAA tool in (ii). The results are reported using superimposed graphs showing task performance curves for Web users and the EIVAA tool, as well as a correlation analysis which investigates the relationship between the two sets of aesthetic judgements.

7.1 On-line Study

This section describes a study conducted over the Web to elicit users' opinions on the visual quality of selected Web pages. The results obtained will be compared with aesthetic predictions done by the EIVAA tool in subsequent sections.

7.1.1 Participants

A total of 202 people visited our study Website and attempted to start the experiment. However, only 137 participants had valid entries. Valid entries represent those from participants who completed the experiment, and were without any reported visual impairments. There were 76 male and 61 female participants. The participants were frequent Web users, except for one person who used the Web occasionally. Two people answered ‘Yes’ to the colour-blindness question, and as we did not have a chance to ascertain the nature or the severity of the impairments claimed, their data were not included in the analysis. Forty-eight (48) of the participants did not have English as their first language, while 89 were native speakers. Participants were recruited via mailing lists within the University of Manchester and the larger community. There were 123 student participants, 12 professionals and 2 people who had other types of occupation not specified in our questionnaire. Since the study was available on-line, participants could carry out the experiment at a convenient time, using their own equipments and space. Consequently, the study participants were not paid for giving their time.

7.1.2 Stimuli

Ten (10) homepages were randomly selected from the top 101-200 Websites in the United Kingdom (UK) as ranked by Alexa¹. We had used a sample from the top 100 in our previous studies (Chapters 3, 4, and 5), and so we wanted an entirely new set of Web pages for the current study. All the homepages were downloaded on the 10th of November, 2011. Due to ethical issues surrounding phishing, we could not upload the live pages for the study. Instead, screenshots of the respective homepages were displayed in colour to the participants. The homepages represented a variety of visual designs. Screenshots of the Web pages, their study ID number, and respective Web addresses are in appendix D.

7.1.3 Task and procedure

The welcome page of the experiment’s Website conveyed the aim of the study, as well as the instructions. There was also a consent section, and participants were expected to click the ‘I agree’ button only if they wished to participate. The task

¹<http://www.alexa.com/topsites/countries/GB>

was to look at homepages selected randomly from a pool of 10 Web pages and rate them with respect to their visual quality. The participants were asked to look at a Web page for 4 seconds, after which another Web page appeared instructing them to rate the homepage they had just seen accordingly. As we were interested in their visceral level responses, we did not allow them to continue to look at the Web page while evaluating the page in question. There was no need for the study participants to rate twice since the homepages were randomised. The same 7-point Likert scale and design dimensions (i.e. clean, pleasing, fascinating, creative and aesthetic) used in the lab-based study in Chapter 4 were employed.

7.1.4 Results

Means and standard deviations were computed for each of the 10 homepages based on the participants' ratings, given the 5 design dimensions. This allowed the Web pages to be ranked under the different aesthetic dimensions. Table 7.1 shows the ratings. The higher the mean score, the higher the Web page ranking for the design dimension. In general, if a homepage was given a high rating for one design dimension, it was likely to get a high rating across the other design dimensions and vice versa, suggesting a positive relationship between the design dimensions. The same was observed in previous studies reported in Chapter 4.

Table 7.1: Participants' aesthetic ratings for the evaluative study

Web page	PageID	Clean		Pleasing		Fascinating		Creative		Aesthetic		Familiarity	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
192.com	ID1	5.26	1.44	4.26	1.31	3.41	1.29	3.38	1.32	3.91	1.28	2.44	1.82
Go.com	ID2	2.93	1.35	3.07	1.28	3.09	1.28	3.24	1.24	2.77	1.13	1.83	1.44
Ikea	ID3	5.33	1.52	4.69	1.30	3.79	1.43	3.36	1.37	4.34	1.20	4.29	1.85
isohunt	ID4	3.27	1.47	3.06	1.23	2.87	1.26	2.99	1.27	2.81	1.11	2.47	1.97
Istockphoto	ID5	5.05	1.35	5.02	1.04	4.42	1.35	4.46	1.36	4.62	1.22	2.42	1.72
mailchimp	ID6	5.97	0.95	5.80	1.10	5.27	1.22	5.19	1.35	5.55	1.05	2.11	1.73
Mashable	ID7	2.96	1.38	3.68	1.16	3.76	1.26	3.76	1.11	3.35	1.18	2.39	1.80
Sourceforge	ID8	4.67	1.42	4.24	1.31	3.75	1.40	3.77	1.27	3.97	1.25	2.93	2.13
squiddo	ID9	5.37	1.24	5.09	1.08	4.59	1.31	4.39	1.29	4.74	1.15	2.17	1.62
Talktalk	ID10	4.14	1.56	4.71	1.31	4.46	1.26	4.51	1.17	4.42	1.18	3.75	1.96

Participants were most familiar with ID3 and ID10 which represent a popular household items retailer and mobile service provider respectively. They gave mostly low familiarity ratings to the other homepages investigated. A correlation analysis between their aesthetic judgements and their levels of familiarity showed

no significant relationships between the two. Consequently, we can say that their ratings here were not tainted by familiarity. Figures 7.1 and 7.2 show examples of the best and the worst homepages in terms of their visual quality:

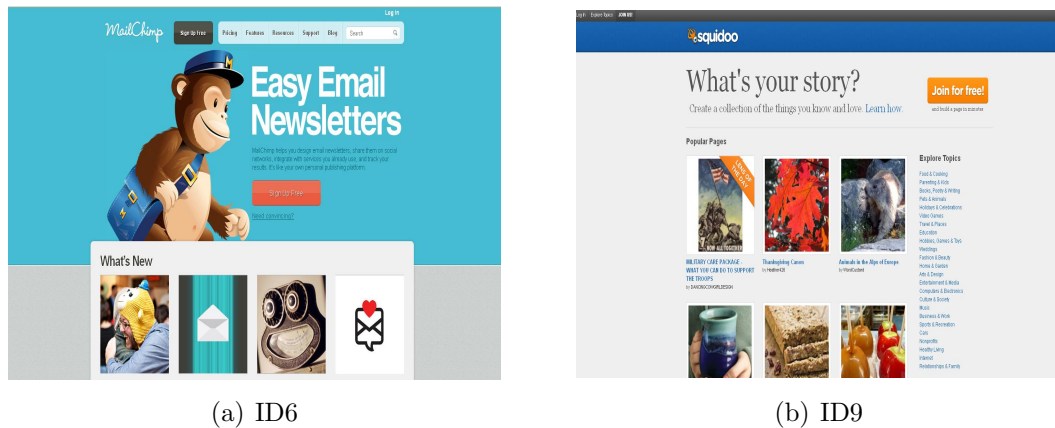


Figure 7.1: Screenshots of Web pages with the best visual quality.

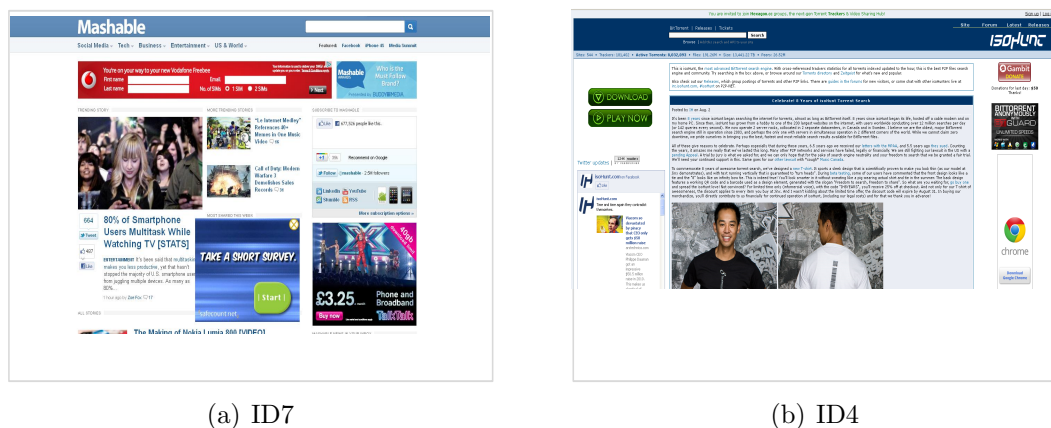
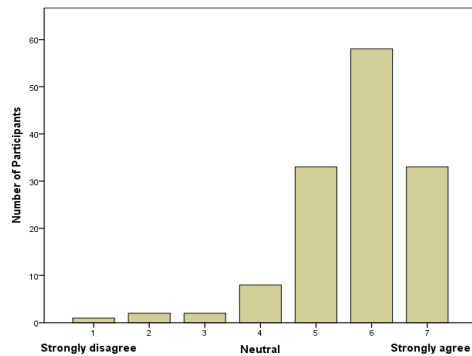


Figure 7.2: Screenshots of Web pages with the worst visual quality.

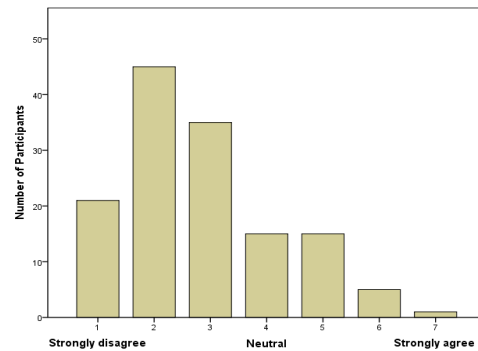
The best homepages were those that had a balance in their image and text usage, while homepages with clutter arising from heavy segmentation or text usage came across as being unappealing. Across our studies, we observe that clarity in visual design seems to be a strong moderator of aesthetic preferences.

7.1.5 Feedback

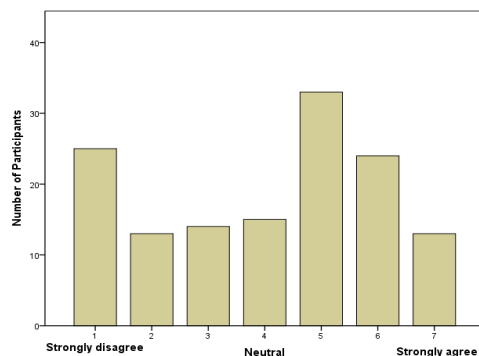
The participants were also presented with some statements on aesthetic perception, and asked to state their level of support or disagreement accordingly. The statements had to do with the influence of the following on aesthetic preference: images, text, animations, simplicity in design, colour, structural arrangements or layout, familiarity and meaningfulness of design. From the after task discussions in previous chapters we gathered that these features played significant roles in moderating participants' judgements. As such, we were interested in the consistency of our observations. Figure 7.3 shows their responses to the statements.



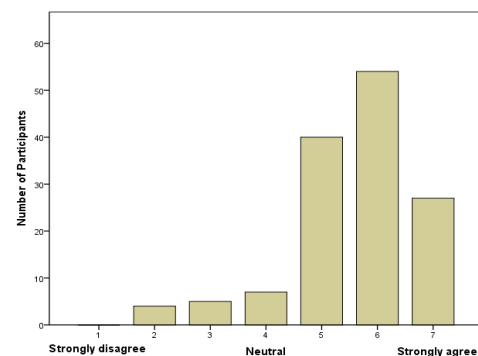
(a) S1: I find Web pages with images or graphics to be visually pleasing.



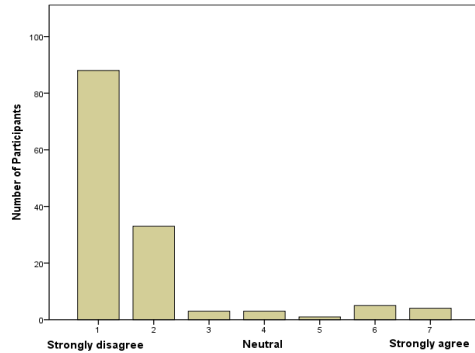
(b) S2: I find Web pages with a lot of text or writing to be visually pleasing.



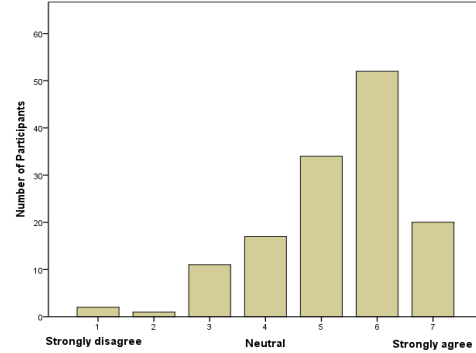
(c) S3: I find Web pages with animations or moving images/graphics to be visually pleasing.



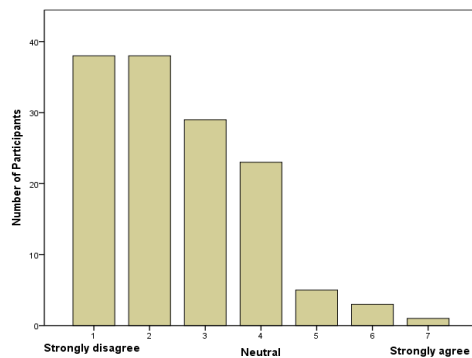
(d) S4: I find simple Web pages to be visually pleasing.



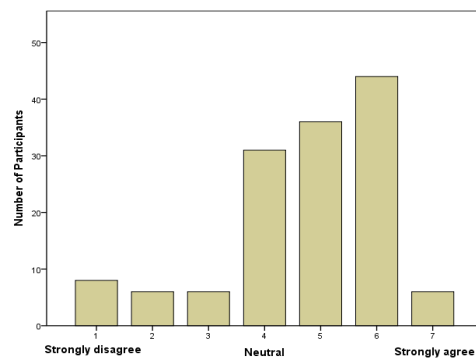
(e) S5: I find **poorly** structured Web pages to be visually pleasing.



(f) S6: I find Web pages I like to use to be visually pleasing.



(g) S7: I find Web pages with **no** use of colour to be visually pleasing.



(h) S8: I find Web pages that are meaningful to be visually pleasing.

Figure 7.3: Attitudinal responses of participants to statements on Web aesthetics

When compared with our previous study in Chapter 4, the aesthetic behaviours of our participants are quite similar. The results meet our expectations again, except for the animation case. The participants agreed that Web pages with images, low text count, simple designs, good structure, some colour, meaningful designs and ones which they were fond of are pleasing. Participants seemed to be divided on whether or not the use of animations on a Web page increases aesthetic pleasure (see sub-graph (c)). This was the case also in the study reported in Chapter 4. Although, movement in Web interfaces allows for a more engaging experience, our data suggests that when it is overdone some users may not find it appealing.

7.2 EIVAA Predictions

Here we present results on the tool’s predictive capabilities given the same set of Web pages used in the on-line study we have just described in the previous section. The tool relies on regression equations which capture salient Web design features found (in Chapter 4) to influence aesthetic judgements.

7.2.1 Task and procedure

The Web pages to be evaluated were uploaded onto the Web Ergonomics Lab server, and the generated urls for each of the 10 homepages were submitted to our tool. Their aesthetic and accessibility scores were generated by the tool and noted down for comparison with ratings given by Web users in the on-line study.

7.2.2 Results

Table 7.2 shows the aesthetic ratings given to the 10 homepages by the EIVAA tool. It also shows accessibility information for the Web pages. The accessibility status is derived from information on the level of cleanness or clarity of the visual design. We had established in the previous chapter that design cleanness was a good proxy measure for non-visual accessibility.

Table 7.2: Aesthetic predictions from the EIVAA tool

Web page	PageID	Clean	Pleasing	Fascinating	Creative	Aesthetic	Accessibility
192.com	ID1	5.45	5.06	4.66	4.63	4.89	high
Go.com	ID2	4.94	4.88	4.57	4.79	4.75	high
Ikea	ID3	4.49	5.05	4.61	4.66	4.88	moderate
isohunt	ID4	4.28	4.35	4.28	4.16	4.33	moderate
Istockphoto	ID5	5.30	5.14	4.79	4.61	4.97	high
mailchimp	ID6	5.35	5.05	4.68	4.60	4.89	high
Mashable	ID7	3.93	5.25	5.43	4.47	5.17	moderate
Sourceforge	ID8	5.18	5.11	4.83	4.54	4.96	high
Squidoo	ID9	5.32	5.16	4.87	4.56	5.00	high
Talktalk	ID10	4.10	4.38	4.39	4.10	4.38	moderate

Most of the Web pages achieve high scores for cleanness compared to the other design dimensions. This can be attributed to the value of the constant in the regression equations. The model for predicting cleanness has the highest. We also notice that the values on the clean design dimension span a wider range

compared with the aesthetic ratings for the other dimensions. It seems the model for predicting visual cleanness discriminates between Web pages in a more distinct fashion. The number of images and text quantity are the major contributing aesthetic factors considered in the cleanness model. Most Web pages have distinct amounts of these features. Other design dimensions (e.g fascinating and creative) which are characterised by Web design features like number of scripts or embedded content, because these features allow for the delivery of interactive and more sophisticated Websites, make use of only a handful of these features per time. For example, several Web pages could use a single embed tag to deliver a main effect. As such, the predicted aesthetic quality of these Web pages along the creative line would be similar or span the same range. The results also show that the Web pages randomly selected for this study have predicted accessibility status levels which range from moderate to high. Since accessibility is predicted from visual cleanness, we see that higher values of visual cleanness would mean the Web pages have a higher possibility of being accessible. Achieving high accuracy predictions for the ‘clean’ dimension is therefore important for accessibility predictions.

7.3 EIVAA Versus Gold Standards

Here we compare aesthetic ratings given by actual Web users and those generated by the EIVAA tool. The relationship between the two sets of aesthetic judgements is also explained using Pearson correlation for a more quantitative analysis.

7.3.1 Cleanness prediction

Figure 7.4 shows the tool’s prediction of visual cleanness superimposed with that of Web users. Apart from ID2, where both aesthetic ratings differ, the results from the EIVAA tool closely mimic those of Web users. ID2 misleads the EIVAA tool because it does not have an overwhelming amount of text or images, but Web users perceive it to be cluttered because of heavy use of segmentation. When the raw values for cleanness in Tables 7.1 (humans) and 7.2 (EIVAA) are compared, we find that the scores span a wider range in the aesthetic ratings given by humans. This is because users rated the homepages using a wider scale which ranged from 1 to 7. The regression models generated have a slightly lower upper bound because of the constant value in the regression equation. This can easily be normalized by using a scaling factor to raise the maximum achievable score.

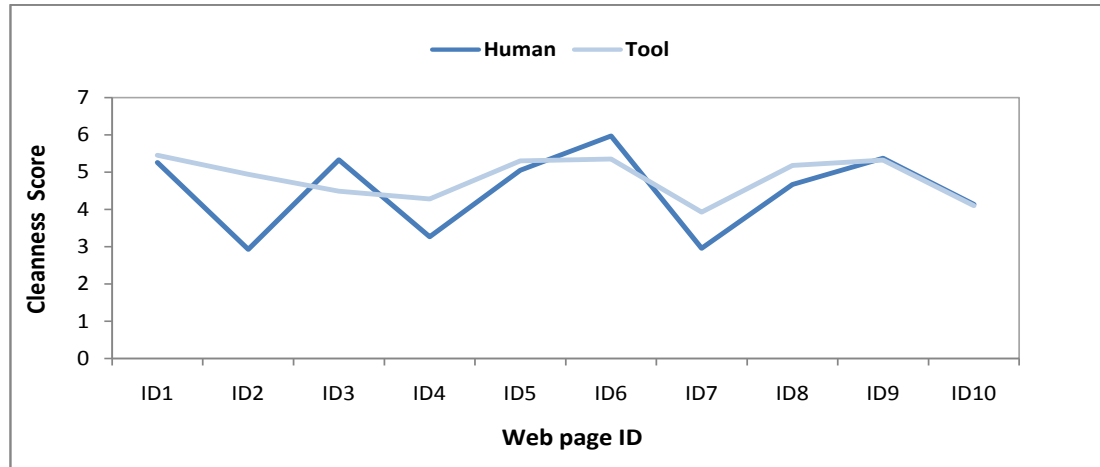


Figure 7.4: EIVAA versus humans on cleanliness prediction

7.3.2 Pleasantness prediction

Figure 7.5 shows the tool’s prediction of visual pleasantness compared with that of its human counterparts. The EIVAA tool deflects from ratings given by Web

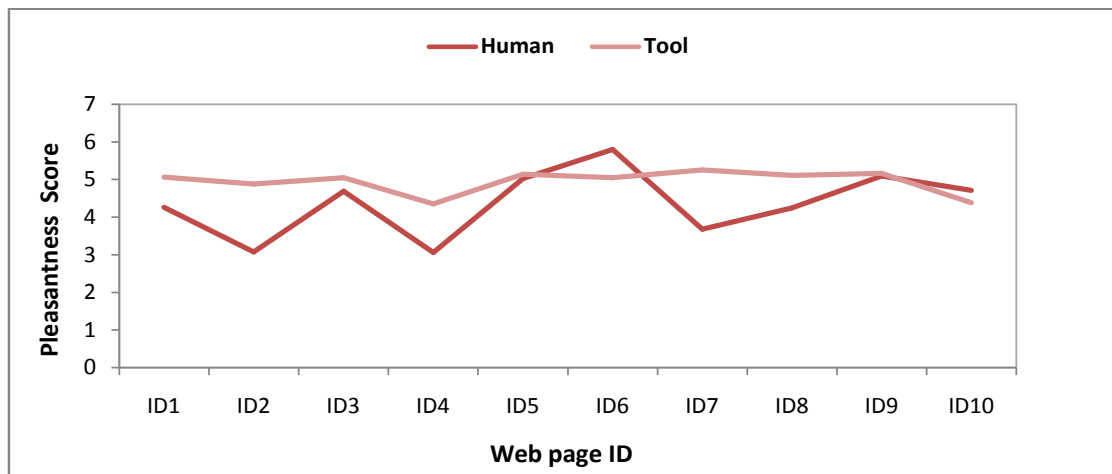


Figure 7.5: EIVAA versus humans on pleasantness prediction

users for a number of pages. This depicts a weaker model than the one described in the cleanliness case aforementioned. It may be the case that attempting to model pleasantness poses a difficult exercise because of subjective variables that cannot be accounted for using measurements of scripts and text quantity in HTML content. In the empirical study in Chapter 4 we had established that

‘pleasing’ was a rather ambiguous aesthetic terminology, and it is not clear what moderates the aesthetic judgements of Web users along this design dimension. Cleanness seems to be a less subjective design dimension as shown here again.

7.3.3 Fascination prediction

Figure 7.6 shows results of the tool’s prediction of fascination levels using the new test data. It reveals a similar curve like the one in the pleasantness scenario.

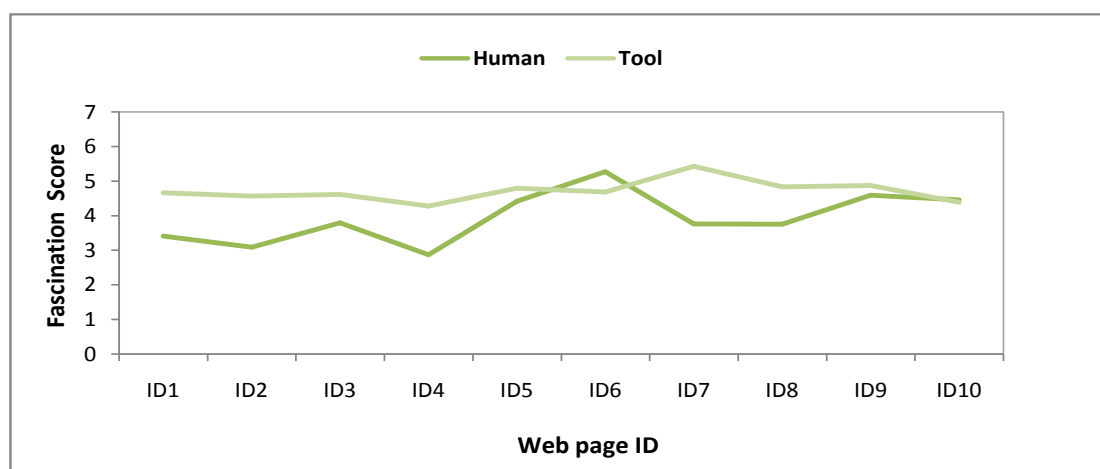


Figure 7.6: EIVAA versus humans on fascination prediction

This model relies on the amount of text and scripts present in the HTML code to rate Web pages. These parameters are the same ones used in the prediction of pleasantness with the only difference being the constant variables in their equation. As such, it is easy to see why their results are similar.

7.3.4 Creative prediction

Figure 7.7 shows the results of tool’s prediction of creativity using the new test data as it compares with those of Web users. We had observed in the empirical studies conducted in Chapter 4 that this design dimension benefits greatly from animations and other forms of movements in the interface. It was interesting to see accordingly that the number of embeded content present on a Web page appeared as one of the predictors for this design dimension. The graph however shows a rather weak relationship between the two sets of aesthetic ratings.

