Assessing dimensions of perceived visual aesthetics of web sites ☆

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Abstract

Despite its centrality to human thought and practice, aesthetics has for the most part played a petty role in human–computer interaction research. Increasingly, however, researchers attempt to strike a balance between the traditional concerns of human–computer interaction and considerations of aesthetics. Thus, recent research suggests that the visual aesthetics of computer interfaces is a strong determinant of users' satisfaction and pleasure. However, the lack of appropriate concepts and measures of aesthetics may severely constraint future research in this area. To address this issue, we conducted four studies in order to develop a measurement instrument of perceived web site aesthetics. Using exploratory and confirmatory factor analyses we found that users' perceptions consist of two main dimensions, which we termed "classical aesthetics" and "expressive aesthetics". The classical aesthetics dimension pertains to aesthetic notions that presided from antiquity until the 18th century. These notions emphasize orderly and clear design and are closely related to many of the design rules advocated by usability experts. The expressive aesthetics dimension is manifested by the designers' creativity and originality and by the ability to break design conventions. While both dimensions of perceived aesthetic are drawn from a pool of aesthetic judgments, they are clearly distinguishable from each other. Each of the aesthetic dimensions is measured by a five-item scale. The reliabilities, factor structure and validity tests indicate that these items reflect the two perceived aesthetics dimensions adequately.
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1. Introduction

Traditionally, the main emphasis of the field of human–computer interaction has been on efficiency considerations. Human–computer interaction researchers and practitioners have traditionally emphasized objective performance criteria, such as time to learn, error rate and time to complete a task (Butler, 1996). Consequently, other relevant aspects have been neglected. Thus, readers of human–computer interaction textbooks can hardly find any reference to aesthetic considerations in design. While some in other design disciplines may reject the importance of aesthetic criteria, these disciplines have nonetheless paid attention and spawned lively debates on this issue. With few exceptions this has not been the case in the field of human–computer interaction.

The importance of beauty, which we now refer to as "aesthetics"—of man, nature, or artefacts—has been recognized since antiquity. Vitruvius, the first systematic theoretician of architecture (1st Century BC), counted beauty among architecture's three basic requirements (Kruft, 1994). Later, Alberti defined beauty as the wholeness of a body, "a great and holy matter" (Johnson, 1994, p. 402). Modern social science has demonstrated the importance of aesthetics in everyday life. In a seminal paper, Dion et al. (1972), demonstrated that a person's physical appearance influences other aspects of social interaction. People are affected by the aesthetics of nature and of architecture (e.g. Nasar, 1988a; Porteous, 1996). Aesthetics was found to play an important role in new product development, marketing strategies, and the retail environment (Russell and Pratt, 1980; Russell, 1988; Kotler and Rath 1984; Whitney, 1988). Bloch (1995) concluded that the "physical form or design of a product is an unquestioned determinant of its marketplace success" (p. 16).

The robust findings regarding the importance of aesthetics in most walks of life make its absence from the human–computer interaction agenda harder to justify. Indeed, recent research indicates that users' interactions with computers are essentially social, and that their responses resemble responses to social situations (Reeves and Nass, 1996). Evidence in support of the importance of aesthetics in various aspects of computing has also emerged recently. This evidence encompasses both hardware and software issues. For example, Apple's iMac was heralded as the "aesthetic revolution in computing," and an indication that the visual appearance of the computer has become a major factor in buyers' purchase decisions (Postrel, 2001). Recent empirical studies in the field of human–computer interaction have also found that the aesthetic aspect of various computing products serves an important role in shaping users attitudes in general (Kurosu and Kashimura, 1995; Tractinsky, 1997; Tractinsky et al., 2000) and specifically in the context of the web (Schenkman and Jonsson, 2000; van der Heijden, 2003).

The ubiquity of web-based applications has generated a large body of research in human–computer interaction regarding the design of such applications. With a few exceptions, though, this research has neglected the aesthetic dimension of web sites. Those studies that do attend to web site aesthetics tend to view it as a unidimensional construct (e.g. van der Heijden, 2003; Schenkman and Jonsson, 2000). Our goal was to further explore how users perceived the aesthetics of web sites beyond the general

question of whether the site is attractive. For this purpose we developed a measurement model of users' perceptions of the aesthetics of web sites. Developing such a model has two-fold advantages. Firstly, the process of developing the measures can in itself provide insights regarding perceived dimension of web site aesthetics. Secondly, developing reliable and valid measures would facilitate future research on aesthetics, its effects on human-computer interaction, and its relation to other perceived qualities of interactive systems in general and of web sites in particular. Due to the paucity of research on this specific topic, we have adopted an exploratory approach to this study, which seeks to identify the relevant constructs and the relationships among them.

The rest of this paper is organized as follows: Section 2 reviews literature on various aspects of aesthetic perceptions in general and in the areas of design and human–computer interaction in particular. In Section 3 we describe a series of studies that were conducted in order to develop and to evaluate a measurement scale of perceived web site aesthetics. In Section 4 we discuss the studies' results and their implications. We summarize our findings and arguments in Section 5.

2. Aesthetic perceptions

The term "aesthetics" has evolved through the years, has been studied from different viewpoints, and has different meanings for different schools of thought. In this chapter we only review a few aspects of aesthetics which serve as a background for our study. We begin with the historical roots of the concept, followed by subsections on philosophical and empirical approaches to the study of aesthetics. We conclude this section by examining how aesthetics was dealt with in engineering, human–computer interaction and web design.

2.1. Historical roots

Historically, aesthetic values appeared as a reformulation of ideas about beauty, subsequently replacing them. In some ancient traditions, beauty, and the perception of beauty, were of cosmic importance (Feagin and Maynard, 1997). The word beauty is commonly applied to things that are pleasing, either to the senses, to the imagination, or to our understanding. The words of Thomas Aquinas reveal the roots of the standard meaning of beauty: "Let the beautiful be defined as that the very apprehension of which pleases" (Sparshott, 1963). Beauty's abiding meaning is associated with order, but in the more modern readings the aesthetic interpretation of beauty is associated with delight and perception (Feagin and Maynard, 1997).

The idea of beauty for its own sake is a relatively new concept in Western thought. Greek philosophers judged artefacts primarily on how suitable they were for their intended use and on the quality of their craftsmanship. Consequently, the idea of judging artefacts based on their creativity or the idea of art as an expression of the artist's personality were absent from their discussions (Arnheim, 1964/66; Osborne, 1968). During the renaissance, the laws of beauty were equated with the laws of nature; beautiful design had to rely on the principles of natural beauty (Kruft, 1994).

The view that considers the aesthetic aspect of artefacts as autonomous, appreciated by its own standards, is dated much later. It is not until the eighteenth century that the word "aesthetics" (from the Greek aisthanesthai—to perceive) was introduced into philosophical terminology by Baumgarten (Saw and Osborne, 1968). Baumgarten argued that the perfection of sensory awareness is to be found in the perception of beauty. By the end of that century "aesthetics" was no longer merely a technical term in philosophy; it became an integral part of the general language. Of the range of connotations of the term "aesthetics" that exist today in various academic disciplines and in common language, we are interested here in its meaning as "*an artistically beautiful or pleasing appearance*" (The American Heritage Dictionary of the English Language), or as "*a pleasing appearance or effect: Beauty*" (Merriam-Webster's Collegiate Dictionary).

Broadly speaking, aesthetics has been studied by two different investigative methods: the philosophical approach (also termed "humanistic" by Porteous, 1996) and the empirical approach (c.f., Swede, 1994). Naturally, both methods have mostly relied on the studies of works of art in developing and establishing theories of aesthetics, although other contexts, such as natural and constructed landscapes, architectural work and other artefacts have served as a fertile ground for the study of aesthetics. We present a brief overview of these methods in the next subsections.