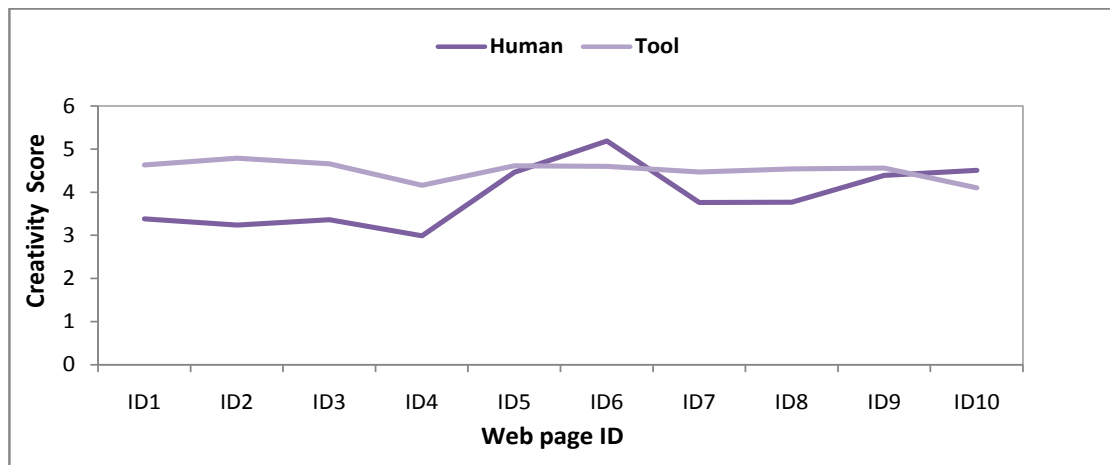


Figure 7.7: Humans versus EIVAA on creativity prediction

7.3.5 Aesthetic prediction

Figure 7.8 shows the results of the tool's prediction of overall aesthetic quality compared with ratings given by Web users. Once again it seems the features are not entirely sufficient to inform the tool regarding the quality of that Web page along this dimension because of its subjectivity.

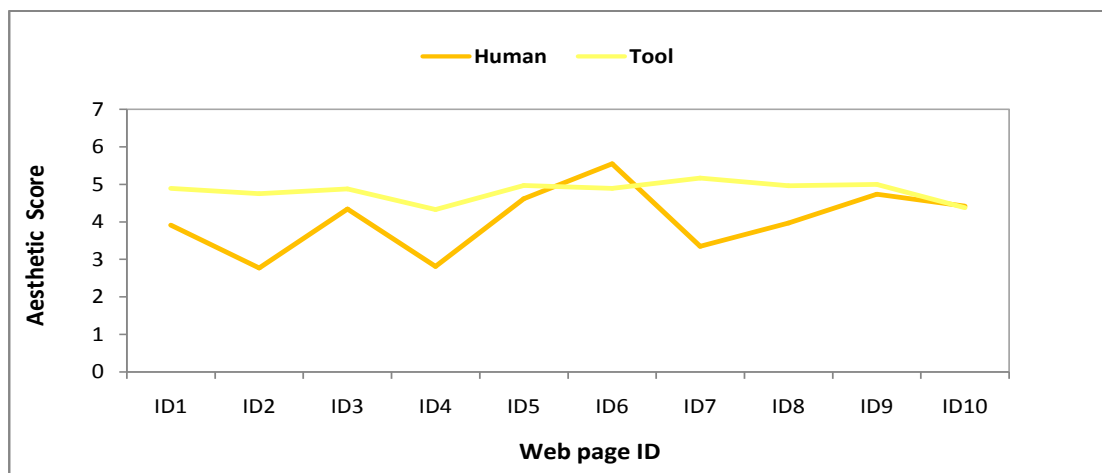


Figure 7.8: Humans versus EIVAA on aesthetics prediction

Table 7.3 shows a Pearson correlation analysis performed between the aesthetic ratings given by actual Web users and that done by the EIVAA tool.

Table 7.3: Correlation between aesthetic ratings given by users and that of the EIVAA tool. Headings with ‘T’ appended indicates aesthetic ratings from the tool

r	Clean	Pleasing	Fascinating	Creative	Aesthetic	CleanT	PleasingT	FascinatingT	CreativeT	AestheticT
Pearson’s coefficient										
Clean	1.000	0.886 ^a (p = 0.001)	0.674 ^b (p = 0.032)	0.560 (p = 0.092)	0.882 ^a (p = 0.001)	0.669 ^b (p = 0.034)	0.384 (p = 0.274)	- 0.066 (p = 0.856)	0.300 (p = 0.399)	0.300 (p = 0.400)
Pleasing		1.000	0.933 ^a (p = 0.000)	0.856 ^a (p = 0.002)	0.998 ^a (p = 0.000)	0.460 (p = 0.181)	0.349 (p = 0.322)	0.088 (p = 0.808)	0.139 (p = 0.701)	0.308 (p = 0.386)
Fascinating			1.000	0.973 ^a (p = 0.000)	0.938 ^a (p = 0.000)	0.303 (p = 0.394)	0.286 (p = 0.423)	0.194 (p = 0.592)	0.027 (p = 0.942)	0.280 (p = 0.433)
Creative				1.000	0.865 ^a (p = 0.001)	0.300 (p = 0.400)	0.202 (p = 0.575)	0.170 (p = 0.640)	- 0.045 (p = 0.903)	0.206 (p = 0.568)
Aesthetic					1.000	0.453 (p = 0.189)	0.323 (p = 0.363)	0.068 (p = 0.851)	0.117 (p = 0.747)	0.282 (p = 0.429)
CleanT						1.000	0.483 (p = 0.157)	- 0.029 (p = 0.936)	0.625 (p = 0.053)	0.383 (p = 0.275)
PleasingT							1.000	0.794 ^a (p = 0.006)	0.771 ^a (p = 0.009)	0.991 ^a (p = 0.000)
FascinatingT								1.000	0.340 (p = 0.336)	0.870 ^a (p = 0.001)
CreativeT									1.000	0.702 ^b (p = 0.024)
AestheticT										1.000

a - significant at the 0.01 level (2-tailed) and b - significant at the 0.05 level (2-tailed).

The aesthetic predictions done by the EIVAA tool have the letter ‘T’ appended in order to distinguish them from those ratings given by Web users. The underlined values in Table 7.3 show the intersection of these two aesthetic ratings of interest. For example, the relationship between the two ratings (human,tool) for the design dimension ‘clean’ can be found at the intersection ‘(clean, cleanT)’. Recall that the main objective of this study is to compare aesthetic ratings given by the EIVAA tool with those given by humans. The study reveals that although the tool closely mimics human aesthetic preference, it performs best for the model which accounted for most of the variance (that is the ‘clean’ model). Significant correlations were obtained for ratings given by humans and the EIVAA tool ($r = 0.669$, $p = 0.034$ when a tenth of the words on a Web page is used) as we can see in Table 7.3. We obtain even stronger correlations ($r = 0.703$, $p = 0.023$) with the full word count taken into account on cleanness level prediction. In Chapter 4 we also found that participants tended to agree with each other along this design dimension. The lower standard deviation values attest to this. It is also important to remember that the statistical models on which the EIVAA tool is based were derived from the aesthetic ratings given by users in the first place. It seems then that the clean dimension is one which is more objective in nature, compared with the other design dimensions investigated here. In other words, the properties which describe this class of designs can easily be operationalized. In our case, the amount of text and images on a Web page sufficed.

For the remaining aesthetic dimensions (i.e pleasing, fascinating, creative and aesthetic), the judgements performed by humans and those done by the tool were not significantly correlated. The design dimension with the least human-tool correlation was ‘creative’ with $r = -0.045$, $p = 0.903$. In the user studies on aesthetic perception (Chapter 4), we had established that Web pages with heavy animations are creative. Consequently, we modeled the creative design dimension with the number of embedded content and amount of text present on a Web page. Our results show that these features were not sufficient to predict this rather complex design dimensions. Similar observations were made for the other design dimensions in Figures 7.5 to 7.8. Since the statistical models on which the EIVAA tool is based were generated from aesthetic ratings done by Web users, we believe that there may be several factors which contribute to the aesthetic preferences of users along these four dimensions. For the EIVAA tool to make more accurate predictions these external features will have to be modeled in some fashion. It

could also be the case that these factors are too subjective to be accounted for using a statistical model. A Web user may consider a design to be fascinating or creative for some very personal reasons we may never be able to elicit. A similar concern is raised in [Lindgaard and Dudek, 2003] where the authors attempt to understand user satisfaction in the context of the Web. External influences are inevitable in studies involving users, as humans are complex beings, with complex preference patterns. Related studies where computational aesthetics is investigated consider design dimensions such as balance, symmetry, equilibrium, density (e.g [Bauerly and Liu, 2006; Zheng et al., 2009]). These aspects of design aesthetics are more straightforward to operationalize. Our work attempts to quantify some of the subjective aesthetic dimensions from [Lavie and Tractinsky, 2004]’s work using Web design features as a basis for classification. The high correlations of the EIVAA tool and aesthetic ratings done by users on the clean dimension further boosts our confidence on the accessibility status predictions. We had established in Chapter 5 that cleanness was the only aesthetic dimension which is related with non-visual accessibility. Accordingly, cleanness was used as a basis for accessibility status predictions in the EIVAA tool.

7.4 Summary

An evaluation of the EIVAA tool has been presented using a new set of Web pages. This was achieved by comparing the tool’s aesthetic predictions with judgements performed by Web users. We observed that if a Web page received high ratings for one dimension it was likely to receive similar ratings for the other dimensions and vice versa. This was observed for both humans and the tool. The EIVAA tool was particularly capable of measuring aesthetic quality in a similar fashion as humans when it came to visual cleanness. The other four design dimensions were more complex to model because of subjective variables that cannot really be accounted for. It is easy to see why these design dimensions are mostly investigated via subjective means in the literature. Most researchers resort to sampling the opinions of Web users only when it comes to design dimensions like the ones we have investigated here. Furthermore, the strong positive relationships between the EIVAA tool and Web users ratings for visual cleanness established in this chapter further confirms cleanness as a suitable proxy measure for accessibility, since cleanness can objectively be determined by humans and an automated tool.

Chapter 8

Conclusion and Future Work

This thesis successfully investigates the link between Web aesthetics and accessibility, and goes on to demonstrate how the aforementioned relationship affects Web users with visual impairments. The need to dispel some of the common misconceptions surrounding these two Web constructs (i.e. aesthetics and accessibility) through the use of empirical evidence was a key motivating factor for undertaking the research described in this thesis. The work directly addresses the most common myth which is the belief by some in the Web community that fancy visual designs hamper accessibility. Some Web designers believe in turn that the accessibility initiative limits their ability to create sophisticated designs. The subtle tension between these two ‘schools of thought’ has contributed to the slow turnaround the Web community has experienced in the area of accessible designs. Many Web designers are yet to imbibe the accessibility culture. Furthermore, a critical survey of the existing literature revealed that while there has been a lot of controversy regarding the use of visual aesthetics and its impact on Web experience for people with visual impairments, very little empirical work has been done. In this thesis we had set out to answer three research questions:

8.1 Aesthetic Judgements

The first question was to enable us to investigate how users classify Web designs and to elicit the factors which moderate their aesthetic judgements. In particular, we were interested in understanding what informs users about the visual quality of Web pages when they have to judge based on certain design dimensions such as *clean*, *pleasing*, *fascinating*, *creative* and *aesthetic* as defined in Lavie and

Tractinsky [2004]’s bi-dimensional framework. Our findings confirm that there are several factors which influence the way users judge the visual quality of Web pages. For each of the visual design dimensions investigated, there were certain indicator properties possessed by Web pages which users relied upon to make their aesthetic judgements, and these properties varied depending on the design dimension being evaluated. For example, a less-dense compositional structure was important for rating a Web page as being clean, while the use of animations was more important for rating a Web page as being fascinating or creative. The properties were used for defining a more objective metric for Web aesthetics.

8.2 Web Aesthetics and Accessibility

The second question was to enable us to uncover the link between Web aesthetics and accessibility. The research work reported in this thesis is a novel attempt to examine the relationship between Web aesthetics and accessibility within a bi-dimensional (classical and expressive) aesthetics framework proposed by [Lavie and Tractinsky, 2004]. Our data reveals the link between the two Web constructs to be a rather complex one, with associated conditionalities that play an important role especially when describing the effect of the relationship on Web users with visual impairments. Our results vary along two lines across studies. For example, in the preliminary study which laid a foundation for the research, significant correlations were observed between the design dimensions ‘clean’, ‘clear’, ‘organised’ (classical aesthetics) and accessibility. This class of Web designs are characterised by their simplicity and minimalism. They address clarity in form rather than appeal or affective aspects of Web designs. The other design dimensions investigated, ‘beauty’ and ‘interesting’ (expressive aesthetics) showed no significant relationship with accessibility. The latter class of designs are more subjective, largely influenced by the imaginative powers of the designer.

Our follow up studies also led to similar results, given different experimental setups. The only design dimension which consistently showed significant relationships with accessibility was visual *cleanness*. We would recall that ‘cleanness’ is a classical aesthetic notion. Visually clean Web pages had fewer accessibility barriers and therefore better accessibility indexes. We established that the small amount of HTML content (e.g. images, links, text, scripts) required to build visually clean Web pages was responsible for this outcome. A Web page with a

simple HTML code base is more likely to have fewer accessibility issues, because the Web designer typically has fewer bytes of code to mind. This is simply a case of moderation in design having a ripple effect on functionality in a positive fashion, and/or too much of a thing not being very helpful. It may be this simplicity or moderation that the design community struggles with or mis-understands sometimes. It is commonly believed that accessible Websites are boring, because of the perceived minimalistic undertone to their designs. Many Web designers fail to see simplicity as an aesthetic notion [Karvonen, 2000].

On the contrary, we do not suggest that the absence of any significant correlations of a positive nature between expressive aesthetics and accessibility automatically means that sophisticated visual designs are a problem to non-visual accessibility. Since we did not observe any significant correlations between expressive Web designs and accessibility, we speculate that this relationship could swing in either direction, and further studies would be required to draw any meaningful conclusions across related studies. Consequently, this does not rule out the possibility of creating fancy and yet accessible Web pages. Our data in this thesis only shows this to be less the case presently. Expressive designs may not necessarily be a barrier to accessibility. However, the relationship between classical aesthetic dimensions and functionality is more consistently established across studies. The literature reveals similar outcomes in sister cases regarding the link between Web aesthetics and usability. Recent studies which adopt the bi-dimensional aesthetics framework also found that Web pages which users perceive to be classically aesthetic were easier to use, while pages which were perceived to be more expressive in their designs came across as being difficult to use. We envision that our findings will give the Web community a more holistic understanding of the interactions between aesthetics and accessibility.

8.3 Proxy Measure for Accessibility

The third and final objective of this research was to develop a software tool which is capable of analyzing the visual appearance of a Web page and using that information to make predictions about the accessibility status of the page. Such a system is desirable as it could help to provide rough estimates of functionality issues, before actual user evaluations are employed. Accordingly, the EIVAA tool was developed. The tool is built on the premise that the way a Web page looks

could be used to predict how easy or difficult Web users would find the Web page in question. In this thesis we established that there is a significant correlation between cleanness in visual design and accessibility. Consequently, design cleanness was used as a proxy measure for accessibility status in the EIVAA framework. The EIVAA tool is built on statistical models which are capable of predicting visual quality by taking into account salient Web page features which influence aesthetic preference. These features were carefully elicited from aesthetic judgements made by 180 Web users in two different studies. An evaluation of the predictive capabilities of the EIVAA tool on an entirely new set of Web pages showed that the EIVAA tool is capable of performing predictions in a way that mimics its human counterparts. A correlation analysis of the relationship between the aesthetic ratings done by humans and that of the tool confirms this. In particular, strong positive correlations were observed between the two sets of ratings along the ‘clean’ dimension. This further boosts our confidence on resulting accessibility status predictions. We envision that this tool will help inform Web developers of the implications of their designs. In summary, this work contributes to efforts that seek to advance an inclusive Web in the following ways:

- It provides an extensive review of existing research in Web aesthetics and accessibility. The review uncovers the prevailing paradigms and experimental approaches employed by researchers in the field, together with their limitations. As a way forward, the review also suggests some best practices and future directions for the research community. The work described in this thesis is a direct response to a critical gap found in the literature.
- It reports empirical studies in which the aesthetic preferences of Web users were elicited, together with design features which moderated those preferences. It then demonstrates how those Web design features could be used to predict aesthetic pleasure in a more objective fashion using statistical models. The existing literature tends to report more subjective approaches.
- It provides empirical evidence on the interplay between Web aesthetics and accessibility. Closely related studies are either non-empirical or do not employ widely validated Web aesthetic frameworks. Our work extends related studies by adopting an empirical approach which involved several user studies and a widely validated framework for describing perceived Web aesthetics (i.e. [Lavie and Tractinsky, 2004]’s framework) respectively.

- It also demonstrates how the visual appearance of a Web page could be used to make predictions about its accessibility status. Previous studies evaluate the two Web constructs in question in isolation. It is common to find tools which evaluate the visual quality of Web pages using certain computational formulations, or automated accessibility checkers which examine the accessibility levels of Web pages based on the conformance of the underlying HTML source code to Web accessibility guidelines. However, to the best of our knowledge, there are no tools capable of giving proxy accessibility status information based on the visual appearance of Web pages.
- Finally, our research data has been published in an open fashion via technical reports, as well as through various competitive peer-reviewed channels. We believe that this will facilitate the replication of our research results if required, and foster data sharing. An index of the associated technical reports is available in Appendix E, while a list of publications is outlined in Section 1.3 of the introductory part of this research thesis.

8.4 Future Work

As this thesis represents a first attempt to empirically explain the interplay between Web aesthetics (as defined in Lavie and Tractinsky [2004]) and accessibility, there is still room for improvement and expansion of the ideas presented here. Regarding the aesthetic dimensions investigated, we had selected a few adjectives which we considered semantically disparate from Lavie and Tractinsky [2004]’s framework. Further work which looks at extending the ideas presented here to cover the full range of aesthetic adjectives used in their framework or indeed other aesthetic frameworks mentioned in the literature (e.g [Wang et al., 2010; Moshaugen and Thielsch, 2010]) might help reveal other aspects of Web aesthetics which have a link with accessibility. This could further inform the Web community regarding classes of visual designs that are more likely to be accessible.

Furthermore, we concluded that the relationship between Web aesthetics and accessibility is more complex than what is reported in related studies. For example, looking at Web aesthetics from a “bi-dimensional” view point, helped to bring to light some interesting outcomes regarding its relationship with accessibility. Also, we had mentioned the issue of cultural dependency and its influence

on aesthetic choices. This is another factor which could be investigated. Consequently, there may be several other external factors moderating this relationship which we did not investigate. Some other factors worth investigating include:

- **The designer's technical background:** It would be interesting to investigate the relationship between Web aesthetics and accessibility, while taking into consideration the background of the designer. We speculate that professional Web developers would be more inclined to develop Websites that are both visually pleasing and accessible. On the other hand, an amateur may be more excited about sophisticated designs than inclusiveness. It is not exactly clear if this is the case. Furthermore, Web developers that are more highly skilled will tend to be employed by bigger corporations, and such institutions would more likely embrace accessibility because of the business and legislative implications. Consequently, those designers are more likely to develop beautiful Websites that are still accessible because of the public face of the company. Amateurs on the other hand, who may start out as free-lancers and small-scale designers may care a little less.
- **The role of current technologies:** The nature of the Web development tools and technologies available is another factor that could influence the relationship under investigation in this thesis [Henry, 2006]. How many of these technologies offer accessibility features? Is it the case that more and more technologies are building in accessibility features, such that recent versions of software tools and Web document presentation technologies are becoming more accessibility-friendly, therefore leading to the design of beautiful Web documents that are also accessible?
- **The role of Web accessibility education:** Another interesting extension would be to examine if the popularity of Web accessibility education in some countries is leading to the development of more accessible designs. On the other hand, is it the case that we see lesser cases of accessible designs in countries where Web accessibility is not a major part of the curriculum in secondary and post-secondary education?
- **The role of legislation:** It could also be the case that in countries where there is strict legislation on digital inclusion, designers are more mindful. As such we observe Web developers creating aesthetically pleasing Web

sites that are still accessible. For example, it would be interesting to see if Websites designed in the U.S.A with strong legislation are more likely to have favourable links between the two Web constructs in question, compared to Websites in other countries where there is no such legislation in place.

Also, the statistical models on which the EIVAA tool is built could be further improved by considering other Web design features which contribute to aesthetic pleasure. A major challenge would be defining these features in an objective fashion to facilitate Web page ranking. Other techniques could also be used to mine visual aesthetic information from Websites. The use of techniques from artificial intelligence (e.g image processing and pattern recognition) could be explored. One on-going study attempts to use data mining techniques to extract a small set of visual features (see [Wu et al., 2011]). This may also help to model more expressive aspects of design aesthetics. We found that this class of design was particularly difficult to operationalize. Perhaps it represents a class of designs which are far complex and comprise of subjective variables which are difficult to account for using only statistical models. Clearly, more work is required in this regard. With better prediction of a Website's visual quality, the resulting proxy accessibility status evaluations would be more accurate. Furthermore, the results for the proxy accessibility evaluations are presented using a three point scale as follows likely low, moderate or high accessibility. A possible future direction could look at providing more detailed information, with specific pointers to areas that need to be repaired or in which design moderation needs to be applied.