2.2. Philosophical approaches to the study of aesthetics

Philosophers have approached the study of aesthetics from a variety of viewpoints. We chose to concentrate here on two of those perspectives in order to clarify our eventual approach to this study.

Intentionality of aesthetic attitudes: Perhaps at the basis of any study of aesthetics lies the question of whether an aesthetic attitude develops when viewing of an object is done with a certain purpose in mind (Fenner, 1996). In other words, when attending an object, is the subject guided by a purpose or a set of distinct properties possessed by the object that are of interest to him? For Socrates, for example, the aesthetic attitude was a derivative of the practical, useful value of an object (Borev, 1981). A modern day development of this argument have been advocated by the functionalist theory of aesthetics that maintained that "if a thing is made to function well, if its construction is well suited to the job it has to do, then that thing will be beautiful" (Osborne, 1968, p. 24). Perhaps the most familiar formulation of this idea can be found in Louis Sullivan's oft-quoted phrase "form follows function." On the other extreme, Kant has claimed that the aesthetic attitude is found when one attends to the object in the absence of any purpose whatsoever (Osborne, 1968). For Kant, the interest is in the object's properties intrinsically and not instrumentally (Borev, 1981). Theophile Gautier has taken this point of view to the extreme: "Nothing is truly beautiful except that which can serve for nothing; whatever is useful is ugly" (Osborne, 1968, p. 200). Obviously, both of these extremes are quite unsuitable to our modern society, where products are judged on both their instrumental and aesthetic merits. Thus, for example, recent theories of design maintain that beauty is not strictly determined by abiding to requirements dictated

by use and economy but rather it is bounded by those conditions. Yet within the boundaries of those forces the designer still have ample leeway in determining the final form (and beauty) of the artefact (Osborne, 1968).

Yet, the contrasting viewpoints regarding the necessity of intentionality for the formation of aesthetic attitudes are related to another important debate regarding aesthetic judgements, which is presented below.

The objective/subjective debate: This pertains to the question of whether aesthetics should be viewed objectively or subjectively. During the Renaissance, beauty was assumed to be an objective property of things. The objective view emphasizes the object's properties and theorizes about those attributes which make it beautiful. Thus, early notions of artefact's beauty have emphasized properties such as order, proportion and symmetry (Osborne, 1968; Fenner, 1996). The quest for the attributes of beauty has lead to attempts to quantify it through mathematical formulae (e.g. the Golden Section) and later to a branch of research that tried to empirically demonstrate the validity (or lack of it) of such formulae (e.g. Boselie, 1992).

On the other hand, the subjective approach, represented by Hume and Kant (cf. Sircella, 1975), argues that the analysis of aesthetics should view beauty within the subject and not in the object. It sees a connection between beauty and emotion. According to Osborne (1968, p. 129) Kant distinguishes between: (1) experienced pleasure that result from an aesthetic experience, which vary by individuals, and (2) the aesthetic experience itself, which is the harmony of the cognitive faculties, and which is relatively invariant among individuals. The beautiful object is one that is adapted to these cognitive powers, stimulates and sustains them. The criterion by which we judge is the private individual pleasure that we experience when the cognitive faculties are fully stimulated. However, since it is difficult to explicitly refer an experience to either being objective or subjective, most current theories are positioned somewhere in between (Rajamannar, 1961), assuming an interactionist position according to which aesthetic perceptions depend both on the stimulus and on the individual's characteristics (e.g. Porteous, 1996).

2.3. Empirical studies of aesthetics

Empirical studies of aesthetics can be roughly divided into two categories. The first category includes studies that attempt to experimentally test hypotheses about the effects of isolated elements of an object or a form on human preferences. This type of research usually seeks to identify general laws of aesthetic qualities that can be found in the evaluated object. It is most commonly associated with the "experimental aesthetics" stream of research (e.g. Berlyne, 1974a). The second category includes studies that are more exploratory in nature, which try to delineate higher order factors that represent peoples' perceptions of the evaluated objects. This stream of research is typified by concerns about subjective perceptions of aesthetics rather than with the objective properties of things.

The experimental approach: During the 19th century, the field of experimental aesthetics emerged in an attempt to rely on scientific methods and empirical data to establish general laws that govern our aesthetic preferences. It was characterized by

Fechner's attempts to discover laymen's preferences based on artistic and architectural objective rules of thumb e.g. the golden ratio and other Pythagorean proportions (cf. Arnheim, 1985). The experimental approach was advocated as a scientific, bottom-up approach, as opposed to the philosophical, top-down, way of understanding aesthetic attitudes (Swede, 1994). The underlying assumption of early experimental aesthetics researchers was that there are universal laws that govern aesthetic response; while there is still a role for individual differences, it is marginal (Swede, 1994). This school of thought, mostly associated with Daniel Berlyne, argues that progress in understanding aesthetics can only be achieved by isolating and manipulating elements (e.g. polygons) or artistic characteristics (e.g. complexity and interestingness) of works of art and studying their effects on the observers' preferences (Martindale et al., 1990; Swede, 1994). Berlyne's (1974b) theory suggests that preference for any stimulus is a Wundt (inverted-U) curve function of the stimulus's arousal potential, which is determined by its collative (i.e. structural, or formal), psychophysical and ecological properties. Although Berlyne's theory was highly influential, subsequent studies have questioned its predictions (e.g. Martindale et al., 1990). Similarly, recent research casts doubts on many contentions of early experimental works (Boselie, 1992; Swede, 1994). Moreover, some of the strongest criticisms of the assumptions of experimental aesthetics as well as its methods are based on the importance of perceiving whole objects or meaningful forms rather than isolated elements (Arnheim, 1992). Thus, in sharp contrast to the experimental approach, Gestalt theory suggests that higher order ("tertiary" or "emergent") qualities are seen directly in things when we look at them as a whole, but do not apply to atomic parts into which things can be decomposed. Therefore, they cannot be measured by experimental aesthetics methods because the whole may sometimes exceed the sum of the elements (Osborne, 1968). Similarly, Arnheim (1988) argues that dynamic forces, rather than "things" or isolated elements determine our aesthetic experience.

The exploratory approach: The exploratory approach is mainly associated with empirical studies that evaluate complete and natural stimuli rather than manipulated, artificial ones. It is concerned more with ecologically valid stimuli (e.g. works of art, buildings, and landscapes) rather than with control of relatively simple stimuli in experimental settings. It is also more concerned with people's judgements rather than with the objective aesthetic properties of stimuli. Finally, this approach is characterized by the use of factor analysis techniques as a method of teasing out people's perceptions of the objects of interest. In this line of research, Pickford (1972) reports a series of studies of works of art based on factor analytical techniques. In the first of these studies, Pickford found a first general factor that mainly represented emotional expression and aesthetic design. The second factor represented atmospheric effect and symbolic expression. In later studies Pickford examined several of Van Gogh's paintings. A general factor emerged which was associated with emotional expression, harmony of design, harmony of colouring and dynamic expression. Hussain (1968, in Pickford, 1972) concluded that three levels exist in the development of aesthetic preference: The first level consists of 'emotional evaluation', which is the feeling produced by the object. The second level consists of 'perceptual evaluation', and includes the perception of objects' details and its

contribution to the whole impression. The third level consists of 'aesthetic evaluation', which is actually an integration of the first two levels. This level does not evolve automatically, but rather depends on complex influences.

Perhaps because of its greater ecological validity, the exploratory approach became the method of choice in research on aesthetics in environmental and architectural studies (Nasar, 1988a). Researchers in this area found that various populations (from experts to laypersons) interpret the aesthetic quality of buildings differently (e.g. Hershberger, 1969). Oostendorp and Berlyne (1978) identified four major dimensions of people's evaluations of 20 buildings representing various architectural styles (from ancient Egyptian to modern): Design clarity, hedonic tone/ arousal, complexity, and familiarity. Nasar (1984) found that responses to urban scenes in Japan and the US were similar in that preferences increased with perceived orderliness, diversity and novelty of the scenes. Evaluations of residential street scenes (Nasar, 1988b) resulted in three major dimensions: visual richness (e.g. ornateness, colourfulness and complexity), openness (vs. closeness) and clarity (vs. ambiguity). Preferences increased with levels of clarity and ornateness.