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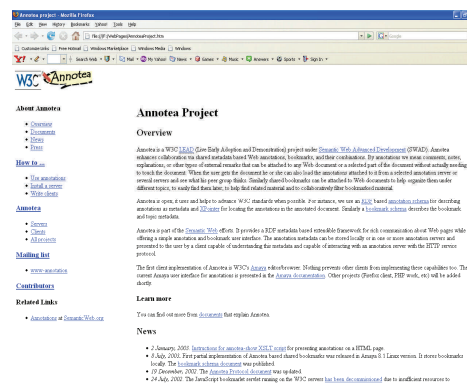
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Appendix A

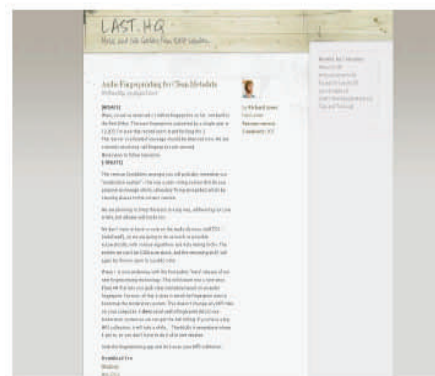
Data for Formative Study



A.1.2 Annotea Project



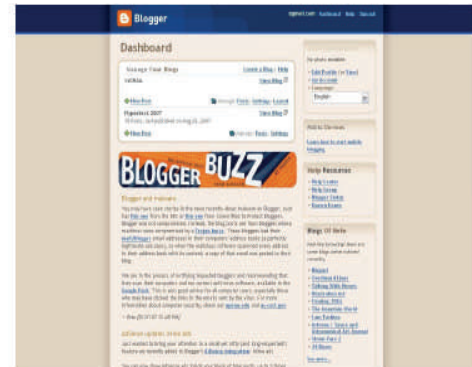
A.1.4 BBC UK News



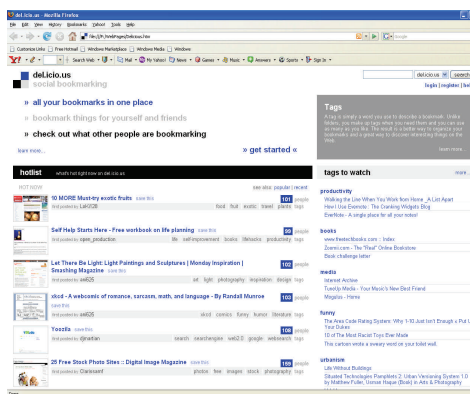
A.1.6 Blogger Post HQ



A.1.7 Blogger Post DE



A.1.8 BBC UK



A.1.9 Delicious



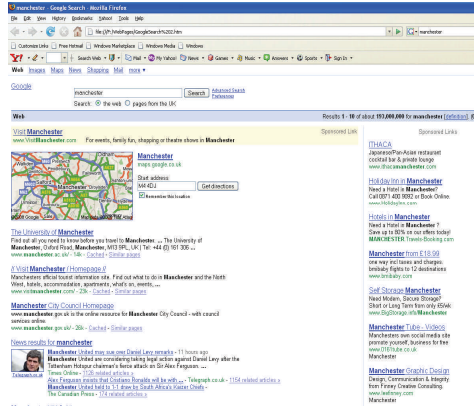
A.1.10 Ebay



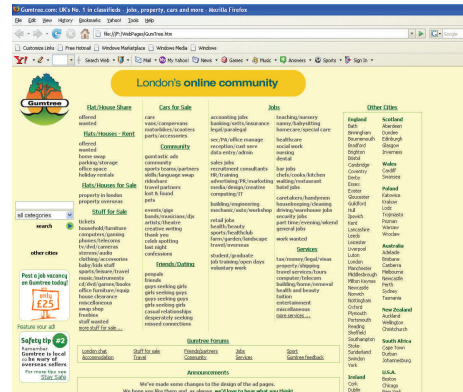
A.1.11 Firefox



A.1.12 Flickr



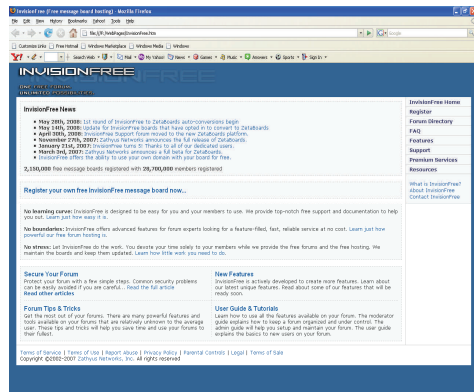
A.1.13 Google Search



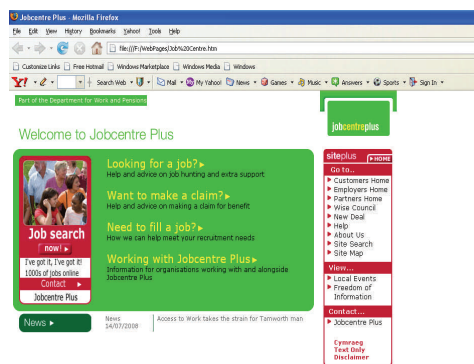
A.1.14 Gum Tree



A.1.15 IMDB



A.1.16 Invision Free



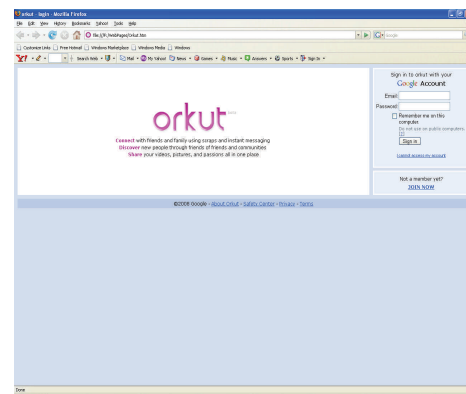
A.1.17 Jobcentre



A.1.18 Mega Upload



A.1.19 MySpace



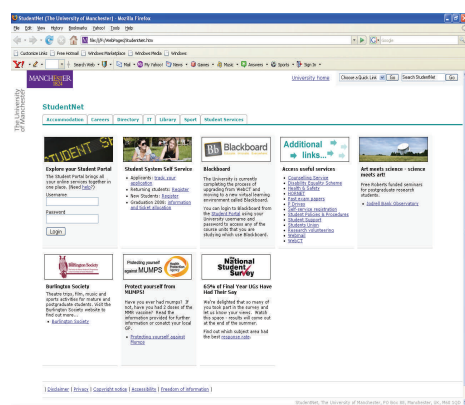
A.1.20 Orkut



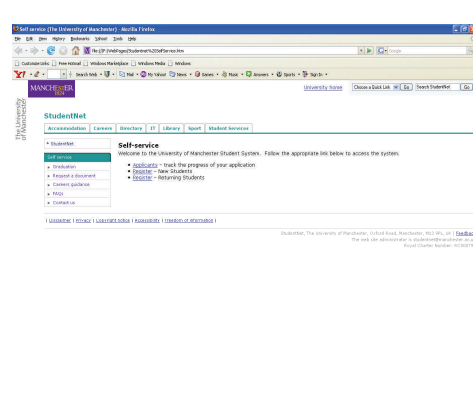
A.1.21 Rapidshare



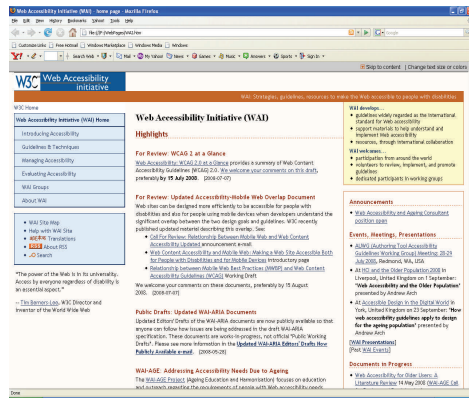
A.1.22 Rightmove



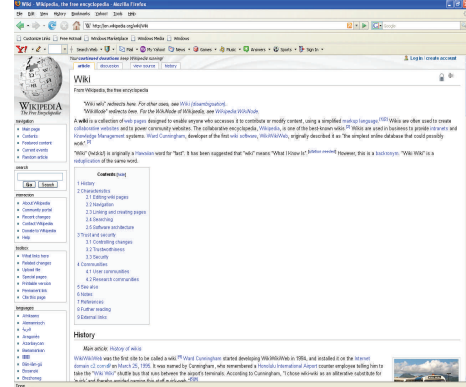
A.1.23 Student Net



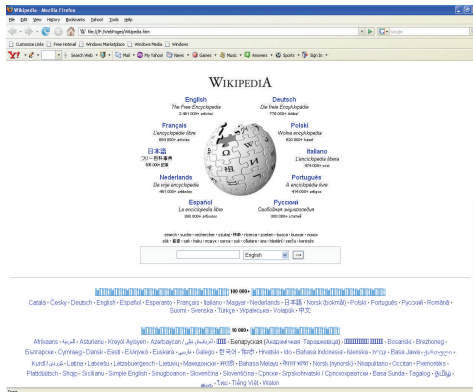
A.1.24 Student Net SelfService



A.1.25 WAI



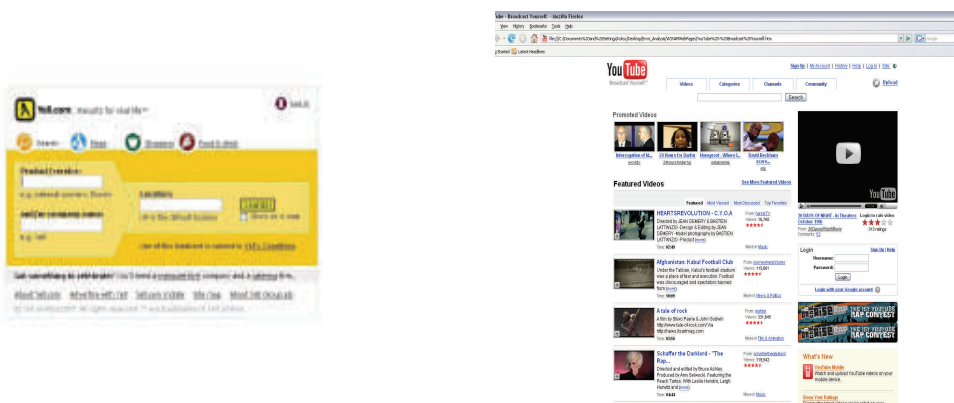
A.1.26 Wiki Result



A.1.27 Wikipedia



A.1.28 Yahoo UK



A.1.29 Yell

A.1.30 YouTube

Figure A.1: Web pages used in the formative study [Michailidou, 2008]

Appendix B

Data for Aesthetic Studies

B.1 Demographics for the Lab-based Study

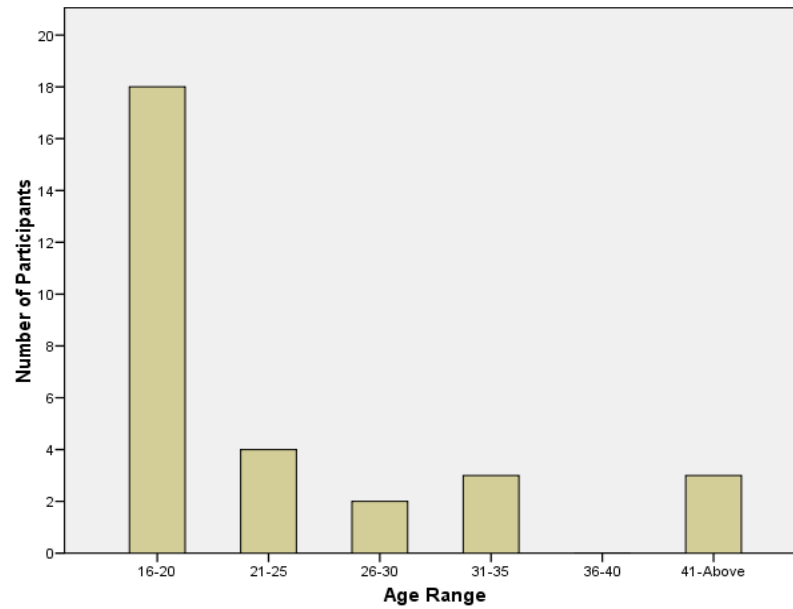


Figure B.1: Age information for the lab-based aesthetic study

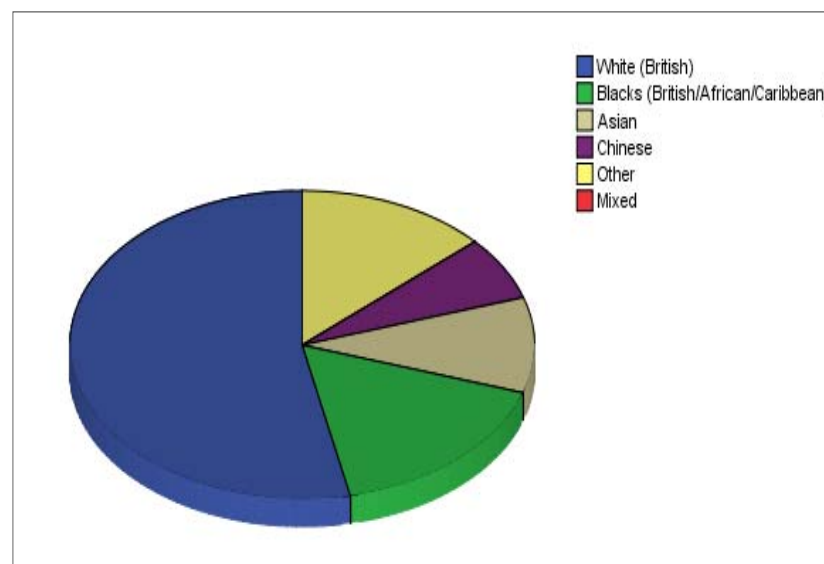


Figure B.2: Cultural background information for the lab-based aesthetic study

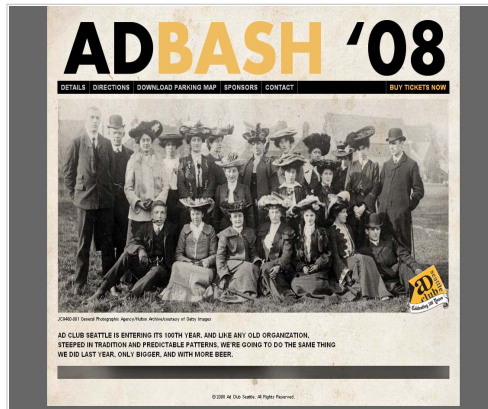
B.2 Web Pages Used in the Lab-based Study

B.2.1 Web page URLs

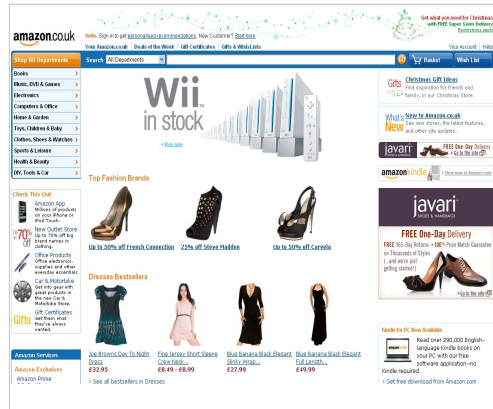
Table B.1: Web pages used in the lab-based study and their urls.

Page Name	URL
Adbash'08	http://theadbash.com/2008/index.php
Amazon	http://www.amazon.co.uk/
Answers.com	http://www.answers.com/
Argos	http://www.argos.co.uk/static/Home.htm
Ask Jeeves	http://uk.ask.com/?o=312&l=dir
Asos	http://www.asos.com/
Autotrader	http://www.autotrader.co.uk/
BBC	http://www.bbc.co.uk/
Bebo	http://www.bebo.com/c/site/index
Big Fat Institute	http://www.bigfatinstitute.org/
Bing	http://www.bing.com/
Directgov	http://direct.gov.uk/en/index.htm
Ebay	http://www.ebay.co.uk/
Ezine Articles	http://ezinearticles.com/
Facebook	http://en-gb.facebook.com/
Flickr	http://www.flickr.com/
Full Sail University	http://www.fullsail.edu/
Good Things by Orange	http://awards.goodthingsshouldneverend.com/
Google	http://www.google.co.uk/
Gumtree	http://www.gumtree.com/
Hello Sour Sally	http://www.hellosoursally.com/
IMDb	http://www.imdb.com/
Jonathan Yuen	http://www.jonathanyuen.com/
Last Fm	http://www.last.fm/
Linkedin	http://www.linkedin.com/
Live Journal	http://www.livejournal.com/
Marks and Spencer	http://www.marksandspencer.com/
Megavideo	http://www.megavideo.com/
Microsoft	http://www.microsoft.com/en/us/default.aspx
Money Saving Expert.com	http://www.moneysavingexpert.com/
Mozilla	http://www.mozilla.com/en-US/
MSN	http://uk.msn.com/
Pantagonia	http://www.patagonia.com/web/eu/home/index.jsp?OPTION=HOME_PAGE&assetid=9492
Play.com	http://www.play.com/
Rapidshare	http://www.rapidshare.com/
Rightmove	http://www.rightmove.co.uk/
Royalmail	http://www.royalmail.com/portal/rm
Solar System Exploration	http://solarsystem.nasa.gov/index.cfm
Target.com	http://www.target.com/
Tesco	http://www.tesco.com/
Twitter	http://twitter.com/
Veer	http://www.veer.com/
Villa San Michelle	http://www.villasanmichele.com/web/ovil/villa_san_michele.jsp
Virgin Media	http://www.virginmedia.com/
We Feel Fine	http://wefeelfine.org/book/
Whalehunt	http://thewhalehunt.org/
Wikipedia	http://www.wikipedia.org/
Wordpress	http://wordpress.com/
Yahoo	http://m.uk.yahoo.com/?p=us
Yell	http://www.yell.com/

B.2.2 Screenshots of the Web pages and their study IDs



B.3.1 ID 1



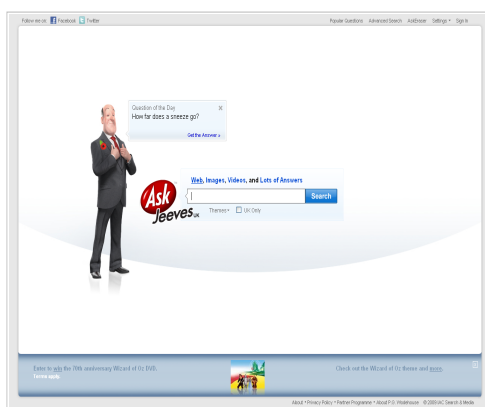
B.3.2 ID 2



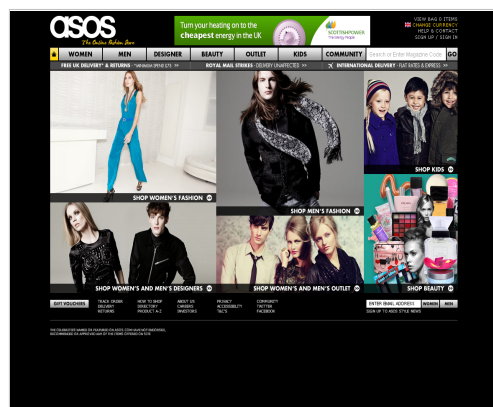
B.3.3 ID 3



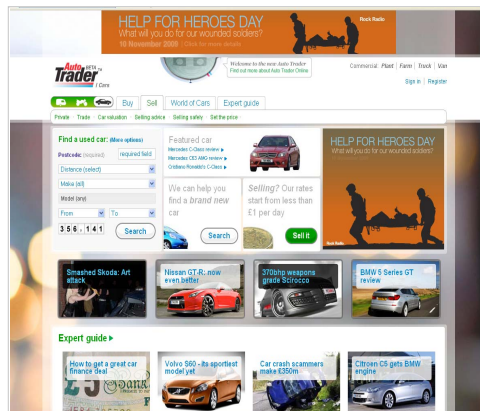
B.3.4 ID 4



B.3.5 ID 5



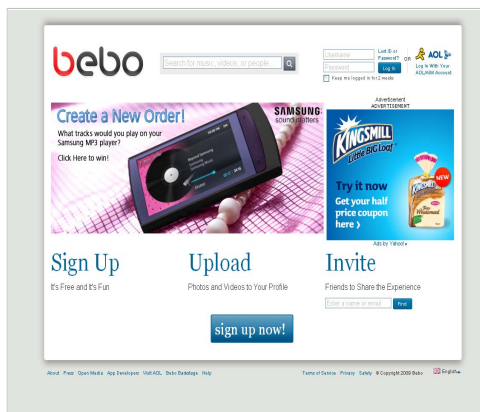
B.3.6 ID 6



B.3.7 ID 7



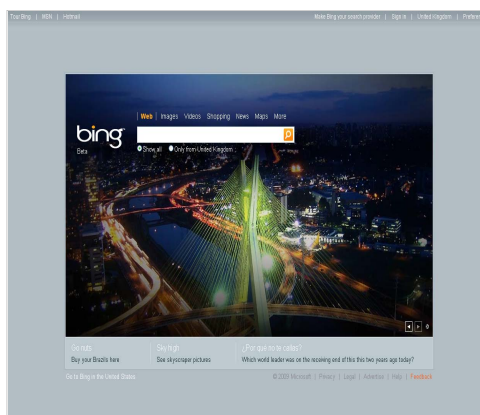
B.3.8 ID 8



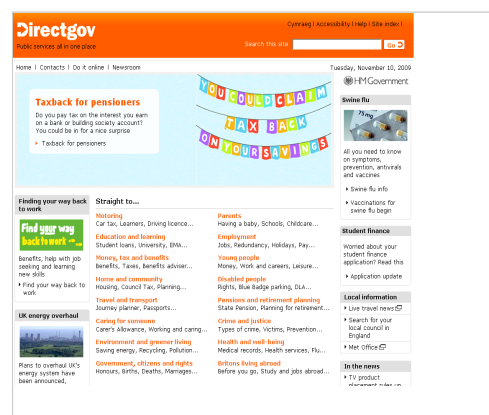
B.3.9 ID 9



B.3.10 ID 10



B.3.11 ID 11



B.3.12 ID 12



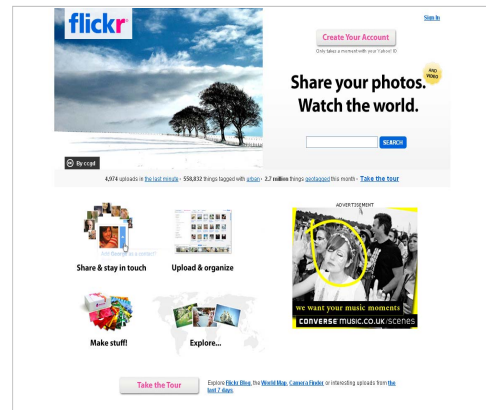
B.3.13 ID 13



B.3.14 ID 14



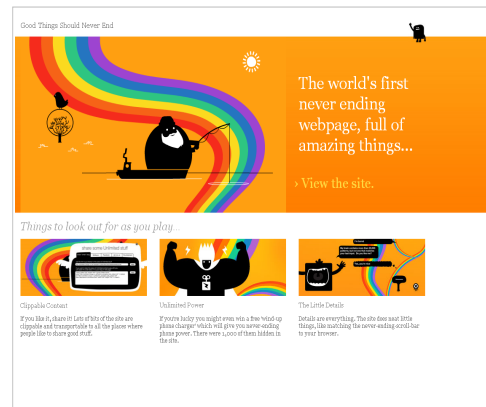
B.3.15 ID 15



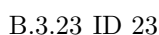
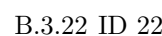
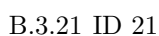
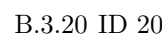
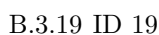
B.3.16 ID 16

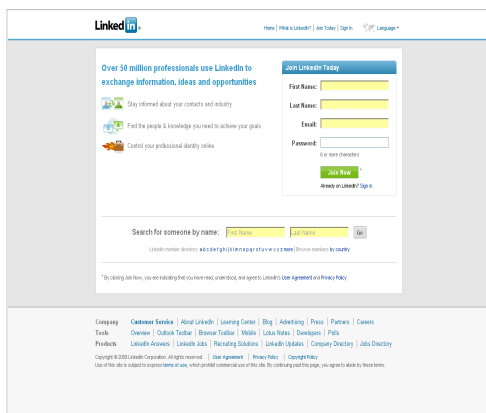


B.3.17 ID 17



B.3.18 ID 18

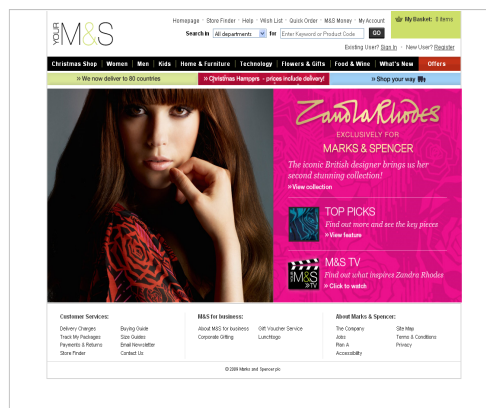




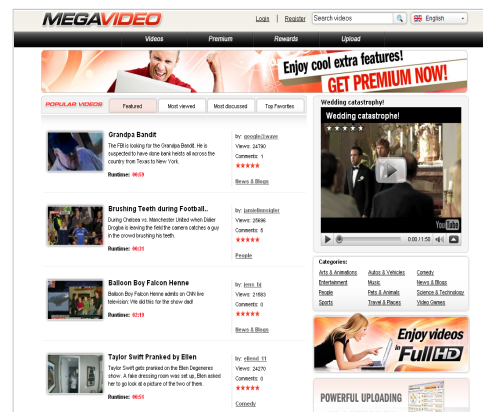
B.3.25 ID 25



B.3.26 ID 26



B.3.27 ID 27



B.3.28 ID 28



B.3.29 ID 29



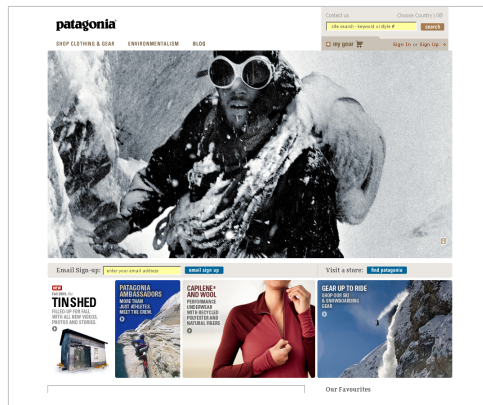
B.3.30 ID 30



B.3.31 ID 31



B.3.32 ID 32



B.3.33 ID 33



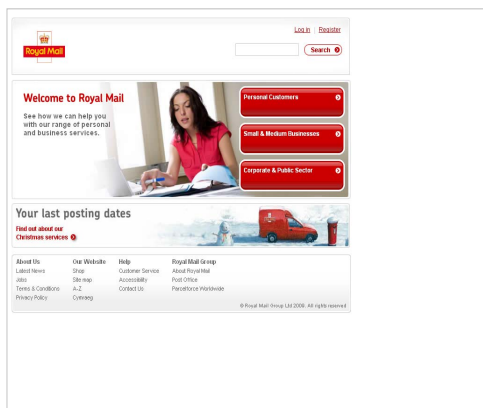
B.3.34 ID 34



B.3.35 ID 35



B.3.36 ID 36



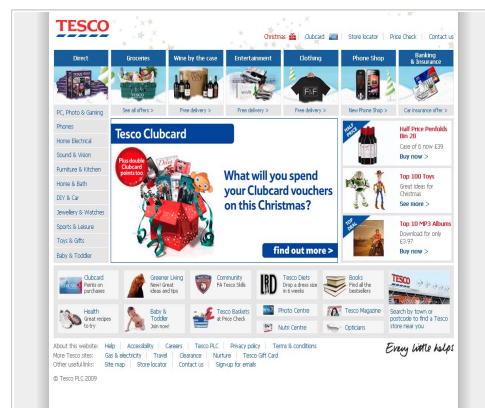
B.3.37 ID 37



B.3.38 ID 38



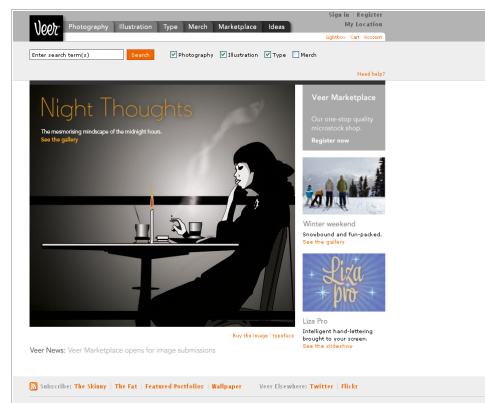
B.3.39 ID 39



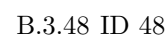
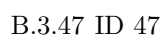
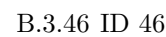
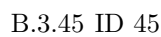
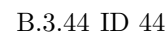
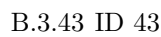
B.3.40 ID 40



B.3.41 ID 41

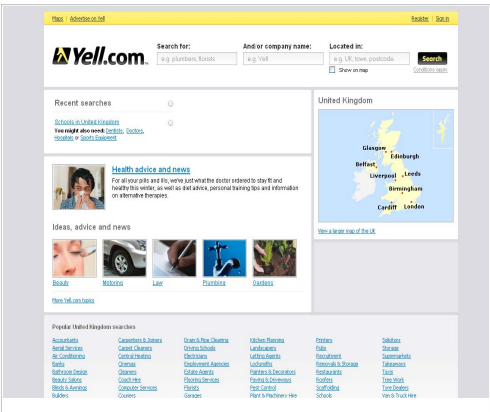


B.3.42 ID 42





B.3.49 ID 49



B.3.50 ID 50

Figure B.3: Screenshots of Web pages used in the lab-based study.

B.3 Materials Used in the Lab-based Study

B.3.1 Participant information sheet

Project Ref: 09026

EMPIRICAL INVESTIGATION OF VISUAL AESTHETICS AND ACCESSIBILITY (EIVAA)

Participant Information Sheet

The aim of this experiment is to understand what sort of Web pages come across to Web users as visually pleasing or good looking. There are no right or wrong answers. All we want from you is your honest first impressions about the Web pages you will be shown. You will be shown 50 Web pages for a short duration, after which you will be asked to rate the pages based on their visual quality. You will be expected to complete a short demographic form before you start rating the Web pages. The experiment should take about 30 minutes to complete, and you will be paid £10 for your time. This experiment has been approved by the University of Manchester committee on the ethics of research on human beings under Ref. No. 09026.

How is confidentiality maintained?

Your name/identity will not be collected. Instead, you will be allocated a number to identify your data. Your name/identity will not be associated with this number in any way.

What if I do not want to take part?

It is up to you to decide whether or not to take part. If you decide to take part, you will be asked to sign a consent form. If you do not wish to participate anymore, you can withdraw without giving any reasons and without detriment to yourself, and if you wish, your data will be destroyed.

Where can I obtain more information?

For more information please contact:

Grace Mbipom

Room LF1

School of Computer Science

Kilburn Building, Oxford Road

Manchester, M13 9PL

E-mail: grace.mbipom@cs.manchester.ac.uk

B.3.2 Consent form

Project Ref: 09026

**EMPIRICAL INVESTIGATION OF VISUAL
AESTHETICS AND ACCESSIBILITY
(EIVAA)**

Consent Form

I clearly understand the nature of the research and what I would be expected to do as a volunteer. I consent to take part and I understand that I am free to withdraw at any time without giving any reasons and without detriment to myself. I agree to the use of anonymous quotes. Any data may also be passed to other researchers.

Sign _____ Date _____

Print Name (Participant) _____

I confirm that I have fully explained the purpose and nature of the investigation and the risk involved.

Sign _____ Date _____

Print Name (Investigator) _____

B.3.3 Demographic form

Project Ref: 09026

**EMPIRICAL INVESTIGATION OF VISUAL
AESTHETICS AND ACCESSIBILITY
(EIVAA)**

P. No

V.Order

Demographics

Please take some time out to fill the following.

1. What is your gender?

☐ Male ☐ Female

2. What is your age range?

☐ 16-20 ☐ 21-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41 - Above

3. How often do you use the Web/Internet?

☐ Rarely ☐ Occasionally ☐ Frequently

4. Is English your native language?

☐ Yes ☐ No

5. Are you colour blind?

☐ Yes ☐ No

6. What is your profession (please specify)? _____

7. What is your cultural background?

- ☐ White
- ☐ Mixed – White and Black Caribbean, White and Black African, White and Asian, other Mixed.
- ☐ Black or Black British – Caribbean, African and other Black
- ☐ Asian – Indian, Pakistani, Bangladeshi and other Asian
- ☐ Chinese
- ☐ Other

B.3.4 Questionnaire

Project Ref: 09026	EMPIRICAL INVESTIGATION OF VISUAL AESTHETICS AND ACCESSIBILITY (EIVAA)	P. No. V. Order
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Please rate the Web page you have just seen accordingly



→



Extremely Cluttered

☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3

Very Clean

Extremely Displeasing

☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3

Very Pleasing

Extremely Boring

☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3

Very Fascinating

Extremely Basic

☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3

Very Creative

Overall, you would say the Web page you have just seen is

Extremely Ugly / ○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ○ 2 ○ 3 **Very Beautiful /**
Unaesthetic **Aesthetic**

Are you familiar with the Web page you have just seen?

☐ Yes ☐ No

B.3.5 Transcriptions from the lab-based study

B.3.5.1 Brief After Task Discussions

Here, the participants tried to explain in general what they were looking out for while judging the homepages?

Table B.2: Short notes from after task discussions with the participants.

PNo.	Participant's comments.
P1	Simplicity, not too many things. The ones with flash look a lot better, although in reality they take long to load.
P2	Anything that is eye-catching. Too much text puts me off.
P3	Basic and Colourful.
P4	Cleanliness.
P5	Something that is midway through, not cluttered but shouldn't have too little.
P6	I like it when it's easy to see.
P7	Good first impression, good images, sexy pictures, not too many words, and familiarity.
P9	Uncluttered pages, clarity, use of standard colours.
P10	Colour and simplicity.
P11	Simple design. Too much information is not good.
P12	Too much information is not good. I like moving graphics, nice colours. I don't like blacks and grays.
P13	How fast I can get information. Too much text is not helpful. I looked for logos each time, because of the short viewing time. Most of the pages are inbetween really.
P14	Pictures and uncluttered pages.

PNo.	Participant's comments continued.
P15	A site that gets the user involved from the outset like Rightmove, Bing, and Google. Images are not the only pointers to visual pleasingness you see. I don't wanna go waoh images!
P16	Clean/cluttered design qualities were very informative for the rating exercise. Nice colours. Most of the pages were basic.
P17	Moving images, colour, not too much writing.
P18	Simplicity like the Twitter page. Appealing graphics. Too much information is not good like the Yahoo page.
P19	Graphics, colour, structure or layout - whether it's cluttered or not. To be honest I don't like it simple, I like it graphically pleasing. I don't like too much text.
P20	I looked out for colour match and pages that caused eye strains like small prints
P21	Simplicity. Things being there without having to use lots of menus. Something different and interesting.

** Data from P8 and P22 were not included in the main analysis of the lab-based study due to invalid questionnaire responses. Discussions from 20 participants were therefore taken into account here, and detailed think aloud sessions were performed for the remaining 10 participants (see B.3.5.2).

B.3.5.2 Think Aloud Transcriptions

Here, the participants tried to explain to the investigator in detail what aided their aesthetic judgements for all 50 homepages evaluated.

Table B.3: Transcriptions for Participant 23

PageID	Participant's comments
ID1	What struck my ..., the pictures of the lady and the guy.
ID2	The Wii. Yeah, I think it's the big pictures. The biggest picture catches my attention.
ID3	Emm, the answers of the day, the feature answers, that actually caught my attention, and after that the second bit was the picture of the sesame street. Yeah, those things, then the pictures that relate to these items.
ID4	What attracted me was the animations. The flash animations.
ID5	For Askjeeves, the search box, because the cursor was blinking. Then the guy next to it.
ID6	Em, there is something that is not covered in here that I want to mention for this Web site. Em, I do not know maybe it's the fine grain of this. I felt that this Web site has a lot of information right, but em none of it attracts my attention immediately until I start to move my mouse then it starts to highlight. That's why I moved the mouse, because I do not know what's there. My first impression was yeah, ok I know you are doing a clothing Web site, but then I do not know what's happening. So I start to move my mouse, sort of like to find my way around. And then when it starts to highlight, that is starts to fade away the rest and just focus on each individual thing when my mouse goes over, that gets my attention and makes it much more clearer. So this is the problem with this Web site. So I do not know what..., I don't think it's..., I do not know, it's like that. Probably it's just a fine grain, yeah.
ID7	Yeah that one, em the thing that actually..., because I have used this Web site, the thing that attracts me normally is the search bit. Then after that the advertised or reviewed car.
ID8	BBC Web site, the featured news attracted my attention. Good use of the featured news. Then the next is the current news on the left hand side.

PageID	Participant's comments continued
ID9	The thing that attracted my attention was the free gift that was in the middle. The photo - actually because the photo was colourful and really huge. Then the next bit was the advert on the right handside, because of the animations. Then the Bebo logo.
ID10	The university Web site, errr the logo of the university is very nice, because it's not symmetrical. Not only it's not symmetrical, it's sort of aligned in style. So it attracted me and I think I spent too much time looking at that, and then I just went off.
ID11	I think the Bing Web site is very beautiful, as in because of the pictures they use; they are very beautiful, but I'll say that usability-wise I will rate it very low. Because I do realise that..., because I have used this Web site before, and this small little squares in between, unless you go over it then you know what are they, or what are they trying to tell you, otherwise you won't know. So, that's what I mean it's very difficult to use it, but it's very visually pleasing. That's why I rate it quite well in the visually pleasing.
ID12	Yeah, the central, the main news that is featured. I am trying to read what's in the picture.
ID13	I felt for a flash of a second I was drawn to the featured items, but then straightaway there were a lot of animations going on so my eyes were fittering around. Then the one thing that could actually capture my attention was the sliding on the bar there, that actually captured my eye.
ID14	I think the logo of it. There's nothing else in there except text to read. So, I started reading some text, but then I went back to the logo.
ID15	The picture of the globe of the Web.
ID16	The picture underneath the logo. Then the advert.
ID17	The animations. Almost the whole page is animated. So, the animations caught my attention.
ID18	Animations again.
ID19	The logo, the creative logo and the search box.
ID20	The spotlight items attract my attention actually.
ID21	The animations, because the whole page is animated.
ID22	The featured show.

PageID	Participant's comments continued
ID23	The images at the bottom. The clear, crisp image. (Investigator: You were not worried that the rest of the page was like empty?) No, not at all, not at all. I felt that it's very pleasing to look at. Although it isn't containing much information. Probably they don't convey much about what the Web site is about until you start to go in, but then as in for the look of it, it looks very pleasing. (Investigator: Do you like that suspense, it's kind of a love or hate thing?) No, I think it's not about a love or hate, but I think that it's... yeah you can say love or hate. I think more of like, it's missing something, but that's the bit. (Investigator: You like the suspense then?) I like the suspense, but it depends on my mood. If let's say I'm just like a casual browser, I will like that. But let's say I am searching for something over the Web, I won't like that Web site. So, it depends on the purpose of my visit and the usage of my internet as well.
ID24	The advert.
ID25	The join section, the join as a member.
ID26	It uses images to describe what the Web page is all about. Those images that they used to give a brief summary of what the Web page is all about actually attracts my attention. So, I think that's the main purpose as well.
ID27	The featured models there. Probably, the model is wearing some items that they are selling. It's the model that actually attracts me, because it's very huge there.
ID28	The video, flash video.
ID29	The image of the Windows 7, and it's because one full image is actually cut into separate bits, that actually attracts me.
ID30	It is very crowded, but not over cluttered, but it's crowded A lot of things going on. What attract me was the advert, because there's nothing else to look at. It's very difficult to read the rest as well.
ID31	The featured product on this Web page which is the firefox Web browser, and the next is the download button.
ID32	It's not very crowded, but it gives a little sense of overloaded information. What attracted me initially wasn't the featured news, but the advert. Then after that the featured news on this Web site. This is the MSN Web site.
ID33	The image of the guy covered in snow, it's the largest image. Then next was the most colourful picture, this girl wearing a dress in red colour, it's very colourful.
ID34	The offers. Then after that was this animation of free delivery that is moving underneath the logo.

PageID	Participant's comments continued
ID35	The logo, because the logo's huge. Then the video, then finally the box which allows you to upload information to the Rapidshare.
ID36	The background of the featured item which is the search-for-properties box. So, it's the background image of it. (Investigator: What about the image?) It's too colourful so it hides the rest of the information from my vision. So, it attracts me, the background. Then later then I noticed the search, which I sort of figured out it's a property Web site, real estate Web site.
ID37	The Royalmail Web site, the service available listed in the buttons, because the buttons are nice and red. Then the image, because the image next to it really huge.
ID38	The featured news and then followed by all the subnews. Because there were images for each of it, and they are very clean, tidy and symmetrical. So, I could just follow it directly. (Investigator: What attracts you more, the text or images?). Images, huge colourful images draw my attention. Sharp crisp images.
ID39	The main news as well, because of the huge images. Then the animations stuff.
ID40	I'm lost. Then I went up to service available, because it seems to me that all the main items..., besides the featured items in the centre, the rest of it are all surrounding. So, there are loads of things that surround it like a border. So, I do not know what or where to begin, so I am totally lost.
ID41	The bird, and the colour. Very simple Web site, but it contains all the necessary information. So it conveys the information to me very quickly.
ID42	The huge image as well, then followed by the colourful image on the right hand side next to it.
ID43	The huge image, then followed by the animations of the drop down menu of the Web site.
ID44	A lot of information on there. Two things that attract my eyes was the sports news and the main news at the same time. But nothing stands out. (Investigator: Is that just because you love sports?) No, it's because of the image, that's why I say nothing stands out. If you ask me which one I will choose, probably it will depend on my interests. Then I will choose between the featured news or the sports. But the thing that attracts me will be these two things, there's no one that dominates it. Then after that it's the animation of the advert.
ID45	The image of the logo, very colourful, very simple Web site.

PageID	Participant's comments continued
ID46	It's very clean, all the information is there, and then the logo of the whale is very cute. (Investigator: It's really tiny, you don't mind?) Yeah, it's tiny, but it's only one colour, and there is no shading or another thing like that, so it's like two dimensions, so it's very easy to take on. (Investigator: So you like simple designs?) Yeah. This is..., it gives me the impression that it's very simple, but yet the photo that they include on this Web site is very creative. It's very creative from the point of view of how the guy takes photos. So, it's a very creative photo, but yet on a very simple Web site. It has a very good contrast on it, that improves the whole thing.
ID47	The Wikipedia main page, the globe with the thing actually attracts me in the centre. But then after that, what attracts me next I couldn't determine, because again it's like a frame thing. So it's very difficult to determine, they are all equal. Sort of I'm lost after the image.
ID48	Em, they tried to incorporate like nine featured news on there, so I think that's information overloaded. So out of the nine featured news, the one that is the most colourful will naturally ..., or the most beautiful or simple yet colourful pictures that is available will attract my attention next.
ID49	The Yahoo Web site, the main news captured my attention very well. The featured news yeah.
ID50	The map of Great Britain actually attracts my attention, and the yellow colour bits because that's the Yell colour.

Table B.4: Transcriptions for Participant 24

PageID	Participant's comments
ID1	That looked quite interesting, again the photograph makes you think oh, I wonder what that is
ID2	Again that one's got a lot of information, but it was a few photographs rather than just a list of words
ID3	And that one again ...yeah, no, at least there were a few pictures on the last one (referring to ID4 here in the given viewing order)
ID4	This one is just again full of lots of information, and little picture
ID5	Yeah, I mean that's a nice easy one if you want to use it you see
ID6	Yeah, the one with the clothes on was a bit more interesting
ID7	Yeah, I suppose I'm not not particularly interested in cars
ID8	No, I don't think that is particularly nice one, again it just looks lots of writing on there
ID9	Yeah, that one again I suppose it's only one picture and again you've just got your three bits to choose from so
ID10	And that one just looked really difficult ...yeah, yeah
ID11	Yeah, that one, I liked that photograph, that was a nice photo
ID12	Yeah, that one again, there's a lot on there. I suppose the headings in different colours makes it a bit easier.
ID13	Yeah, that's better with having the pictures rather than just a list of texts, but again there's a lot on that screen to look at
ID14	That one just looked no, lots of writing there, no that one
ID15	That looked quite clear, I don't use it... no
ID16	That one looks alright, because it got bits, but just quickly looking at it you know which bits to go, and you haven't got to read a whole page to go
ID17	Well I liked that one, because it got a bit of movement on it.
ID18	I thought that was a nice one.
ID19	Yeah, I do use that, and because I use that I know they do change the bit at the top there. So, do make sure when you do go on that you do look to see what they have on top, otherwise it would be boring

PageID	Participant's comments continued
ID20	And again that one no, it's just a list again
ID21	That one I quite liked that one, I thought that one was quite good. I don't know what it would be about, I think you'll perhaps go a bit further
ID22	And that one again, it just looks a bit like a newspaper, I won't bother to read that
ID23	That one I thought, again because there wasn't much on it you sort of look down to see what it was. (Investigator: What did you think about that?) Yeah, I think it will make you look at it, and perhaps try to see what the next page was..., yeah see what else is gonna happen.
ID24	Yeah, again the colours will make you look at it a bit I think
ID25	I suppose if you knew what it was and wanted to use it, it looks quite easy, but just flicking through you think oh no
ID26	Most about all of them you just look at the drawings on the top and ignore the writing, ignore the writing and look at the pictures really
ID27	Yeah, the picture caps again, you think I wonder what that is. It's probably the pictures that sort of..., not the text, it's the pictures.
ID28	That one just looks boring
ID29	Yeah, that's not too bad, again it doesn't have too much writing
ID30	No, I didn't like that one
ID31	Yeah, that one didn't look too bad, because again I think if you wanna use that you knew which bits to click, you've not got quite so many choices.
ID32	Yeah, that just looked a lot of writing really
ID33	Yeah, that was quite interesting at least you've got the photos
ID34	Yeah, that one again, I have used that one, and again there's a lot on the screen
ID35	Yeah, that one... wasn't too much on there so..., and again there was that little bit at the bottom and you might be tempted to click on that arrow and see what it actually did
ID36	That bit at the top I thought was quite nice, but then you look down there and you think, oh no, too much writing again

PageID	Participant's comments continued
ID37	Yeah, that's quite an easy one, because again there's not too much on there, a bit boring, but...
ID38	Yeah, at least the colours of that one... although there's a lot of text on it, the colours sort of made you want to look at that one a bit more
ID39	Again that one is a bit, yeah..., but again I suppose it's in boxes so it's a bit better, but a lot to look at
ID40	No, that one again, and I have used that one and it takes you ages to find what you want
ID41	That one, I mean it was clear, but it just looked boring
ID42	That one again, it's quite an interesting picture
ID43	Yeah, I like that one, it makes you think of holidays
ID44	No, no I don't like that one, no, because that one again you think huuuu there's too much to look at
ID45	Yeah, that one I quite liked as well
ID46	Yeah, I like that one, that one you think oh, I wonder what this is, I'll have a look at that one. (Investigator: ...even though the image is so tiny?) Yeah, yeah perhaps the image could have been a bit bigger but eh.
ID47	Yeah, the page is just boring on that one, just the colour really
ID48	That one's not so bad, because it seems sort of boxes in, so it isn't just a whole page of writing, so that's not too bad.
ID49	But then sometimes if you've got like that (pointing at the Yahoo page) with the adverts on, actually that's a bit annoying
ID50	-

Table B.5: Transcriptions for Participant 25

PageID	Participant's comments
ID1	I thought it was quite interesting because it's got a big image really, but it stands out a bit... they've used up gray, but they've got colour to make some of the work less standard kind of thing of thing.
ID2	It's a bit boring, a bit cluttered in places , but because it's just what you shop with makes it a bit better really, because it's usually what you want to buy kind of thing
ID3	I found that quite boring, too much text on it really.
ID4	I am bias to that, I do quite like it because they use quite a few mixtures of colours on it.
ID5	That's quite...This is ok, it's quite colourful, but I don't think it's got quite enough stuff on it.
ID6	I quite liked that actually, because it's got quite a few big pictures and not too much writing.
ID7	I have used this once before. It's not the easiest website to use I think, but it's got quite a lot of information on there. It's a bit awkward to find some of it.
ID8	I think this one has got too much text on it. It's not quite bad because they've got quite a few pictures on it. A bit too much on it.
ID9	I think that's a bit boring actually. I think there's probably not enough text on it, with that one. There's lots of pictures on it, but not enough information really. So you'll have to click on a few links to get in, I don't really know. (Investigator: So you like the balance, a bit of text and a bit of pictures?) Yeah, a bit of text, a bit of images.
ID10	I find that very boring actually, again there was too much text on that one.
ID11	I think that's a bit plain really. This is a bit of copying of Google too much kind of thing really. They just shove their own image in the background.
ID12	I know that, I have tried using that website before. It's really rubbish to use I tell you that, but it's not the easiest to look around really either.
ID13	Ebay is not too bad actually, It's got quite a few images on it, might be more interesting. It's got a bit of text so you know where you going really.
ID14	I found that quite boring as well, because of all the text really. There's barely any colour on that one either.
ID15	It's quite colourful, but there's not really anything on it. With Facebook of course nothing really happens untill you logged in, so

PageID	Participant's comments continued
ID16	That was ok, that needs a little bit more text really, more what the website is about. The images are nice anyway I think.
ID17	I really like the interactivity on this one, and I thought that was quite good. They've got the balance just right above. You that text along the bottom, if they just got rid of that text, I think that website will be quite good. (Investigator: Is that a balance for you, the text and the image?). The text are nice on this side, but you see like the bottom lump kind of thing. If they got rid of that. I think that will be a lot better, if they got rid of the bit more text at the bottom, I think that would be better.
ID18	I like that because of the movement on it. I saw the video of it.
ID19	It's a bit boring, but I like how the background changes ever so often related to what day it is.
ID20	I feel there's too much text on it. I don't like the background colour either.
ID21	I quite like this website, because it's got a bit of video on. It probably could do with a bit more text about what it's about.
ID22	I think that's a bit of a boring website as well really. I think when they have too much of a white background and not enough pictures going on really.
ID23	I quite like that website, but I didn't really know what it was about. I couldn't really tell what the website was really. (Investigator: So did you find that interesting or not, the suspense?). It did make it more interesting, because you wasn't quite sure what you was thinking and it would persuade you to go on it. But if you use it a lot, because I didn't know what it's for, I imagine that would be a bit annoying.
ID24	I don't think this is a bad website. They've got the red banner on the top, and they've got a blue background in the background of it, and it makes it a bit more interesting
ID25	I think it's quite plain really. They've tried to do different colours on it. It's just a bit boring.
ID26	No, I don't know what it was about. I don't know really. I don't the adverts at the side, I understand they've gonna make profit but they are a bit annoying really.
ID27	I thought that was ok. It's got a big picture. It's got quite enough text really, and enough links to go over to the next parts.
ID28	That was ok. They've got the balance just about right. I think a bit less text on that will probably be ok.

PageID	Participant's comments continued
ID29	The top bit is ok, but all the text along the bottom. I think they could have just left it with the links and that would have been enough really.
ID30	I've been on this website. I really hate the design of it. It looks really cheaply made. Like this picture of him is all been cut out. It looks really badly photoshopped. I don't know, it just looks very old-fashioned the way it's set out. There's just loads of text on it. I don't know what it's about that website. I don't like it.
ID31	I like this website actually. I like the background colour, like how it's got some image in the background of it.
ID32	I think it's a bit cluttered. It reminds me of Yahoo's website's page that has got too much text on it. If you cut it down a bit. It would be ok.
ID33	I quite like that, because it's got..., the images are quite big, and all that writing down the bottom, you didn't really see that until afterwards. So, it was ok that one was.
ID34	(Investigator: Have you used that?) Yeah, I've used that quite a bit. Did a lot of christmas shopping on that. I quite like play actually. It's got enough stuff on there, but I think sometimes it has a bit of too much writing on it. I think it could do with a few more images, or just the images a bit big would do.
ID35	That's very boring the website really. It's..., I think they need to put something else in the background. It looks a bit plain.
ID36	I think that's got too much text I think really in that. There's too much of a white background compared to a few images they've got, and then lots of text everywhere.
ID37	Emmm, that was ok. It looks ok, it's not too bad. I think the size of it. It ought to do with actually taking that whole page, because anyway you've got it just at the corner really. (Investigator: So you prefer it to fill up?) I prefer it to fill the whole page really.
ID38	See, I quite like that because of the mixture of the different colours on it. I think that one quite works. There's quite a lot of text on it, but it looks interesting. I think it's the images they've used, but because it's spaced it makes it obviously slightly more interesting. It makes it more interesting. Just the images I think, more than anything.
ID39	It's ok. It's not too bad. I don't know, I think that almost got too many images on, and too much going on. (Investigator: Oh, so too many images puts you off?) Yeah, if there's too much..., I don't mind just one big image and a few little bits of others, but when it's lots of little ones everywhere, it's a bit distracting, because you don't know what quite you supposed to be looking at.
ID40	That's another one that is about. It was ok. I think the images on that one are too small. I think they need to make them a bit bigger I think.