2.4. The role of aesthetics in engineering design

As mentioned earlier, engineering and aesthetics in the ancient world were married almost by definition since judgements of the product's usefulness and beauty were one and the same. The tension between the engineering and the aesthetic qualities of products has become more pronounced during and following the industrial revolution, as emphasis on mass production shifted the balance against aesthetic considerations. In the early 20th century, Loewy and Dreyfuss, two industrial design pioneers, began introducing aesthetic considerations to mass production, partially because they recognized its capacity as a marketing instrument (Petroski, 1993). An important function of aesthetics in engineering is the satisfaction of human requirements. From the consumer viewpoint, aesthetic quality can make engineering products more readily acceptable and can improve their commercial value. Yamamoto and Lambert (1994) found that aesthetically pleasing properties have a positive influence on people's preference of an industrial product. Furthermore, the impact of product appearance was stable across organizational units, and for people of different technical orientations. Yamamoto and Lambert (1994) suggest that people cannot arrange and weigh the factors in a complex decision with pure objectivity. Consequently, the product's aesthetics can act as a factor enhancing the desirability of that product. From a designer viewpoint, an aesthetic approach can also reveal solutions to hidden problems, because visual thinking leads to clarification of forms and to their organization into integrated patterns (Ashford, 1969).

The degree to which aesthetics considerations gained (or should gain) importance in the industrial landscape remains a contested issue. Norman (1988) suggested that the pendulum may have swung too much in favour of putting aesthetics ahead of usability. Recently, however, it has been argued that modern design has placed too much emphasis on performance issues and not enough on aspects, like aesthetics, that promote pleasure (e.g. Green and Jordan, 2000; Norman, 2002).

2.5. Aesthetics in human-computer interaction

Traditionally, the human–computer interaction literature expressed only passing interest in the aesthetic aspects of the interaction. In reviewing guidelines and principles advanced by human–computer interaction experts, one cannot help but notice the marginalization of the aesthetic dimension. Discussion of aesthetic issues is infrequent and is almost invariably qualified by warnings against its potentially detrimental effects (Tractinsky, 1997). Tractinsky et al. (2000) suggest that this might be the result of two different processes. One process is characterized by a "backlash to recent tendencies by the computer industry to oversell glitz and fashion in its products…" Another process relates to the field's origins "in disciplines that emphasize efficiency" rather than affect (p. 128). There is little doubt that, in general, the aesthetic criterion is an integral part of effective interaction design (Alben, 1996). Yet, readers of human–computer interaction textbooks can hardly find any reference to aesthetic considerations in design.

The rationales and guidelines often advocated for web site design resemble those used to direct human–computer interaction in general. While Neale and McCombe (1997) describe how to design a usable and visually appealing web site, the emphasis is clearly on the functional and the usability aspects of the design rather than on aesthetics. Similarly, Spool et al. (1999) assess web sites and draw guidelines based on usability as the sole criterion. Nielsen (2000) maintains that two basic approaches to web design exist: the 'artistic ideal' that reveals the designer's self-expression and the 'engineering ideal' that provide solutions to users. While "there is a need for art, fun, and general good time on the web," Nielsen contends that "the main goal of most web projects should be to make it easy for customers to perform useful tasks…" (p. 11). Hence, clear and effective communication of ideas is the design principle to follow on the Web (Lynch and Horton, 1999). What the users actually prefer is not as clear, though. Some empirical evidence suggests that beauty was the most important determinant of preferring a web site (Schenkman and Jonsson, 2000) or that it has affected perceptions of other web site qualities (van der Heijden, 2003). Indeed, in strike contrast to the principles and the guidelines advocated by usability researchers and gurus, any random perusal of web sites would suggest that aesthetic considerations are paramount in designing for the web.