PageID	Participant's comments continued
ID41	I quite like the look of that, but there's not really any information about it. But again, it's because it's a social network, there generally isn't anything on it, and it's only really a login page. So, as a login page, it's fine.
ID42	I quite like that. That seems to have... It's just got one nice big image, and a couple around and then just about the right amount of writings on it.
ID43	I really like that one. It's quite a plain idea, just having the big picture in the background, but it's got the text that moves in there. It's just right that one seems to me. (Investigator: Ok, that's a perfect site?) I would say that's practically a perfect site, yeah.
ID44	I think that again is a site like MSN, it's got too much going on. There's too much writing everywhere, and you get the advert stuck on the corner as well.
ID45	I that one is quite interesting, because you don't really know what it's about. You wanna kind of click to find out what it actually is about. I think it stands out on the black background with just a bit of the spray colour everywhere.
ID46	That again is quite an intriguing website really what it's about. I quite like the image. Just very plain idea, but it makes you wanna find out more about it. (Investigator: Even when the image is so tiny, you know like in the centre squatting?) It could do with a bigger image, but it makes it more interesting about it. I think the problem with Websites are that you don't actually know what they about, which can be a bit annoying sometimes, especially when you are trying to find something.
ID47	The bit I don't like about that is, you know the bulky bit at the bottom, with all the different languages. I think they need a few more colours put into it like some red or something put into it instead of just being blue. (Investigator: Red?). I think just make it stand out a bit more. It's just plain.
ID48	This was a bit boring really. I think it needed a few more images. I think the grey background makes it a bit too plain.
ID49	Again, I think there's too much writing on it. I do quite like how they've got the down side of it. A bit of that images. That's quite a good idea having just little images next to the marks, but there's too much writing I think on that one.
ID50	Emm, that's not too bad. I don't like how they do all the links along the bottom. They just do it like a big collection. I think it's better when they do like a site map, like an option of it and then you get the page of all the links, because you eventually find the way that way.

Table B.6: Transcriptions for Participant 26

PageID	Participant's comments
ID1	Awwwww, no. This is the one I really hate. I don't like those old pictures. It reminds me of ghosts.
ID2	Yes this is good. This is the sort of feeling I like. (Investigator: Can you describe that feeling?). You have pictures in the middle, and different pictures for different categories. So, that's very easy to read, and just like that.
ID3	(Investigator: How about the Answers website. What do you think about the visual quality. Is it appealing or not?) No
ID4	It's not that bad, but I can't say I like it, but I don't hate it.
ID5	I don't like this guy.
ID6	This one is ok, but seems the pictures are small.
ID7	Autotrader, I've been there several times. No particular feeling. (Investigator: About it's visual quality?) Errrr, no.
ID8	BBC, no particular feeling on that.
ID9	This is quite clean, and I like it.
ID10	I don't like that man.
ID11	Yeah, I like this one. (Investigator: Why do you like it?) I like the picture, and also it's very simple. You know what to do, and where to go directly.
ID12	Errrrr, I don't like that.
ID13	Hmmmm Ebay, because I use Ebay a lot, so I kind of know where to go on the Ebay website. From the front page, it's appealing to me, yeah.
ID14	Again, too many text.
ID15	Facebook is quite simple, like the Linkedin website.
ID16	Flickr, no particular feeling about that.
ID17	The text on the left hand side is quite small, and there are a lot of text on it. It's difficult to read.
ID18	I like this one as well. (Investigator: Why do you like the Orange website?) The art works, just that feeling.
ID19	Google is ok. I like it.
ID20	Again, too many text.

PageID	Participant's comments continued
ID21	Awww, I like this one. I really like this one, good. (Investigator: Is that just the animations?) Just the feeling. I like that feeling.
ID22	This one again, there's too much words, too much information on it.
ID23	This is quite wired. I always expect something to come up in the middle there. (Investigator: So that was wired to have something at the bottom there. Did you quite like the suspense and all that? Did it make you start thinking what are these people up to?) No, actually... , because I was waiting and the rest, and was kind of disappointed. I don't quite like that one.
ID24	Not sure about that. It's something in the middle with regards to the clutterness. (Investigator: It's midway?) Yeah, it's midway
ID25	This is quite simple and clean.
ID26	This one, no particular feeling about that.
ID27	It looks good. (Investigator: Just because of the picture of that lady there?). Yeah, that lady there.
ID28	It's quite clear what you are looking for on this one. So, it's clean layout and everything thing is there, and these bullet points are great.
ID29	This one is kind of ok.
ID30	This is the one I really hate. There's too many things on it.
ID31	Again this is a feeling like the Twitter website. I like such kind... (Investigator: You like sky blue colour?) Yeah, and also the feeling of the art works and the similar intervals.
ID32	I don't like the man in the middle. I don't know who that is, but I just don't like him.
ID33	I really, really like this one. The picture is very kool. (Investigator: What do you mean by kool?) Just fascinating, I just like it.
ID34	Play.com is nice. Yeah. Not too many comments on that one.
ID35	This one is very simple.
ID36	I don't like those eyes.
ID37	It's simple and clean.
ID38	I don't like this one. (Investigator: Why?) Because there are too many words on it, and small fonts I can't read.

PageID	Participant's comments continued
ID39	The advertisement in the middle is nice, and the feeling is nice, kind of cosy.
ID40	This one there's too much information.
ID41	Twitter, I'm quite used to it so I just like the layout. I like the feeling.
ID42	Yeah again, I like this, there's more artwork here.
ID43	This one is pretty nice. (Investigator: Why?) I like the picture.
ID44	I hate the flash thing, the advertisement. I don't like that.
ID45	I like this as well. I just like the arts.
ID46	I quite like this one. It's all white with a nice picture in the middle. It's very clean.
ID47	This one is pretty ugly I think, especially those things at the bottom.
ID48	That one has an empty box which doesn't look great. The layout is nice, but it's just the empty box that doesn't look great.
ID49	For this one. I have used it for quite a long time. So, I know where every thing is. (Investigator: So you are familiar with the page?) I'm familiar with that one, yeah.
ID50	It quite simple I think, but the problem is it has a lot of words at the bottom which is hard to read.

Table B.7: Transcriptions for Participant 27

PageID	Participant's comments
ID1	The visual quality was ok. It was bright, It was clean. (Investigator: Is that just because of the..., did you like the picture?). I just like the picture.
ID2	O beautiful!
ID3	It's ok. It's alright. (Investigator: You did not mind the text and all that?) No, no
ID4	It's a familiar website, so I love it.
ID5	For me, it was boring.
ID6	For me, it's not the kind of website I would like to use. (Investigator: Why do say that?) Maybe because of my age.
ID7	It was clean, it's ok.
ID8	It's news, it was alright.
ID9	The quality was ok, but I'm not familiar with the website.
ID10	A lot of wordings, and you know...
ID11	Beautiful. (Investigator: Did you like the website?) Yes, I did. (Investigator: What attracted you to that website?) The colour.
ID12	There were a lot of colour rioting.
ID13	It was alright.
ID14	No, I didn't like it. (Investigator: Why?) So many words, and the colour.
ID15	It was ok.
ID16	It was ok.
ID17	The visual quality was alright. (Investigator: What attracted you to that webpage particularly?) It was quite bright.
ID18	It's clean, but it's not what I would love to watch. (Investigator: Why do you say that?) It's for kids, it's not for adults.
ID19	Google, yeah it was alright.
ID20	Just one colour! No

PageID	Participant's comments continued
ID21	It's clean, but it's for kids.
ID22	The visual quality was alright.
ID23	It looks dull.
ID24	It's clean.
ID25	(Investigator: Do you like the Linkedin website?) Yes.
ID26	The colour not bright.
ID27	(Investigator: The Marks and Spencer website, you like it?) Yes sure. (Investigator: Why?) That's where I do my shopping.
ID28	No. The visual quality was ok, but I've never used it.
ID29	It's ok. It was alright.
ID30	Too many...I don't know... They have so many words on it, but the visual quality was clean.
ID31	It's ok, it was clean equally.
ID32	Yes. (Investigator: Did you like the MSN website?) Yes, I did. I use it.
ID33	No. (Investigator: You didn't like it?) Because I am not familiar with it.
ID34	Play com was ok. (Investigator: Have you used it before?) No, I have not. (Investigator: But you just like it?) (Investigator: Is it the pictures or?) The pictures, and it was quite bright.
ID35	It's boring.
ID36	Equally boring to me.
ID37	Yes, sure. (Investigator: Do you like this?) Yes. (Investigator: Why?) I get all my letters from there. (Investigator: How about the visual quality?) Beautiful. (Investigator: Do you like red colour?) Yes, yeah it's quite bright.
ID38	The quality is ok, but the colour is not bright. (Investigator: So you don't like colours like black on Webpages?) Yeah.
ID39	That was good.
ID40	(Investigator: Tesco webpage, did you like the visual quality of that?) Yes, I did. (Investigator: Why?) I do my shopping in Tesco.

PageID	Participant's comments continued
ID41	No, no. It was dull, and boring.
ID42	Investigator: How about the Veer webpage, did you like that?) I did. (Investigator: Why, what attracted you to the Veer webpage?) The colour was ok, it's quite bright.
ID43	Awwwwwww, I love it. (Investigator: Why, why do you love the Villa?) The colour, the beautiful... you know, red and green, it's beautiful.
ID44	That's my media..., the virgin I use.
ID45	(Investigator: Did you like the 'We feel' webpage?) No, I didn't. It was very dark and boring.
ID46	It's quite bright.
ID47	It's beautiful.
ID48	It's not...,it wasn't bright and then boring. (Investigator: But that was white colour there at the background, you didn't just like it?) No.
ID49	Yahoo, that's right, used to Yahoo.
ID50	(Investigator: Did you like the Yell webpage?) Yes. (Investigator: What attracted you to that?) They have bright blue on the white background, it fits.

Table B.8: Transcriptions for Participant 28

PageID	Participant's comments
ID1	Not good, because there is a wastage of space. (Investigator: You don't like sticking in big pictures?) Yeah, I mean it's a waste of space. It's a webpage obviously you have to utilise it properly.
ID2	Amazon is nice actually basically. (Investigator:why?) I mean there's everything in there. The offers and ...
ID3	No. There isn't proper categorisation of the conents.
ID4	It's again..., I mean there isn't proper presentation of the information.
ID5	Yeah, it's good.
ID6	Yeah, this is a nice one, because everything is just right there. You can just click in and go on.
ID7	No, because again, there isn't proper flow of the inforamtion.
ID8	Not much. Again, it's not categorised properly.
ID9	Yeah. (Investigator: because you have the signup, upload..., I see what you mean.) Yeah, everything is there.
ID10	No. I basically like the webpages where there is nice categorisation of the information. Instead of just dumping the information.
ID11	No, not good. Do you see what I mean? There shouldn't be a wastage of the space. They just put a big picture in at the front.
ID12	It's nice, but it's not much creative, because the way the organisation is used, because everybody will go through that. It would have been more creative and more user-friendly, but it's not so.
ID13	Yeah, but still they could have optimised it to a better way. (Investigator: In what sense should they have done differently?) I mean for the user who is looking at the page for the first time, it will be very difficult to find out. So, the main idea of the page should be for the user who is seeing it for the first time. It should be very easy for them to understand it.
ID14	No. Too much of information on that.
ID15	Yeah, it's nice.
ID16	It's nice. I mean compared to the one, which one was that...Linkedin? This is good.
ID17	This one, I have never gone to that website, but it's really nice.
ID18	It's very basic. (Investigator: Even with the bits of animation there?) It's just creative, but the information in it is very basic.

PageID	Participant's comments continued
ID19	This, of course this is the best one, because you find everything in there, like images, the videos, the documents. You've got everything in the page, but still it's so simple. (Investigator: Oh, I see what you mean, by categorising). Yeah the categorisation, it's very important.
ID20	There's too much of information in that, which is clustered.
ID21	This is good, but it's a waste of time for the user to go through that, you know the music. It's not really necessary.
ID22	It is clustered or cluttered whatever.
ID23	No. I mean..., when the user would find that there is information somewhere else. It has to be at the centre of the screen. There's nothing in it. (Investigator: You don't like the suspense on that webpage?) No.
ID24	It's good, yeah. I mean whatever it is, Lastfm will come under the same category like Megavideo. It's good that you would find information about the videos right in there.
ID25	Yeah, it's good.
ID26	No, it's not so good. It could be improved.
ID27	This is a very nice website, and my favorite page, because everything is categorised into special offers. You can just go there and you know everything about whatever is happening. (Investigator: So is that an example of a perfect webpage?) Kind of, because when you see it, then you don't find the contents to be clustered just one place. That is very important.
ID28	(Investigator: Is Megavideo a nice looking webpage to you?) Yeah, it is good.
ID29	(Investigator: Do you think the Microsoft webpage is a nice one?) No, but still because of the downloads and all is not categorised properly. But still compared to Firefox, this is better.
ID30	This could be very nice. I usually browse this page very often. This could be a very nice page if they would have done it properly, but it's usually very difficult navigating into the particular pages.
ID31	No, because the product is a release. There isn't much information on that.
ID32	This is good. (Investigator: You like that one, why?) The main thing is categorising the content information into the centre of the page which will interest the user.
ID33	There isn't much content in it. There's just big picture. (Investigator: You don't like big pictures?) I mean there should be something else instead of wasting the webpage just like that.
ID34	(Investigator: Is that page attractive?) Yeah, it's good. (Investigator: Why do you think so?) Because all the information is in there.

PageID	Participant's comments continued
ID35	It's not good, because they could have done it in a more better way to search accordingly, but it's not done that way.
ID36	Here, it's not organised properly again.
ID37	It is basic. It can be improved more. It can be customised well.
ID38	This is good because every information is organised accordingly. (Investigator: So you will like to have lots of text?) Text in the sense em... user should be able to find out every information in the webpage itself, so that they don't navigate into those other pages. Because once you see it, then you should be able to find out that ok, yes, there is some information in it which I would like to see. (Investigator: So every page should be like self contained?) Yeah, for example you've got the newsletter, or any details that should be concerned, that should be detailed in the first page itself.
ID39	This is good, but still not organised properly.
ID40	It's nice, because everything is detailed and user can click in wherever they want.
ID41	It's nice. (Investigator: Why do you say that?) I mean, you have only the search and you can just go for the search and everything in. (Investigator: So, that's what you classify as beautiful. When you can start using it immediately?) Yeah, it should be user interactive. I mean in the webpage itself you should be able to find out everything you want.
ID42	This is very basic. It would have been improved more, in more way. Like if you compare with the more pages, like you know, like Virgin is not a basic page. They would have improved it's quality.
ID43	This is good, but there isn't much information.
ID44	No, because the user can't browse in all the details. It's just clustered.
ID45	Even this one, there's no information in it. It's very basic.
ID46	No. This is very basic. There's nothing in it.
ID47	This is very easy for any language people. You don't have to struggle for anything, they just go straight.
ID48	This would have been more creative, but it's just clustered information here and there.
ID49	This is really nice, because the user can easily browse, and there's nothing to really struggle so much in getting information
ID50	(Investigator: What did you think about the Yell webpage with respect to it's visual quality?) It's not good. (Investigator: Why do you say that?) I think it could be more creative or something like that. I mean, it's not creative at all. It's just the basic.

Table B.9: Transcriptions for Participant 29

PageID	Participant's comments
ID1	This page is not clear. It's just a very big boring picture.
ID2	Yeah, this page is quite easy. The design. The page is very nice, and very clear. The writing is very clear. (Investigator: You were not worried that there were lots of images on it. It was ok by you?) There's is lots of images, but they separate them, so it's not very close together, using white colour as errr...
ID3	It's ok, but a lot of information, a lot of writing close together and it makes the work unclear.
ID4	Argos is ok, using good colours and good pictures, but errr a lot of information together is not very clear.
ID5	Not nice, because the page is empty, nothing on it. Not creative in this way.
ID6	Not nice, because I think they just put picture, and picture close together.
ID7	Not clear very much.
ID8	It is ok, still a lot of information clustered together.
ID9	This is simple, basic and clear. (Investigator: This is your example of a perfect page, is it?) Not creative on it I think. They don't do a lot of effort.
ID10	No, I don't like this one, because there's a lot of information, writing close together.
ID11	Yes, it's very simple this one.
ID12	Nnnn, the colour and a lot of information close together. No, I don't like it.
ID13	Ebay, it is ok, but a lot of pictures.
ID14	No, it's very boring. It's difficult to find what you want.
ID15	Yes, very simple. Not creative on it's own, but yet very simple.
ID16	Yeah, a little bit clear.
ID17	No, this is not clear, and the writing is very, very small.
ID18	Yeah, the colours, and is very nice for kids.

PageID	Participant's comments continued
ID19	Google, because it's familiar..., very nice.
ID20	Gumtree, it is ok, but a lot of information and small writing.
ID21	No, it is boring.
ID22	Hmmm, it's ok .
ID23	It's nothing. Just empty screen.
ID24	Hmmmm, it's ok.
ID25	Nothing on it.
ID26	A lot of information, and small writing close together.
ID27	This is clear, good colours.
ID28	Yeah, it's ok, but a lot of writing and pictures close together.
ID29	—
ID30	It look like ok, but it is very crowded. A lot of writing and pictures close together. It's difficult to find what you want.
ID31	The same thing, not clear.
ID32	MSN, clear, but a lot of writing. You need effort to find a thing.
ID33	This is very boring, especially this big picture. Not clear.
ID34	Hmmmm, not very good. Clustered.
ID35	It's nothing. Just simply a screen.
ID36	I think the colour is not good for me.
ID37	Royalmail, it is very clear and simple page.
ID38	Hmmmm, not clear. They are using these blue colours make their writing difficult to read.
ID39	This is crowdy.

PageID	Participant's comments continued
ID40	Tesco is ok. (Investigator: It's not crowded?) A little bit crowded, yeah.
ID41	Twitter the same thing, not any creative on it.
ID42	No, I didn't like this. The picture, the colour
ID43	This is very nice picture, but not creative on it.
ID44	I think they chose great colours, but it's a little bit crowdy.
ID45	This one is boring for me. It's black.
ID46	This is a very nice picture and simple design. Nothing creative on it.
ID47	Wikipedia is boring pages.
ID48	Hmmm, it's ok, but not fascinating.
ID49	Yahoo, it is ok. Maybe a lot of information in small writing.
ID50	Yell homepage is ok.

Table B.10: Transcriptions for Participant 30

PageID	Participant's comments
ID1	No, boring, no. (Investigator: Which was your best webpage if you just think back?) Well, Yahoo and BBC.
ID2	(And then Amazon, do you like this design or not, is it good looking, appealing or not Amazon?) Well, I like it. (Investigator: Because you use it.) Yeah. (Investigator: Apart from using it, the visual quality is it ok?) Well, It's good, yeah it's good.
ID3	Yeah, ok. I mean it's useful. (Investigator: Do you like the visual quality, is it nice?) I used to use.
ID4	Well, it's not that good.
ID5	I don't like it. It's boring.
ID6	Quite attractive yeah
ID7	Yes. (Investigator: What do you think about the visual quality, is it good, is it professional?) It is good, yeah, professional.
ID8	BBC, I like it. (Investigator: Because you listen to BBC everytime. You don't think it's cluttered, not too much information there?) It's organised, anything you want you get at it.
ID9	It's a simple one. (Investigator: And you said you like simple designs?) Yeah, sometimes I do.
ID10	Well, I don't like this. Many words there.
ID11	It's attractive.
ID12	Well, no. (Investigator: What don't you like about it?) It seems like it's not organised
ID13	I like it. They organised it.
ID14	I don't like this. (Investigator: Why?) Many words there.
ID15	It's boring, but it's yeah straightforward.
ID16	Yeah, it's simple one.
ID17	No, I don't like it. Many words there and just..., the homepage should be like something attractive. (Investigator: So the flash and all that is not attractive to you?)
ID18	Well, I liked it, but it's not creative.
ID19	Yes, simple one. It's good. I like it. I mean that is research website.

PageID	Participant's comments continued
ID20	Well, it's useful, but the design should be modified.
ID21	Well, boring.
ID22	Yeah, I like this. I use this. (Investigator: Oh, you just like it because you use it a lot?) Yeah, like it's simple, it's useful I mean. You can use it easily.
ID23	No, just boring design.
ID24	It's good. (Investigator: What's good about it?) I mean, it's attractive.
ID25	It's boring.
ID26	Well, I don't know, but that's a simple one.
ID27	It's useful. I mean, the design is good. (Investigator: What's good about the design?) Well, visually.
ID28	It seems organised, and creative.
ID29	Well, a simple one. (Investigator: Do you like simple designs?) Sometimes I do.
ID30	Well, many colours there, but I don't like this.
ID31	Oh that's straightforward. You don't have to put many things on it. I mean it's just like use this software.
ID32	Well, it's public. (Investigator: What's your opinion on it, the colours, the way the things are arranged, is it nice or not?) It seems organised.
ID33	They designed it well. I never used this. (Investigator: Do you like the visual quality?) I like this, yeah.
ID34	Yeah. (Investigator: You like it?) Yes. (Investigator: Why?) Well, many activities there.
ID35	No, no. I've never used this. I don't know for what this one. (Investigator: How about the visual quality?) Well, I don't like it.
ID36	Well, I never use this. It seems like easy to use. (Investigator: How about the visual quality, is it neat, is it professional?) It looks nice. Well, I don't like the words, the words is like small ones.

PageID	Participant's comments continued
ID37	Well, it's not creative, but it's straightforward as well. Not many there I mean.
ID38	Well, that's straightforward. I mean that's good, I mean you can find what you want.
ID39	I don't use this, but it seems it's good. (Investigator: Is it just appealing to the eyes or not?) Well attractive.
ID40	Yeah, that's good.
ID41	That's boring as well. (Investigator: It's fine?) It's fine, but not creative.
ID42	I don't know this, but it seems like boring.
ID43	I don't know this villa. Well, it seems like beautiful.
ID44	Yeah, it's good, really nice. (Investigator: Why, why do you say that?) Well it's creative for me, it's organised. (Investigator: You don't think there's much information on that, that's fine with you?) No, it's good.
ID45	Well, I don't like this. It's boring. Well, I don't really like dark colours.
ID46	It's boring.
ID47	Well it's like a familiar page, but I have used this kind of webpage a lot, but that's first time of coming here. (Investigator: Is that attractive or not?) Well, yeah, it seems attractive, but because of many languages there, well.
ID48	(Investigator: The Wordpress webpage, is that a good Webpage with respect to its visual quality?) No, not at all. Well, it seems like it's not good enough. It's boring, well...
ID49	Yeah, it's good. It's public. I mean, yeah, it's creative, clean, emm fascinating.
ID50	Well, it is good, creative. Well, I have never used it.

Table B.11: Transcriptions for Participant 31

PageID	Participant's comments
ID1	The webpage is dull and not very bright, and the the picture kind of blur.
ID2	It looks better, and it's easily accessible, and the colours are quite calm. (Investigator: So you are attracted to calm colours generally?) Yeah, basically. (Investigator: You didn't think it was cluttered because of the items displayed all over?) No, no. (Investigator: So, that's perfect for you?) Yep.
ID3	Emmm, the colours are bright, and it's not very spaced out. I mean the words on the Webpage, and there are not many pictures.
ID4	Argos, kind of colour harmony, but kind of you know cluttered.
ID5	AskJeeves is just too plain.
ID6	Asos basically is good, but it needed to be a bit well arranged. It has too many pictures.
ID7	Autotrader is just like a very basic website, nothing very spectacular. (Investigator: Not even the cars all around?) No.
ID8	BBC, the colour schemes are in harmony. It's quite nice, yeah.
ID9	Bebo is plain and simple. It's a good one.
ID10	No, no, no. This is not a very fascinating webpage. Just one colour, and the rest are just words.
ID11	Bing is fine. The colour is calm, and the background of the whole website is calm. It's just like a simple wbsite.
ID12	Too cluttered.
ID13	Same with Ebay, but the only good thing is there is harmony in the colours used.
ID14	Nah, not fascinating, cluttered.
ID15	Facebook is straight and simple. Calm colours, and it's good. (Investigator: What do you mean by calm colours, can you just tell us the colours?) The colours are in harmony basically, they don't fight with each other.
ID16	Flickr is a good one. (Investigator: What makes it good?) Simple and the way the animations go. It's fine.
ID17	Hmmmm, well, it's just a busy webpage and not very fascinating.
ID18	Shouting colours. Rainbow colours. It's not very clean, and all that, but it's ok. (Investigator: Well this company can't really help, because you see orange is like the colour of the brand, and so this is the Orange homepage.) Well, to me it's not like appealing.

PageID	Participant's comments continued
ID19	Google is straightforward and clean. It's a very simple website. You can just run around the website before you know, and the colour harmony is good too.
ID20	Gumtree, good colour harmony, good emm...the words are a bit spaced. Not very cluttered, but it's good.
ID21	Way too simple. Looks like something from the kids in kindergerton.
ID22	Well, a bit cluttered. Not very fascinating, although the colours are good.
ID23	Way too simple and plain. Very basic Website.
ID24	Hmmm, not very fascinating, but well, it's nice.
ID25	Linkedin, the colours are ok, but no animations, nothing fascinating about the webpage.
ID26	Livejournal, I think it's a bit cluttered.
ID27	Marks and Spencer is beautiful. (Investigator: Why do you say that?) The combination of pictures, and good colour schemes, and the wordings are not that cluttered. You know, it's easy to just get around. So, it's a good one.
ID28	Megavideo, well not very fascinating. It's just there. Just basic stuff.
ID29	Microsoft is good. Good colour scheme, good animation. Simple to get around, and it's fine.
ID30	Money saving expert is just too cluttered, and the colour schemes are just out of the way.
ID31	Firefox is good. Good colour schemes. Easy, fascinating.
ID32	MSN is kind of cluttered, but it still has the good colour hamony which is pleasant to the eyes. That's all what we need.
ID33	Pantagonia, lots of pictures, not very simplified. It's ok.
ID34	Cluttered and lots of images, and all that.
ID35	Rapidshare is plain and simple. (Investigator: Do you like that or not?) No, it's just too basic, nothing very spectacular can keep you on the page for a long time.
ID36	Rightmove is just so cluttered. Too many colours, it just pisses you off before you know it.

PageID	Participant's comments continued
ID37	Royalmail, straight and simple. You can get around easily. The colours are in harmony as well.
ID38	Emmmm, the NASA homepage is good. Although it's kind of cluttered, but the colours are fine. I think it's easier to get around too. (Investigator: Is that just because you like space exploration?) No, it has nothing to do with that. That's the first time I'm just even visiting, I'm seeing something from NASA.
ID39	Emmm, I think it's a bit cluttered, and it's not very good to the eyes.
ID40	Tesco, makes a bit of meaning. The colours are in harmony. The images are not big, although there are many pictures, but the animations and how to get round the website is easy. (Investigator: You said something about meaning, it makes meaning. Is that because you shop there, and so you are attracted to that?) No, no, no. I don't even shop online, I go to the shops, so...
ID41	Oh Twitter is lovely. (Investigator: Why?) Very peaceful, the colour schemes are very pleasing to the eyes. I mean, you can just stay here, and you can just be going round it and round, it's good.
ID42	Night thoughts is too basic. Just one picture and..., it's alright.
ID43	It's a very basic webpage, with just one very big picture. You really don't know exactly what you are looking at.
ID44	Hmmm, Virgin, nice colour schemes. It's a bit cluttered, but nice animations and good picture quality. (Investigator: You seem to like red colour). Basically, it's just not liking the colour, it's just that when the colours are in harmony, as in they don't fight with each other, you know...
ID45	It's a basic webpage, you know. It's not very fascinating, but it's something different anyway, it's good.
ID46	The Whalehunt is way out simple, and the colour is good, calm, just like the Twitter one.
ID47	Wikipedia is way too cluttered, not fine, not beautiful.
ID48	Emmm, it's just very basic, and lots of words, no really good colour schemes, and it's just basic.
ID49	Yahoo is fine. It's clean in terms of the picture quality, the colours used, and I mean it's easy to get around it.
ID50	Yell is quite basic. It's ok, it's fine.

Table B.12: Transcriptions for Participant 32

PageID	Participant's comments
ID1	It looks archaic, old. (Investigator: Is that a good thing or bad thing?) It's ok. Of course, try as much as possible to leave it at what it is. Not using mordern colour or images for old pictures. So, that's why it's like that, but it's ok. It's not something that would hold your attention. It looks blurred anyway. Probably because an old picture, they tried reprinting it. So, that's just it.
ID2	This one looks fine. It speaks for itself. The images are there, as in it's just straightforward. You just click on the image and there you go. (Investigator: Don't you think there's too much on that?) Too much on one side, too much information, but it's ok, it's well organised. As in they are not superimposed on each other, so you can see it's well organised. That's what makes some sense in it. I think it's well organised. (Investigator: Compared to Argos?) Yes. Argos they are just superimposing themselves on each other. So, it's ok.
ID3	The same thing with this one. Too much information at the same time.
ID4	Argos, too much information at the same time. It's fine, it's ok, but too much information at the same time.
ID5	Simple, for it's simplicity. (Investigator: Is that a good or bad thing?) Is a good thing. For it's simplicity, it's ok. It speaks for itself. The image speaks for itself, and it's just straightforward. You don't have to be wondering around, you know what you need to do. (Investigator: What do you mean by the image speaks for it self. Is it telling a stroy?) You are surfing the net, it says Askjeeves. It just speaks for itself. What do you want to do? It says ask. How far does this go, such and such...
ID6	This one is ok. It looks creative anyway.
ID7	This one looks just ok, and is fine. It looks a bit creative, because you see the different cars and all those stuff.
ID8	BBC is ok, but too much information at the same time.
ID9	This one is ok. I think I like the colour. The site is just simple, as in it speaks, and is just straightforward. Signup, upload, infact it's simple. So, you don't have to be having so many things fighting about, fighting with so many things, like the Ezine site. This one is not like that, This one is ok.
ID10	This one is just neutral, inbetween.
ID11	This is beautiful. (Investigator: Why do you say that?) You can see natural background, it looks natural. As in, they designed it close to nature as much as possible. It looks like a picture that was snapped, and just reproduced. That's just it.
ID12	This one is ok. It's simple also.

PageID	Participant's comments continued
ID13	Beautiful, beautiful, beautiful. (Investigator: Why do you say that?) Good colour combination. If you look at it critically well, you find out that the colours are not shouting against themselves. Everything is like just ok. (Investigator: So, for the visual quality of a webpage, is the colour like the most important thing for you?) Yeah, one thing is colour, colour puts somebody off. Like for me, when the colour is shouting too much, it puts me off. Number 1, because I need to access information. Naturally everybody responds to colour. While some people respond to bright colours, some respond to dark colours. Whenever they see the colours that put them off, no matter what information you are putting on that colour, doesn't make any sense to them. Because before anybody would access the information, he would be attracted to the information by the colour of the background first. (Investigator: Oh! so the colour carries some information, that is speaking?) Yeah, colour speaks. Anywhere you see red is like danger. Anywhere you see green, it's like go ahead. But there is a way you can combine the red and the green and it makes sense. But there are sometimes you just put some colours and ... For example, some people are put off by the colour pink, and they keep seeing pink, pink, pink, everywhere. It won't make any sense to them. Some people are put off by the colour gray. Infact gray puts off some people a lot. And some people whenever they see shouting red; shouting red, puts people off as well. Something like brown is very friendly. Something like blue, depending on the shade of the blue is very friendly as well.
ID14	So many colours, you get confused where to start from.
ID15	It's fantastic, it's ok. (Investigator: Is that because you use Facebook?) Yeah, probably, because it's straightforward and easy. It speaks for itself. It's straightforward. It's easy to access, and all those stuff.
ID16	Flickr is ok, but I think the picture needs to be a bit better off than this.
ID17	This one isn't original, it looks like cartoon. For a university it should be something better than that.
ID18	This one is fine, it's creative. (Investigator: You are not bothered about the orange colour there?) No, no, no, it's ok. It's creative, it's fine, it's ok. It's not putting you off.
ID19	This one is beautiful. The colour combination is there also, and it looks very creative.
ID20	Beautiful, it's ok. Well arranged. Everything the same colours. There's no colour confliction. (Investigator: Ok, so you like one or two colours. What would you advice?) Yes, you can see the green, you can thicken the green and light green, and just get a little colour that makes it look real and straightforward. Because when you have too many colours shouting at your eyes, everything is shouting at you, you get confused. You don't know where to go from or first. (Investigator: Ok, so you prefer different shades. If you just pick a colour, you work with different shades of that colour?) Yes, yes it's ok.

PageID	Participant's comments continued
ID21	This isn't good at all. It looks dull.
ID22	Too much information in it.
ID23	This is beautiful. (Investigator: Beautiful! What's beautiful about it?) It's simple, straightfoward, and simple, just a few colours. Very good background, and colour combination.
ID24	It's ok, it's beautiful, it's ok. (Investigator: The amount of information is alright with you?) The information is alright.
ID25	It doesn't look fascinating at all, just routine.
ID26	Too much information. The colours are not very original. It looks like a child's cartoon.
ID27	Marks and Spencer is good, it's beautiful. It looks simple, and it looks natural. It speaks for itself. (Investigator: What do you mean by natural when it comes to visual design?) As in, ok, the other time I was talking about the Royalmail, they had a picture of a person there, a lady there, and this is a picture of a lady. That looks like a cut and paste, the other one over there. (Investigator: It's not sharp?) No, it's not sharp. This one looks as if someone was snapped, as if the person was just behind the scene. (Investigator: So this has to do with how professional the photographer was?) Yes, yes, professional.
ID28	Megavideo is still ok, because not too many colours are in it.
ID29	Beautiful. It looks beautiful. It's simple and very directional.
ID30	This one has too many colours, too much information at the same time. (Investigator: So, is this a good or bad Webpage with respect to the visual quality?) It's not a very good one. I will flip through it once and then go back to it again.
ID31	Firefox, it's ok as well. (Investigator: Do you like the colour combinations in the Firefox Webpage?) It doesn't look very much emm... as in, it just looks balanced to an extent, but not too fascinating.
ID32	MSN is ok. Lots of information, but it's ok. (Investigator: Is that a good or bad thing when you have lots of information. Did you say it's ok with you still?) Yeah, it's ok with me, as in, you could start surfing around and find out information that you need.
ID33	This one looks ok, it's fine.
ID34	It's beautiful, but too much information at the same time also.
ID35	This one doesn't look original.
ID36	Too much information at the same time.

PageID	Participant's comments continued
ID37	The Royalmail is just average as well. Investigator: Why do you give it average for its visual quality?) You see, If you look at it closely, it doesn't look very natural.
ID38	This one looks just inbetween. (Investigator: Why is it?) Probably the colour is a bit dull.
ID39	It looks beautiful, fine colour combination. (Investigator: What's fine colour combination in your own words?) Probably because of the Christmas stuff. It really looks like Christmas anyway.
ID40	Tesco is ok, but has got too many things on it at the same time. Cluttered, too much information at the same time.
ID41	Twitter is just ok. (Investigator: Is that average again?) Yeah, average, inbetween.
ID42	It's ugly. It doesn't send any good message at all. It's dull, it's not even attractive, it's not fascinating. Probably the colours, I don't know.
ID43	Very fine. It's natural. (Investigator: So you have an attraction for pictures that have a bit of nature in them?) Yeah, nature.
ID44	This is beautiful, plenty of information, but it seems to be a crowded. It's cluttered, too much information
ID45	We feel fine, it's got a good background, but the colour blending is poor. Poor colour mixture, but it's ok.
ID46	This is beautiful. (Investigator: What's beautiful about it?) The colour, the presentation. It looks very much natural.
ID47	This is one is just not fascinating at all, except for the fact that it gives information. (Investigator: What's horrible about it?) Lots of languages written on it. Not communicating.
ID48	This one is just average as well.
ID49	The visual quality is ok, but a bit blurred - the picture, but it's ok..
ID50	This particular webpage is just average. It's attractive, it's a bit attractive and it's ok. Just average.

B.4 Demographics for the On-line Study

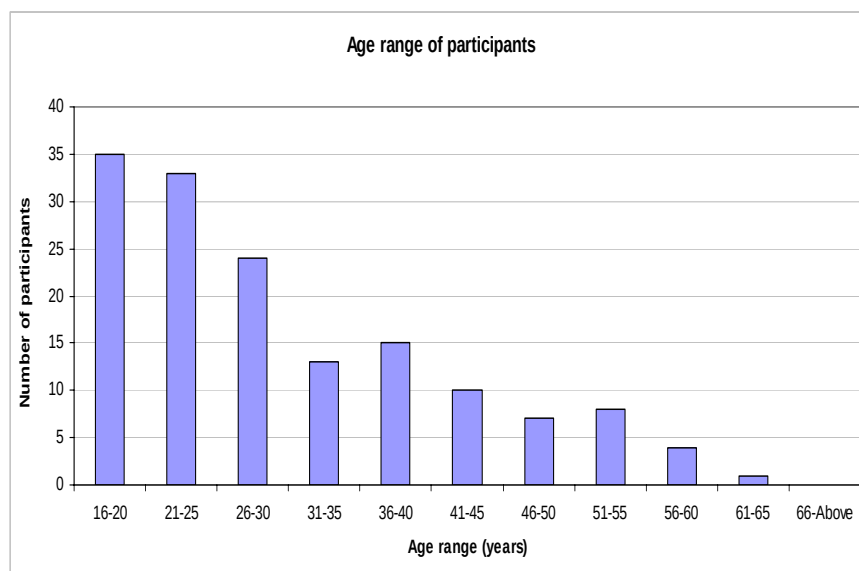


Figure B.4: Age information for the online aesthetic study

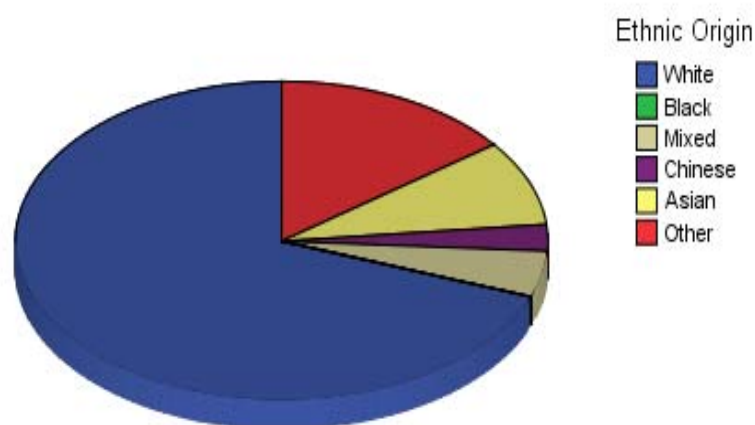


Figure B.5: Cultural background information for the on-line aesthetic study

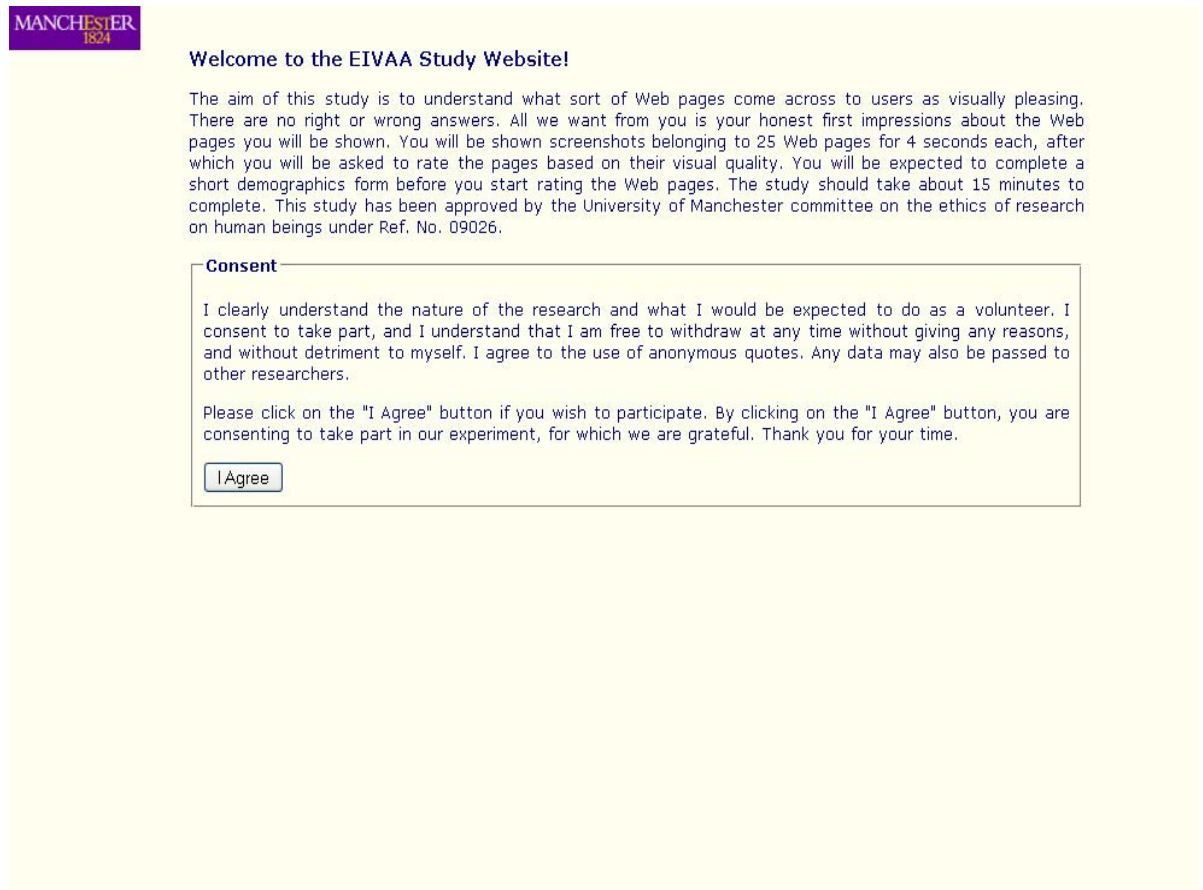
B.5 Web pages Used in the On-line Study

Table B.13: Webpages used in the on-line study and their urls.

ID	Page Name	URL
ID1	Answers.com	http://www.answers.com/
ID2	Askjeeves	http://uk.ask.com/?o=312&l=dir
ID3	Asos	http://www.asos.com/
ID4	Bigfat University	http://www.bigfatinstitute.org/
ID5	Directgov	http://direct.gov.uk/en/index.htm
ID6	Ezine Articles	http://ezinearticles.com/
ID7	Facebook	http://en-gb.facebook.com/
ID8	Fullsail University	http://www.fullsail.edu/
ID9	Google	http://www.google.co.uk/
ID10	Hello Sour Sally	http://www.hellosoursally.com/
ID11	Jonathan	http://www.jonathanyuen.com/
ID12	Livejournal	http://www.livejournal.com/
ID13	Marks and Spencer	http://www.marksandspencer.com/
ID14	Microsoft	http://www.microsoft.com/en/us/default.aspx
ID15	Pantagonia	http://www.patagonia.com/web/eu/home/index.jsp?OPTION=HOME_PAGE&assetid=9492
ID16	Play.com	http://www.play.com/
ID17	Rightmove	http://www.rightmove.co.uk/
ID18	Target	http://www.target.com/
ID19	Tesco	http://www.tesco.com/
ID20	Twitter	http://twitter.com/
ID21	Veer	http://www.veer.com/
ID22	Virgin Media	http://www.virginmedia.com/
ID23	Whalehunt	http://thewhalehunt.org/
ID24	Wordpress	http://wordpress.com/
ID25	Yell	http://www.yell.com/

B.6 Screenshots from the On-line Study Website

B.6.1 Welcome page



MANCHESTER
1824

Welcome to the EIVAA Study Website!

The aim of this study is to understand what sort of Web pages come across to users as visually pleasing. There are no right or wrong answers. All we want from you is your honest first impressions about the Web pages you will be shown. You will be shown screenshots belonging to 25 Web pages for 4 seconds each, after which you will be asked to rate the pages based on their visual quality. You will be expected to complete a short demographics form before you start rating the Web pages. The study should take about 15 minutes to complete. This study has been approved by the University of Manchester committee on the ethics of research on human beings under Ref. No. 09026.

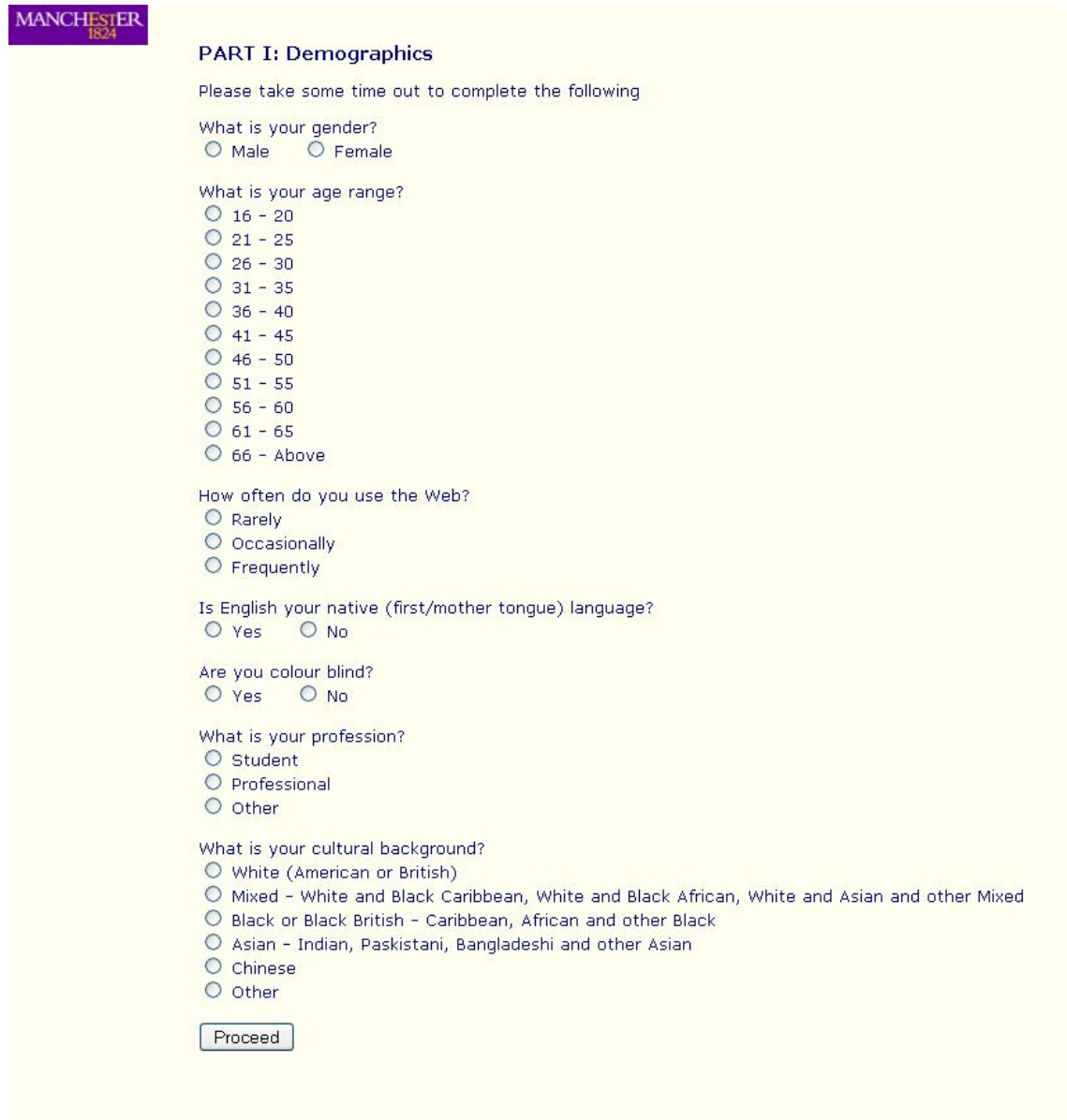
Consent

I clearly understand the nature of the research and what I would be expected to do as a volunteer. I consent to take part, and I understand that I am free to withdraw at any time without giving any reasons, and without detriment to myself. I agree to the use of anonymous quotes. Any data may also be passed to other researchers.

Please click on the "I Agree" button if you wish to participate. By clicking on the "I Agree" button, you are consenting to take part in our experiment, for which we are grateful. Thank you for your time.

Figure B.6: The experiment welcome page.

B.6.2 Demographics Web page



MANCHESTER
1824

PART I: Demographics

Please take some time out to complete the following

What is your gender?

☐ Male ☐ Female

What is your age range?

☐ 16 - 20
☐ 21 - 25
☐ 26 - 30
☐ 31 - 35
☐ 36 - 40
☐ 41 - 45
☐ 46 - 50
☐ 51 - 55
☐ 56 - 60
☐ 61 - 65
☐ 66 - Above

How often do you use the Web?