2.6. The new wave: considering aesthetics in human–computer interaction and web design

Increasingly, research seeks to study the aesthetic aspects of human–computer interaction and to strike a balance between usability and aesthetic considerations. Gait (1985) was among the first to raise this issue. He claimed that more interesting interfaces increase users' arousal and sustain their interest and effectiveness. While for over a decade this sentiment was marginal at best in the human–computer interaction community, recent publications in both the popular and the academic press indicate increased awareness of this neglected aspect. For example, Apple's iMac was heralded as the "aesthetic revolution in computing" (e.g. Postrel, 2001). Researchers have also

begun studying the role of aesthetics in interaction design; its effects on the users, and its relations with users' perceptions of other system attributes and with the overall experience of their interaction (e.g. Tractinsky, 1997; Jordan, 1998; Jennings, 2000; Karvonen, 2000; Tractinsky et al., 2000; Lindgaard and Dudek, 2002).

The new wave of research on the visual aesthetics of computer interfaces suggests that aesthetics is a strong determinant of pleasure experienced by the user during the interaction (Jordan, 1998). It was found to be highly correlated with the seemingly orthogonal dimension of the system's perceived usability both before (Tractinsky, 1997) and after (Tractinsky et al., 2000) the interaction, as well as with user satisfaction (Tractinsky et al., 2000; Lindgaard and Dudek, 2002). Similarly, in the context of web sites, Schenkman and Jonsson (2000) found that beauty was a primary predictor of overall impression and preferences of web sites, while van der Heijden (2003) found that visual attractiveness of the site affected users' enjoyment as well as perceptions of ease of use and, to a lesser extent, usefulness. Karvonen (2000) suggested that simplicity may serve as a linkage between usability and aesthetics. While simplicity is considered a key guideline in creating usable systems (e.g. Nielsen, 1993, 2000), Karvonen reminds us that it is also an aesthetic notion.

Fogarty et al. (2001), claim that since computer technology has moved beyond the confinements of the work environment and into the rest of our lives, its use has expanded into wider aspects and its requirements have shifted as well. If once the value of computing technology was measured mostly by its usefulness for solving problems and by its usability, additional requirements, such as desirability, have now emerged. Issues of visual appeal and aesthetics have become an integral part of interactive systems design.

2.7. Summary

In this chapter we reviewed literature from the general aspects of aesthetics, to the more specific areas of human–computer interaction and web site design. While far from being exhaustive, the review illustrates the complexity and intricacy of the issues involved. It appears that despite its centrality to human thought and practice, aesthetics has played a negligible role in human–computer interaction research. Although recent experimental and theoretical developments demonstrate increased awareness of its importance, without appropriate tools of measuring aesthetics (regardless of how it may be defined or conceptualized) future research will be severely limited. To address this issue, this work was set to develop a measurement instrument of perceived web site aesthetics.

3. Method and results

3.1. Research approach

This study is aimed at exploring users' perceptions of the aesthetics qualities of web sites. As such, it conforms more to the tradition of exploratory studies of

aesthetics as mentioned in Section 2, rather than to the tradition of experimental aesthetics. While we do not reject the possibility of objective aesthetic qualities of artefacts, this study is clearly about subjective perceptions. Naturally, given that most likely users' visits to web sites carry some utilitarian intentions this research is not situated in a Kantian "disinterestedness" context. Finally, due to the novelty of the web medium, we did not want to confine ourselves to testing aesthetics models or theories from other domains. Therefore, we have used an exploratory research method in an attempt to tease out the relevant aesthetic perceptions.

3.2. Theoretical issues in scale development

Scale development is a longitudinal process, which involves the construction of a basic set of measurement items, followed by several iterations that test the scale's unidimensionality, reliability, and validity (e.g. Converse and Presser, 1986; Gerbing and Anderson, 1988). Using recommendations for developing measurement scales (e.g. Hinkin, 1995), we performed 4 studies that covered the following activities: item generation, scale development using exploratory factor analysis, and validity assessment and replication using confirmatory factor analysis.

Because there is scarce theory and evidence about how users evaluate the aesthetics of web sites and regarding the underlying constructs of their perceptions, we started our study in an exploratory manner. Thus, we sought first to generate a measurement model that will define the number and the nature of the dimensions that underlie users' perceptions of web site aesthetics. For this purpose we used exploratory factor analysis in the first three studies. Exploratory factor analysis is particularly suitable to identify "a set of latent constructs underlying a battery of measured variables" (Fabrigar et al., 1999, p. 275). Once we reached such a set of latent constructs we conducted a fourth study that used confirmatory factor analysis (e.g. Anderson and Gerbing, 1988; Gerbing and Anderson, 1988; MacCallum and Austin, 2000) to refine and to test the model that emerged from the preceding studies.

3.3. Issues in exploratory factor analysis

Exploratory factor analysis involves a series of design and analytical decisions that are highly consequential for the obtained results (Fabrigar et al., 1999). While the recommendations regarding these decisions are not always indisputable, we tried to follow a consensual set of recommendations that has emerged recently (Fabrigar et al., 1999; Russell, 2002; Conway and Huffcutt, 2003). These recommendations relate to the sample size, the method and criteria for factor extraction, and the factor rotation method. Regarding sample size, we followed MacCallum et al.'s (1999) suggestion that when the communalities are high (> 0.6) and the factors are well defined (have at least three or four high loadings), sample sizes of 100 are often adequate. Based on recommendations by Fabrigar et al. (1999) and Conway and Huffcutt (2003), we used a common factor model (Maximum Likelihood) as the factor extraction method. The number of factors for extraction was determined by a combination of multiple methods: the scree test, parallel analysis (Watkins, 2000),

and interpretability of the factors. Finally, based on recommendations in the above sources, we used an oblique factor rotation method. The exploratory factor analysis studies were analysed using SPSS 11.0.

3.4. Item generation

Items intended to measure the construct of perceived web site aesthetics were generated from two sources: (1) A literature review, undertaken to identify the aesthetic construct in general (Section 2 in this manuscript). (2) Eleven respondents (including 4 professional web-designers, 4 human–computer interaction researchers, 2 interior designers and an architect) were asked to provide a list of adjectives representing aesthetics. The final set of adjectives was selected from the larger pool by excluding duplicates or opposite words. A comprehensive list of 41 items was eventually compiled (see Appendix A).

The rest of this section describes the four studies.

3.5. Study 1—first cut exploratory factor analysis and item reduction

Study 1 was conducted in order to refine the item pool for measuring the perceived aesthetics of Web sites. This study involved a preliminary round of exploratory factor analysis on the original list of 41 items.

Sample: One hundred and twenty-five engineering students (36 female, 89 male with an average age of 25) volunteered to participate in the study for course credit.

Procedure: The participants worked in groups in a supervised computer laboratory. They visited a web site and completed an online questionnaire based upon their impression of that site. The participants were randomly assigned to one of two sites. Half of the participants evaluated the Times Magazine site: http://www.times.com. The other half evaluated the Universal Usability site: http://www.universalusability.org. The participants evaluated the web sites on each of the adjectives using a 7-point scale ranging from (1) "strongly disagree" to (7) "strongly agree". After the rating, we asked the participants to comment about the set of items and to propose additional adjectives that they thought were missing from the original set.

Results: Eight factors emerged with eigenvalues greater than 1.00, explaining 61.5% of the total variance. However, the scree test and the parallel analysis indicated that a 2-factor solution is more likely. In addition, evidence for the existence of two interpretable factors emerged from the results of oblique rotations of various numbers of factors (ranging from 1 to 8). Based on these results, we reviewed the list of items for items that either had loadings of less than 0.5 on their main factor, items that exhibited high cross-loadings, and items that the participants mentioned as problematic. Following this review, several items were removed or slightly modified and four new items were added to the item list.