☐ Rarely
☐ Occasionally
☐ Frequently

Is English your native (first/mother tongue) language?

☐ Yes ☐ No

Are you colour blind?

☐ Yes ☐ No

What is your profession?

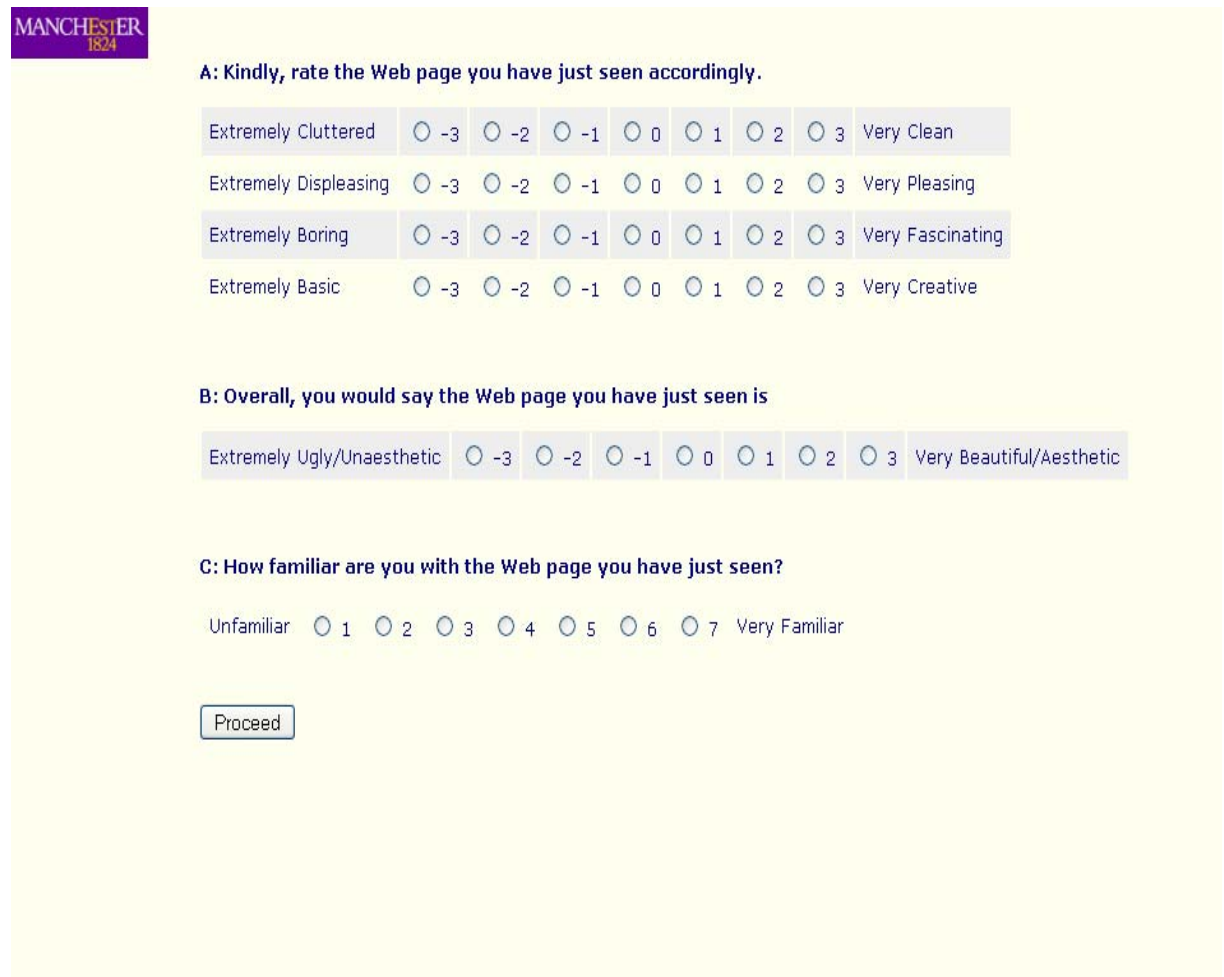
☐ Student
☐ Professional
☐ Other

What is your cultural background?

☐ White (American or British)
☐ Mixed - White and Black Caribbean, White and Black African, White and Asian and other Mixed
☐ Black or Black British - Caribbean, African and other Black
☐ Asian - Indian, Pakistani, Bangladeshi and other Asian
☐ Chinese
☐ Other

Figure B.7: The demographics Web page.

B.6.3 Rating Web page



MANCHESTER
1824

A: Kindly, rate the Web page you have just seen accordingly.

Extremely Cluttered	☐ -3	☐ -2	☐ -1	☐ 0	☐ 1	☐ 2	☐ 3	Very Clean
Extremely Displeasing	☐ -3	☐ -2	☐ -1	☐ 0	☐ 1	☐ 2	☐ 3	Very Pleasing
Extremely Boring	☐ -3	☐ -2	☐ -1	☐ 0	☐ 1	☐ 2	☐ 3	Very Fascinating
Extremely Basic	☐ -3	☐ -2	☐ -1	☐ 0	☐ 1	☐ 2	☐ 3	Very Creative

B: Overall, you would say the Web page you have just seen is

Extremely Ugly/Unaesthetic	☐ -3	☐ -2	☐ -1	☐ 0	☐ 1	☐ 2	☐ 3	Very Beautiful/Aesthetic
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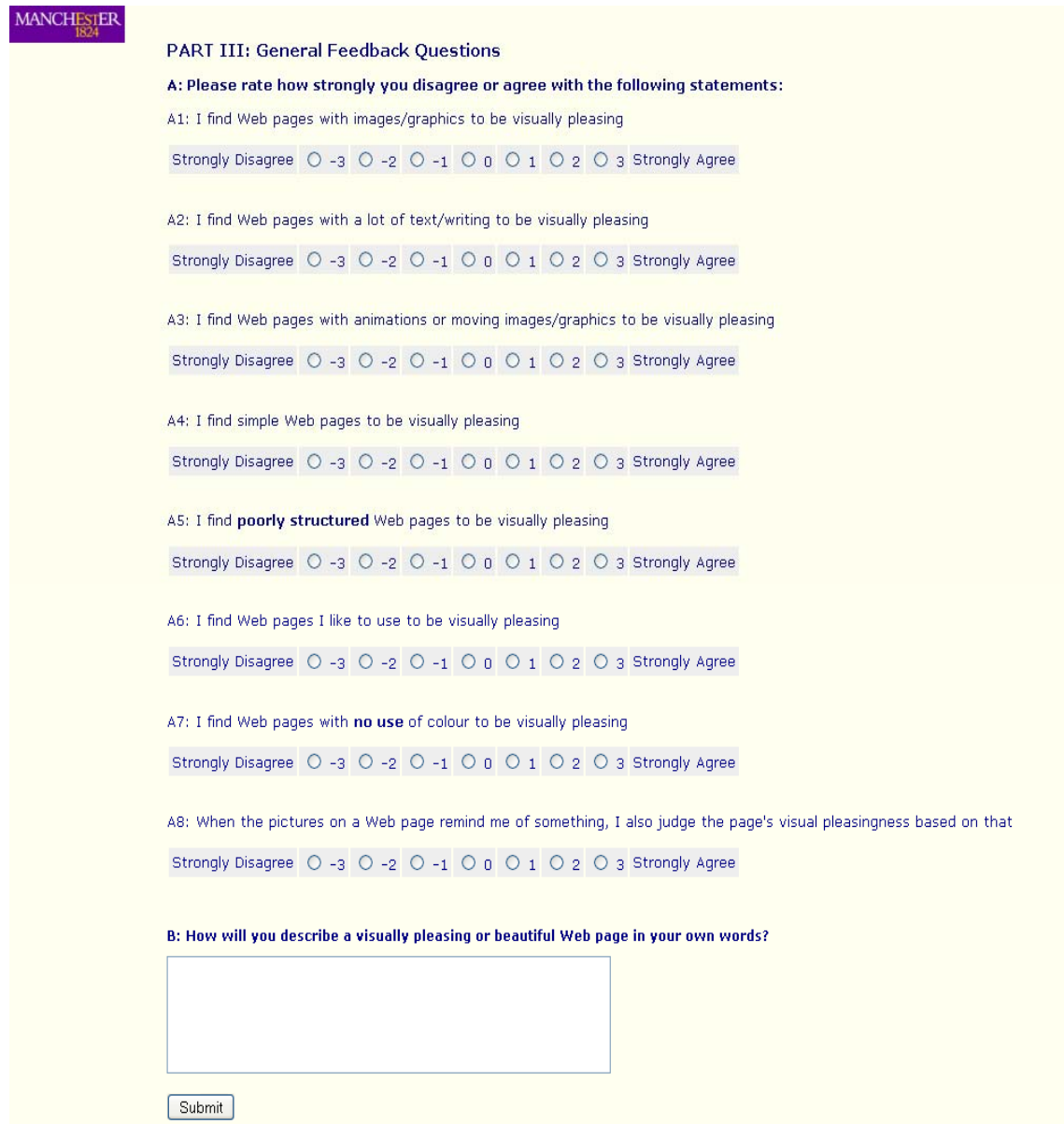
C: How familiar are you with the Web page you have just seen?

Unfamiliar ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 Very Familiar

[Proceed](#)

Figure B.8: The Web page for rating.

B.6.4 Feedback Web page



MANCHESTER 1824

PART III: General Feedback Questions

A: Please rate how strongly you disagree or agree with the following statements:

A1: I find Web pages with images/graphics to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A2: I find Web pages with a lot of text/writing to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A3: I find Web pages with animations or moving images/graphics to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A4: I find simple Web pages to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A5: I find **poorly structured** Web pages to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A6: I find Web pages I like to use to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A7: I find Web pages with **no use** of colour to be visually pleasing

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

A8: When the pictures on a Web page remind me of something, I also judge the page's visual pleasingness based on that

Strongly Disagree ☐ -3 ☐ -2 ☐ -1 ☐ 0 ☐ 1 ☐ 2 ☐ 3 Strongly Agree

B: How will you describe a visually pleasing or beautiful Web page in your own words?

Figure B.9: The feedback Web page.

B.7 Feedback Comments

Participants' responses for the subjective feedback question below:

Question: How will you describe a visually pleasing or beautiful Web page in your own words?

Table B.14: Participants' feedback responses.

PNo.	Participant's comments.
p1	Clean and easy to find the information/links that you want. Use of pictures with labels to help to find appropriate links.
p2	No comments.
p3	Simple, uncluttered, small images for things like buttons and menus, larger images for whatever visual information is being presented on the page.
p4	No comments.
p5	Clean, good balance of colours, text in a clean font only where needed, no adverts, not too many links/panels, minimalistic, and does it's job well, and nothing else.
p6	One that I instantly recognise and where the navigation is obvious.
p7	More high quality images/animations, less plain texts, with a good structure.
p8	No comments.
p9	Simple, with some graphics and not too much colours and text.
p10	Plain with big bright pictures and with a basic yet intuitive menu or navigation tool.
p11	Simple, clean content. Easy to navigate. The Web page makes it obvious where I should click to get to things that I think are obvious. Probably contains a search box. Doesn't contain tabs or nested menus. Isn't garish.
p12	It is simple and calm, doesn't shout things at me that I am not looking for and is welcoming and inviting.
p13	Clean layout, complementary colours, amusing or clever element of design, not just the same old tabular same old, not too much jarring animation or colour or images.

PNo.	Participant's comments.
p14	First and most important: It should be CLEAR what the Web page does - and what you can do on it, i.e. what is its purpose. Second, it should be obvious how to navigate, and there MUST NOT be an indication or suggestion (much less the reality) that the places one can navigate to are going to be filtered based on choices you make, in an attempt for the computer on the other side to 'guess' what it is you're looking for. After that, good, use of clean graphics in an urbane, refined style with colours that stand out without being garish - i.e. nothing overly subdued, "pastel-tone", nothing too bright and saturated. Images should involve simple shapes, usually combinations of geometric figures. Nothing 3-D, no animation. Finally, some small things, like no reverse-colour fonts (light on dark), avoidance of long text lists, no "entry screens" with a graphic only you have to click on, or large, distracting graphics/backgrounds in the main page.
p15	Simple, no loud colors, multiple colours if required with light shades. Writing in dark colours. Organised, categorized.
p16	Clean, colourful, simple but with a creative layout and use of images within the page. It's nice to see unique features as much of the Web looks the same and is becoming extremely boring to look at.
p17	It can not be explained . Depends on individuals.
p18	Simple, to the point and without distractions
p19	Not cluttered, easy to understand.
p20	No comments.
p21	A page with no clutter, where structural elements have rounded corners, adequate color contrast, backgrounds are not very dark, making use of nice or appropriate typography is really important and it should have a touch of surprise normally conveyed by a nice original pic or surprising/creative web structure.
p22	No comments.
p23	Simple - not too much text with simple navigation. Use of relevant images.
p24	Not too much text, clean graphics, not cluttered, serve well the purpose of the site
p25	Simple but creative design; professional use of colors and typography; stylistic; not crammed; with easily identifiable navigation elements and grouping; with logical grouping of elements;

PNo.	Participant's comments.
p26	No comments.
p27	No contrasting colors, no images that take the focus away from the content. Easy and intuitive to navigate with pleasant animations such as rollovers, but not any animated gifs.
p28	No comments.
p29	Not too much and not too little.
p30	Visually pleasing is when I like it when I see it. Of course this does not have anything to do with functional aspect.
p31	Not charged with too much content, with balanced use of colours (never using a too heterogeneous palette of colours) and with a layout structuring content in a coherent way from a semantic point of view.
p32	No comments.
p33	No comments.
p34	Pages with a minimalistic or coherent aspect, with a good identity. Pages that present the several components of the page in a harmonious relation among themselves, making good use of empty space.
p35	Simple means beautiful.
p36	Colors to be balanced and to be able to easily and visually find the information you are seeking.
p37	I love webpages with photographs and just the right amount of white space. The font size is big enough to read where you don't have to strain and there are headers.
p38	Interesting graphics / images. Minimal text, just enough to guide the user on site navigation. Animation and video can make for visually pleasing sites.
p39	Clean design, crisp fonts of a sensible size for body text (10-12pt), limited use of images.
p40	Visual pleasure is difficult to articulate. I usually associate the goodness of a page with how clear the function is, whether I can identify key content, and whether I know what to do next. So visual pleasure to& me is lack of noise.

PNo.	Participant's comments.
p41	A page with a clear purpose or function and a logical arrangement of content, with small simple graphics to add interest and the sparing use of color to highlight important elements.
p42	Visual impact that draws your attention and makes you want to explore what it offers. Lengthy text only if I want it and not pushed at me when I don't. Fairly short lists of hypertext links. Simplicity at first but without being overwhelmed once past the home page.
p43	Images should not be too much messy and at the same time pages should have proper combination of colours which should be eye pleasing. I strongly recommend not to use dark colours.
p44	You showed pages for sites that required different kinds to entry. For example, the simplest site is the most complex, Google. I do not like sites that give you a lot but partial information about the different directions you can go. I do like a well guided and graphical entry.
p45	A page with a clean look, not overloaded with information. If I cannot easily find content on it, then it is not a good page in my opinion. Items that distract me from the information are annoying.
p46	A Web page should not have so much info jammed into it that it's hard to read and absorb what's there. The colors and images should adhere to the classic ideals of beauty and not try to shock the sensibilities of the viewer.
p47	It makes me curious to click on something - or it helps me find what I am looking for.
p48	If it serves to its purposes, while maintaining a feeling of quality, which can be appreciated in many different forms: typography, arrangement of the elements on the screen, good illustrations... then it is pleasing. For example, A List Apart, Jason Santamaria, Subtraction... are examples of extremely beautiful (and useful) pages.
p49	A pleasing page has an uncluttered look, i.e. if there is text, it relates to a specific <i>*answer*</i> I'm looking for. Not too many columns and not a jumble of links to a multitude of subjects; rather, an appearance of some thoughtful organization. I like images that stand out, especially on a home page, and that represent what the site is <i>*about*</i> , sort of a visual clue to the site interior. Pages with large amounts of text such as e-articles are fine as long as the text is laid out in a straight-forward manner and additional text pages are clearly linked. Drop down lists are some of my least favorite page elements; they are rarely user friendly. I usually prefer pages with a white background for the text and a black or white background for the uncoded bits that surround the text and image areas. The page content seems to be clearer with black or white as a sort of frame.

PNo.	Participant's comments.
p50	No comments.
p51	These questions are very difficult to answer. The answer for me is that it depends. A page with no color can be more visually pleasing than a page with color, depending on the design and context. A beautiful page shows creativity, artistry and does not hurt my eyes. It has a balance of contrast and color for the content. A beautiful page invites me to click on something to explore. A beautiful page is relevant to the site / content it supports. It should also load quickly and/or elegantly.
p52	It is obvious what it does; has enough info but not too much; easily readable font/size; color use is restrained - used where it is needed but no for the sake of using color; non-strident colors; loads quick; animation is only used when needed and has an on/off switch; music if really required, starts off and the user must make a positive action to turn it on and must be able to turn it off (I will kill/leave a webpage if it starts making music that I can't easily turn it off); ABSOLUTELY must be work even if javascript is turned OFF (ok to ask to tell me to turn on Javascript on local/specified site(s) and then give me a chance to get back to the original Website.)
p53	Simple and easily navigated to get to what you want.
p54	No comments.
p55	Regardless of how visually pleasing a Website is, the sight of adverts completely puts me off. I don't like it when sites try to get as much information as possible. I think interesting or new stuff should be explicitly on show whilst the more specific stuff should be a link or two away. If a person came to the site in search of something specific they'll find it. Visually pleasing sites appear to know what they're doing whereas one's that try too hard and overcomplicate things can often look scrappy. I think the best site I've ever come across is NewScientist.com It's simple, tells you what's new and nothing more.
p56	Simple, uncluttered, up to the point, minimal use of colours.
p57	Basic.
p58	No comments.
p59	Some pages are extremely beautiful and some are average.
p60	Simple design supported by images, keep the amount of content moderate, too much is disconcerting, text should be structured in a way that allows a quick overview over the page's content.

PNo.	Participant's comments.
p61	Clean, simple, elegant, uncluttered.
p62	No comments.
p63	Images are different, out of the ordinary, and use some color. I look at the different font sizes and think the emphasized fonts are considered important.
p64	Something simple, uncluttered and easy to read. The location of its navigation links are easy to see and easy to see all of them. Pictures often add to the beauty but also add to the clutter.
p65	A Website that does not bombard me with too much information on the frontpage that I first arrive at, but provides a clear route where to head next during my visit.
p66	As simple and as clean as possible while maintaining it's purpose and functionality.
p67	Simple, clean easy to navigate, enough graphics or color to make it memorable.
p68	Suited to task.
p69	No comments.
p70	Main pages of the best Websites: 1) Make good use of their "real estate" - the most important part of the website gets the best placement, and its text and graphics are strongly related to each other and to the purpose of the site or the site's organization. 2) They are not cluttered. Clutter for me includes: - Multiple menus and tab levels along the top, with more menus layered in two or more lines at the top of the page, side, and bottom; and/or columns of menus taking up the main page (ugh). Especially if the menus' types and/or purposes overlap each other. - Too much text, especially too much small text that is hard/difficult to read - Graphics that don't relate to the purpose of the site or organization and that don't meaningfully inform you about what you can expect to find on the site. 3. Use labels with wording that clearly and succinctly conveys their meaning - labels or buttons with multiple lines of text read as clutter to me. And if I can't immediately get the gist of the meaning of that word, it again reads as clutter to me. I do have different standards and expectations for pages inside a web site - I do expect that they will be more content-heavy and less graphically oriented (depending on subject matter, of course), but I still will be seriously annoyed by unneeded clutter! Best of luck with your research study.

PNo.	Participant's comments.
p71	A Webpage is beautiful when it is visually engaging, elegantly organized, and above all offers a clear pathway to the information or service sought. Aesthetics are definitely important on the Web, but the visual beauty of a Webpage must be relevant to my information needs or they simply distract. Sometimes minimalism is useful, sometimes not.
p72	I like some color, some graphics/pictures, and white space. I like links where I can find more information if I choose or a easily navigable menu of choices, but these do not have to be pictures or graphics. I also like a "search" option so I can quickly find information. I don't want all the information contained on one page if the text become so tiny that it is hard to read with "old eyes" or those with visual issues.
p73	No comments.
p74	No comments.
p75	One that utilizes contrast and UI elements that facilitate my purpose for being on the site. The example questions above are too binary for me despite the rating scale, by the way. Thanks. Good luck.
p76	Lots of colour co-ordination and images in a logical order with simple, relevant text.
p77	Esthetically harmonious in shape, dimensions and colors.
p78	Well organised, good mix of text and image - text must be to-the-point and easy to read. Expandable menus and hideable features make Websites cleaner.
p79	A Website that is functional above all; if the information I need is easy to find, I will find the site more visually pleasing as well. A lot of different menus, animations, different colors and fonts make it difficult to find information, so these things are less pleasing.
p80	A visually pleasing Web page should have a balance between the amount of text presented onscreen with the amount of graphics, with any presented text clearly segregated and concise. I personally hate Web pages that contain too many text boxes and adverts on the first/home page.
p81	Colour, a few large images, not too cluttered. options very clear.
p82	Not too many colours.

PNo.	Participant's comments.
p83	Direct navigation for pages used for shopping/information services simple colour palettes for those. Interactive and unusual flash based pages for those pages showing art work etc. Ease of access to useful information and obvious links to information.
p84	No comments.
p85	Simple, creative, well structured and animated.
p86	Simple, clean with a big image and not too much writing or confusing elements on the front page.
p87	Simple, uncluttered, not too much text
p88	Neutral colours. Not too garish. Well spaced. Mac-like.
p89	Simple, uncluttered, easy to navigate, large clear graphics- not too many.
p90	Unique, Colourful, Creative, Simple, Artistic.
p91	Simple, focused, easy to navigate, and has everything you need to click on its homepage (e.g., contact details, delivery charges, terms and conditions, advanced search, etc). No ads.
p92	No comments.
p93	Simple, clearly laid out, easy to use.
p94	Informative, no oversized fonts with a clean layout.
p95	Simple, inspiring images and meaningful text. No additional advertisements.
p96	One that is clean and simple with links to what you want to use from the Website.
p97	Simple, clean and user friendly neutral/pastel calming colour scheme. simple animation.
p98	No comments.
p99	No comments.
p100	As minimalist as possible with one or two images that blends smoothly into the background which should ideally be a solid color that is not dark.

PNo.	Participant's comments.
p101	Simple, properly structured, good use of colors, based on theme of website
p102	Simple and easy to use but with a few images and a colour theme.
p103	Well-structured; carefully-chosen fonts; few, and carefully chosen and created graphics; no animated images; plenty of empty space.
p104	No comments.
p105	No comments.
p106	Clear and simple to understand so that it is easy to find what you want but also good use of colour/images.
p107	Pretty.
p108	Simple, with some graphics, clear layout with access to all required areas.
p109	No comments.
p110	Your eye seems naturally drawn to the items of interest on the page.
p111	Simple but original layout and design, images of beautiful characteristics, text understandable but intuitive.
p112	A visually pleasing website would have some 'white space', not be cluttered with lots of links, or ads, or moving images, and have an easily accessible and useful menu bar. There would also be some use of colour.
p113	No comments.
p114	A logical layout that is easy to use. Not cluttered with adverts or masses of information. User friendly and comprehensive with eye catching images. There should be a moderate amount on the page; not minimalist nor cramped. Colours are appealing, particularly if they complement each other and do not clash and distract attention too much.
p115	No comments.
p116	A page with a layout that allows the page's function to be grasped quickly and also generates a good feeling in the user - either through the reassuring familiarity of certain aspects of the page, or through good design involving well thought out design features that are easy on the eye. A page that is not boring.

PNo.	Participant's comments.
p117	No comments.
p118	Needs to be simple, but not boring. Which is hard I know!
p119	Simple yet artistic. Not too cluttered with tiny fonts.
p120	Clean, simple, creative.
p121	Bright colour, not too much text, not too many pictures but a bold, unusual or interesting photo - (like the guy in the big jacket one you showed), not too many indexes, easy to navigate around, if it's too wordy I won't even look at it. I want links and an easy time when I want to find what I want quickly.
p122	Beautiful.
p123	Something that catches my eye and makes me want to read on/visit again.
p124	One that doesn't have too much information, where I can find what I want. Not too much text, not too much images. It's difficult to describe.
p125	Easy to use, making me want to use it again.
p126	Text not cluttered and varying in format depending on purpose (link/etc); main features of website grouped together at the top or at the side; links with "buttons" for them: buttons are not too shiny/round/bloated.
p127	Simple, uncluttered, with images but not too many. good colouring.
p128	Something that is simple, with more images than text. More colours generally adds to its appeal.
p129	Something that serves it's purpose, doesn't make your eyes work hard to find the information you need.
p130	Simple, dynamic, easy to navigate.
p131	Something that is clearly structured yet has alot of different fascinating images and good colour use, and is easy to navigate around without having to read through lots of text.
p132	Clean, not a lot of clutter, looks like it would be easy to use.

PNo.	Participant's comments.
p133	Detailed yet attractive.
p134	Not too cluttered, but tastefully colourful. Easy to navigate and simple to understand at first glance.
p135	Simple and effective: nice scenic photo with a small amount of text that leaves you wanting to find out more.
p136	No comments.
p137	To look pleasant.
p138	They must use colour but not a complicated colour scheme. Sticking to max. four colours is best and not bright tacky colours. Simple to use and matching fonts. Lots of help using the website if needed.
p139	Something that does not contain too much data and makes use of images and colours when appropriate.
p140	Club and bar sites, holiday destinations.
p141	Colour, not masses of writing, pictures.
p142	Something a bit different to other websites with plenty of colour and fewer words.
p143	Simple, clean - easy to derive function at a glance.
p144	Colors that do not clash and are not hard to look at. Data that is well organized. Easy and Intuitive to use.
p145	One that uses colour in an eye catching way and provides the most relevant information in the simplest way. I like contemporary images.
p146	No comments.
p147	Nice pictures, clear, like art, easy to navigate.
p148	No comments.
p149	Simple layout with sections separated into blocks with some colourful images/logos.
p150	Simple and clean. Very few buttons to click on the homepage. Clear text, few words. Creative style with some fun or unexpected element.

PNo	Link	Image	Animation	Label	Button	Font	Menu	Tab	Colour	Text	Header	Video	Audio	Javascript	Advert	Structure	Background	DropDownList	TextBox	SearchBox
p51			✓						✓											
p52					✓				✓				✓							
p53																				
p54															✓					
p55	✓																			
p56									✓											
p57																				
p58																				
p59																				
p60		✓								✓						✓				
p61																				
p62																				
p63		✓				✓			✓											
p64	✓	✓																		
p65																				
p66		✓							✓											
p67																				
p68																				
p69					✓			✓												
p70		✓		✓			✓			✓										
p71																				
p72	✓	✓					✓		✓											✓
p73																				
p74																				
p75																				
p76		✓							✓	✓										
p77									✓	✓										
p78		✓					✓			✓										
p79			✓			✓	✓		✓											
p80		✓							✓	✓					✓				✓	
p81		✓							✓											
p82									✓	✓										
p83	✓		✓						✓											
p84																				
p85			✓													✓				
p86		✓								✓										
p87										✓										
p88									✓											
p89		✓																		
p90									✓											
p91															✓					✓
p92																				
p93																				
p94		✓				✓										✓				
p95										✓					✓					
p96	✓		✓																	
p97									✓											
p98																				
p99																				
p100		✓							✓								✓			

PxNo	Link	Image	Animation	Label	Button	Font	Menu	Tab	Colour	Text	Header	Video	Audio	Javascript	Advert	Structure	Background	DropDownList	TextBox	SearchBox
p101		✓			✓				✓							✓				
p102		✓							✓											
p103		✓	✓				✓													
p104																				
p105																				
p106		✓							✓											
p107		✓																		
p108																✓				
p109																				
p110																				
p111		✓					✓			✓						✓				
p112			✓												✓					
p113																				
p114		✓							✓						✓					
p115																				
p116																				
p117																				
p118																				
p119							✓													
p120																				
p121	✓	✓							✓	✓										
p122																				
p123																				
p124		✓								✓										
p125																				
p126					✓					✓										
p127	✓	✓																		
p128		✓								✓										
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p130																				
p131		✓							✓	✓						✓				
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p145		✓							✓											
p146																				
p147		✓																		
p148																				
p149		✓																		
p150					✓				✓	✓						✓				
TOTAL	12	52	12	2	4	11	9	2	46	30	1	1	1	1	7	18	4	1	1	3

Appendix C

Data for Accessibility Audits

C.1 Materials Used in the Accessibility Audits

C.1.1 Demographic form

Project Ref.
No. 09026.

Participant No.

Demographic Form

Please take some time out to answer the following questions. Put an x where applicable.

1. What is your gender?

☐ Male

☐ Female

2. What is your age range?

☐ 20 – 25

☐ 26 – 30

☐ 31 – 35

☐ 36 – 40

☐ 41 – 45

☐ 46 – 50

☐ 51 – 55

☐ 56 – 60

☐ 61 – 65

☐ 66 - 70

3. Please rate your English Language fluency level

☐ Beginner

☐ Intermediate

☐ Fluent

4. How long have you been working in the Web accessibility area?

☐ 1 – 3yrs

☐ 4 – 6yrs

☐ 7 – 9yrs

☐ 10 - 12yrs

☐ 13yrs - above

5. How would you rate your knowledge of Web accessibility?

☐ Beginner

☐ Intermediate

☐ Expert

6. How many Websites have you tested for accessibility in the last 6 months?

Please specify here:

7. Have you ever worked as a Web accessibility consultant?

☐ Yes

☐ No

C.1.2 Participant information sheet

Project Ref. No. 09026.

EMPIRICAL INVESTIGATION OF VISUAL AESTHETICS AND ACCESSIBILITY (EIVAA)

Participant Information Sheet

The aim of this experiment is to assess the accessibility level of Web pages using the barrier walkthrough method. You will be given a Web page(s) and a spreadsheet(s) with a list of common accessibility barriers faced by 3 categories of users with visual impairments namely: *blind users*: people who cannot see and have to use screen readers to access the Web; *users with low vision*: people who see partially and require screen magnifiers, accessibility features offered by operating systems, and sometimes screen readers to access the Web; and *users with colour blindness*: people who cannot distinguish between certain colours. Imagine users with the listed visual impairments are seeking information/ browsing the Web. You will be expected to examine a Web page for the presence of the barriers listed. The spreadsheet(s) will be used to record your findings. If you find more than one occurrence of a barrier type, please repeat/insert a row in the spreadsheet to enable you record your findings. If you cannot find a particular barrier type on a given webpage, just leave the cell blank or write Not Applicable (N/A). Proceed with the barrier walkthrough method as follows:

STEP 1

Go through the barrier checklist, if you find a barrier on the given Web page, please state the **impact** level of the barrier in question as follows:

- 3 – The barrier will definitely make a user with the stated visual impairment to give up on their task.
 - 2 – The barrier will make a user with the stated visual impairment adopt a trial-and-error strategy.
 - 1 – A user with the stated visual impairment can cope or still get around with the barrier in question.
- Please feel free to use your expertise and discretion to assign an *impact* score to a barrier on a Web page. The above serves as a guide only. Remember 3 is the worst and 1 is the best case.

STEP 2

Then, state the **persistence** of the barrier based on the following criteria:

- 3 – The barrier will show up continuously when a user is trying to carry out a task for example.
 - 2 – The barrier shows up often.
 - 1 – The barrier appears once and rarely shows up again.
- Please feel free to use your expertise and discretion to assign a *persistence* score to a barrier on a Web page. The above serves as a guide only. Remember 3 is the worst and 1 is the best case.

STEP 3

Finally, please select the appropriate **severity** rating for the barrier found using the table below:

Impact	Persistence	Severity
1	1	minor
1	2	minor
1	3	significant
2	1	significant
2	2	significant
2	3	critical
3	1	critical
3	2	critical
3	3	critical

As part of the study, a demographic and post-evaluation form will be filled to ensure we take into account a wide cross-section of judges.

This experiment has been approved by the University of Manchester committee on the ethics of research on human beings under Ref. No. 09026.

Where can I obtain more information about the barrier walkthrough method?

Please read about the barrier walkthrough method here if you need some more insight or wish to clarify what a particular barrier means in the context of this study:

<http://sole.dimi.uniud.it/~giorgio.brajinik/projects/bw/bw.html>

How is confidentiality maintained?

Your name/identity will not be collected. Instead, you will be allocated a number to identify your data. Your name/identity will not be associated with this number in any way.

What if I do not want to take part?

It is up to you to decide whether or not to take part. If you decide to take part, you will be asked to consent via e-mail. If you do not wish to participate anymore, you can withdraw without giving any reasons and without detriment to yourself, and if you wish, your data will be destroyed.

Where can I obtain more information about this research in general?

For more information please contact:

Grace Mbipom
Room LF1,
School of Computer Science,
Kilburn Building, Oxford Road,
Manchester, M13 9PL,
England, UK
E-mail: grace.mbipom@cs.manchester.ac.uk

Thank you for giving your time.

C.1.3 Post-evaluation form

Project Ref.
No. 09026.

Post Evaluation Questionnaire

Participant No.

Page Name:

Please take some time out to answer the following questions:

1. How long did it take you to complete the evaluation?

2. Which tools did you use to help you evaluate the Web page given?

Please specify any automated tools, assistive technologies etc. used to aid the process.

3. Can you please rate your confidence in identifying and rating all the accessibility barriers?

☐ (1) very low ☐ (2) ☐ (3) ☐ (4) ☐ (5) very high

4. Is there any other barrier that you have identified in the Web page(s) that is not listed in the given barrier sheet? Can you provide a brief description please?

5. Can you please rate the level of effort required to do the evaluation?

☐ (1) very low ☐ (2) ☐ (3) ☐ (4) ☐ (5) very high

6. Can you please rate the level of your productivity?

☐ (1) very low ☐ (2) ☐ (3) ☐ (4) ☐ (5) very high

C.2 Severity and Confidence Interval Matrices

Table C.1: Severity (left) and confidence interval (right) matrices for ID1

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.23	0.54	0.31	11	BL	0.04 0.49	0.28 0.79	0.09 0.57	
LV	0.25	0.75	0.13	6	LV	0.01 0.58	0.42 0.99	0.00 0.36	
CB	0.33	0.67	0.33	1	CB	0.00 0.78	0.22 1.00	0.00 0.78	

Table C.2: Severity (left) and confidence interval (right) matrices for ID2

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.75	0.25	0.13	6	BL	0.42 0.99	0.01 0.58	0.00 0.36	
LV	0.80	0.20	0.20	3	LV	0.47 1.00	0.00 0.53	0.00 0.53	
CB	0.67	0.33	0.33	1	CB	0.22 1.00	0.00 0.78	0.00 0.78	

Table C.3: Severity (left) and confidence interval (right) matrices for ID3

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.60	0.40	0.10	8	BL	0.30 0.87	0.13 0.70	0.00 0.29	
LV	0.63	0.38	0.13	6	LV	0.30 0.91	0.09 0.70	0.00 0.36	
CB	0.50	0.50	0.25	2	CB	0.09 0.91	0.09 0.91	0.00 0.63	

Table C.4: Severity (left) and confidence interval (right) matrices for ID4

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.20	0.20	0.70	8	BL	0.00 0.49	0.00 0.49	0.40 0.94	
LV	0.22	0.56	0.33	7	LV	0.01 0.53	0.25 0.84	0.08 0.65	
CB	0.33	0.33	0.67	1	CB	0.00 0.78	0.00 0.78	0.22 1.00	

Table C.5: Severity (left) and confidence interval (right) matrices for ID5

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.80	0.20	0.20	3	BL	0.47 1.00	0.00 0.53	0.00 0.53	
LV	0.50	0.33	0.33	4	LV	0.15 0.85	0.03 0.71	0.03 0.71	
CB	0.33	0.33	0.67	1	CB	0.00 0.78	0.00 0.78	0.22 1.00	

Table C.6: Severity (left) and confidence interval (right) matrices for ID6

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.83	0.17	0.17	4	BL	0.54 1.00	0.00 0.46	0.00 0.46	
LV	0.60	0.40	0.20	3	LV	0.20 0.94	0.06 0.80	0.00 0.53	
CB	0.50	0.50	0.25	2	CB	0.09 0.91	0.09 0.91	0.00 0.63	

Table C.7: Severity (left) and confidence interval (right) matrices for ID7

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.75	0.25	0.06	14	BL	0.52 0.93	0.07 0.48	0.00 0.19	
LV	0.80	0.10	0.20	8	LV	0.51 1.00	0.00 0.29	0.00 0.49	
CB	0.33	0.67	0.33	1	CB	0.00 0.78	0.22 1.00	0.00 0.78	

Table C.8: Severity (left) and confidence interval (right) matrices for ID8

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.42	0.33	0.33	10	BL	0.17 0.69	0.10 0.61	0.10 0.61	
LV	0.50	0.50	0.13	6	LV	0.19 0.81	0.19 0.81	0.00 0.36	
CB	0.33	0.67	0.33	1	CB	0.00 0.78	0.22 1.00	0.00 0.78	

Table C.9: Severity (left) and confidence interval (right) matrices for ID9

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.55	0.45	0.09	9	BL	0.27 0.81	0.19 0.73	0.00 0.27	
LV	0.75	0.25	0.13	6	LV	0.42 0.99	0.01 0.58	0.00 0.36	
CB	0.33	0.67	0.33	1	CB	0.00 0.78	0.22 1.00	0.00 0.78	

Table C.10: Severity (left) and confidence interval (right) matrices for ID10

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.13	0.44	0.50	14	BL	0.00 0.34	0.21 0.67	0.27 0.73	
LV	0.57	0.14	0.36	12	LV	0.32 0.81	0.00 0.38	0.14 0.61	
CB	0.25	0.75	0.25	2	CB	0.00 0.63	0.37 1.00	0.00 0.63	

Table C.11: Severity (left) and confidence interval (right) matrices for ID11

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.17	0.43	0.43	21	BL	0.04 0.35	0.24 0.63	0.24 0.63	
LV	0.37	0.32	0.37	17	LV	0.17 0.59	0.13 0.53	0.17 0.59	
CB	0.25	0.75	0.25	2	CB	0.00 0.63	0.37 1.00	0.00 0.63	

Table C.12: Severity (left) and confidence interval (right) matrices for ID12

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.57	0.29	0.29	5	BL	0.23 0.88	0.02 0.64	0.02 0.64	
LV	0.50	0.50	0.25	2	LV	0.09 0.91	0.09 0.91	0.00 0.63	
CB	0.33	0.67	0.33	1	CB	0.00 0.78	0.22 1.00	0.00 0.78	

Table C.13: Severity (left) and confidence interval (right) matrices for ID13

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.80	0.20	0.10	8	BL	0.51 1.00	0.00 0.49	0.00 0.29	
LV	0.67	0.22	0.22	7	LV	0.35 0.92	0.01 0.53	0.01 0.53	
CB	0.33	0.33	0.67	1	CB	0.00 0.78	0.00 0.78	0.22 1.00	

Table C.14: Severity (left) and confidence interval (right) matrices for ID14

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.71	0.29	0.14	5	BL	0.36 0.98	0.02 0.64	0.00 0.40	
LV	0.83	0.17	0.17	4	LV	0.54 1.00	0.00 0.46	0.00 0.46	
CB	0.67	0.33	0.33	1	CB	0.22 1.00	0.00 0.78	0.00 0.78	

Table C.15: Severity (left) and confidence interval (right) matrices for ID15

Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.50	0.50	0.06	14	BL	0.27 0.73	0.27 0.73	0.00 0.19	
LV	0.69	0.31	0.08	11	LV	0.43 0.91	0.09 0.57	0.00 0.23	
CB	0.50	0.50	0.25	2	CB	0.09 0.91	0.09 0.91	0.00 0.63	

Table C.16: Severity (left) and confidence interval (right) matrices for ID16

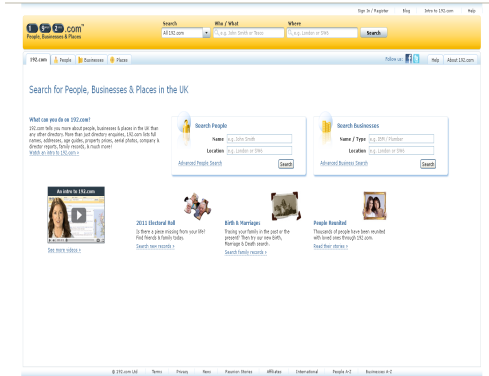
Severity					Severity				
Type	1	2	3	Total	Type	1	2	3	
BL	0.23	0.38	0.46	11	BL	0.04 0.49	0.15 0.65	0.21 0.72	
LV	0.55	0.09	0.45	9	LV	0.27 0.81	0.00 0.27	0.19 0.73	
CB	0.50	0.50	0.25	2	CB	0.09 0.91	0.09 0.91	0.00 0.63	

Appendix D

Data for Evaluation

D.1 Web Pages Used in the Evaluation

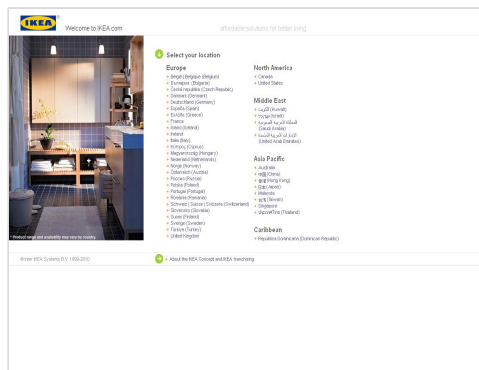
D.1.1 Screenshots of the Web Pages and their study IDs



D.1.1 ID 1



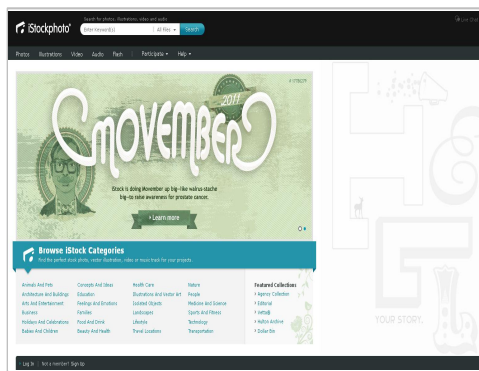
D.1.2 ID 2



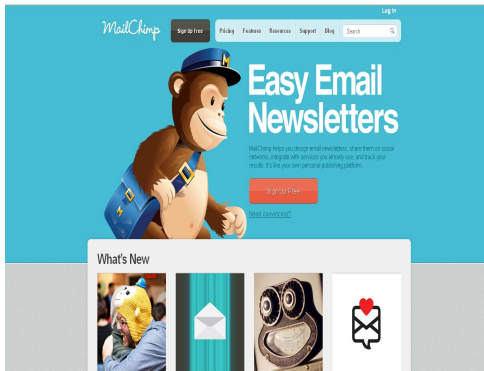
D.1.3 ID 3



D.1.4 ID 4



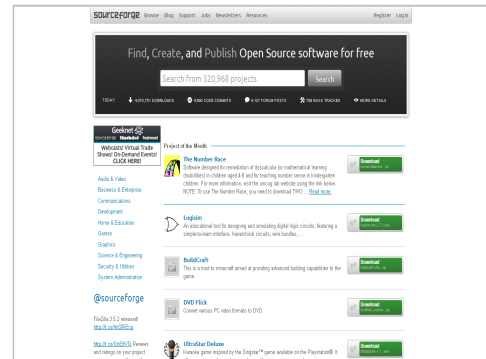
D.1.5 ID 5



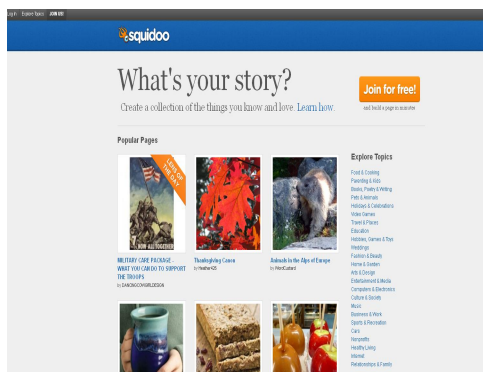
D.1.6 ID 6



D.1.7 ID 7



D.1.8 ID 8



D.1.9 ID 9



D.1.10 ID 10

Figure D.1: Screenshots of webpages used in the evaluation.

D.1.2 Web page URLs

Table D.1: Web pages used in the evaluative study and their urls.

Page Name	URL
192.com	http://www.192.com/
Go.com	http://go.com/
Ikea	http://www.ikea.com/gb/en/
isohunt	http://isohunt.com/
istockphoto	http://www.istockphoto.com/
mailchimp	http://mailchimp.com/
mashable	http://mashable.com/
sourceforge	http://sourceforge.net/
squidoo	http://www.squidoo.com/
talktalk	http://sales.talktalk.co.uk/

Appendix E

Technical Reports

- **Examining the Relationship Between Visual Aesthetics and Web Accessibility: A Formative Study**
Available on-line at <http://wel-eprints.cs.manchester.ac.uk/68/>
- **Visual Aesthetics and Accessibility: Extent and Overlap A Review of the Literature**
Available on-line at <http://wel-eprints.cs.manchester.ac.uk/82/>
- **Commonalities Between the Aesthetic Judgements of Web Users**
Available on-line at <http://wel-eprints.cs.manchester.ac.uk/134/>
- **The Interplay Between Web Aesthetics and Accessibility**
Available on-line at <http://wel-eprints.cs.manchester.ac.uk/>

Appendix F

Ethics Approval

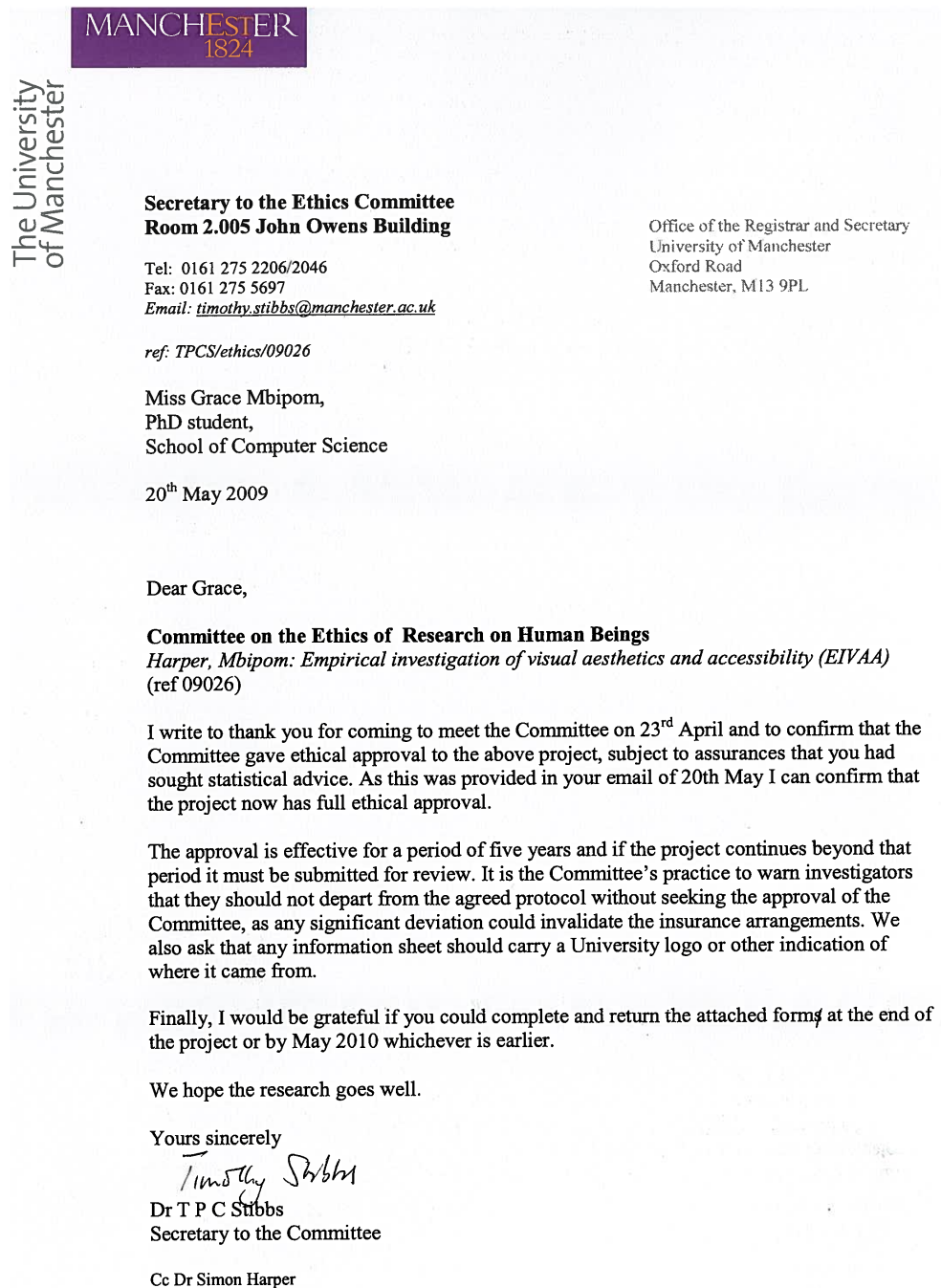


Figure F.1: Ethics approval letter