3.6. Study 2—identifying a simple structure

The purpose of this experiment was to further refine the modified set of 35 aesthetic items and to gauge the instrument's dimensionality. A computerized

questionnaire was used to collect the data. The participants evaluated the design of two web sites based on a 7-point scale ranging from (1) "strongly disagree" to (7) "strongly agree".

Sample: Two hundred and twelve third-year undergraduate engineering students participated in this study (120 male, 92 female with an age average of 24.8) as partial fulfillment of the requirements in an introductory human–computer interaction course.

Procedure: The participants visited an e-commerce site and performed the task of ostensibly purchasing a pair of items via the site. Upon completion of the task, they answered the online questionnaire. The participants were assigned randomly to two sites: 107 participants evaluated the Gap store site http://www.gap.com, and the other 105 participants evaluated the Macy's store site http://www.macys.com. The participants worked in a supervised computer laboratory.

Results: An exploratory factor analysis was conducted on each site separately and on the combined data set from both sites. The results obtained were very similar. In all analyses, using the criteria of scree test, parallel analysis and interpretability of results, 2 factors were extracted and rotated using the Oblimin method. Based on the item loadings, we came up with a tentative characterization of the two factors. The items that are loaded on one factor represent traditional notions of aesthetics (e.g. "well organized," "clear," "clean" and "symmetrical"). Hence, we termed this factor "classical aesthetics." Most of the items that were loaded on the other factor represent qualities that go beyond the classical principles and that stress the designer's creativity and expressive power (e.g. "originality," "fascinating design," and "using special effects"). We termed this factor "expressive aesthetics."

Following this study the list was further refined and ten items which did not have loadings above 0.5 or items that had high loadings on both factors were dropped. We also dropped all items which were phrased in negative terms.

3.7. Study 3—assessing reliability and validity

The main goal of this study was to establish the two-factor structure of the aesthetics instrument and to refine it. A secondary goal was to examine and to refine instruments for other constructs that would serve in the next study to demonstrate the construct validity of the aesthetic instrument by establishing discriminant and concurrent validity. Four additional constructs were chosen for this purpose: usability, playfulness, pleasure, and service quality.

Usability: The items for the usability scale were chosen after consulting the literature (e.g. Nielsen, 1993). As mentioned in Section 2, several studies have indicated that perceptions of systems' usability and aesthetics might be related (Kurosu and Kashimura, 1995; Tractinsky, 1997; Tractinsky et al., 2000; Lindgaard and Dudek, 2002). Thus, we expect to find positive association between the aesthetics factors and usability.

Playfulness: Playfulness is a state characterized by perceptions of pleasure and involvement (Sandelands and Buckner, 1989; Webster et al., 1993). Playfulness can play an important role in human-computer interaction (e.g. Webster et al., 1993; Liu

and Arnet, 2000). The items representing the playfulness measure are a subset of the microcomputer playfulness measure introduced by Webster and Martocchio (1992). Some researchers (e.g. Csikszentmihalyi, 1990) have found association between aesthetics and the state of optimal experience, or what Csikszentmihalyi terms "flow". Flow is also used (e.g. Webster et al., 1993) as the theoretical basis for measuring and studying playfulness in human–computer interactions. Therefore, it is postulated that the playfulness measure will be positively correlated with the aesthetic measure.

Pleasure: A feeling of pleasure is mentioned as a prominent emotion accompanying the aesthetic experience (e.g. Sheppard, 1987; Fenner, 1996). It should be distinguishable from other emotions which artefacts and nature may evoke in us, such as sadness, anger, or love (Sheppard, 1987). This construct is expected to correlate positively and highly with the aesthetic measures. Items for this measure were adopted from Mehrabian and Russell (1974).

Service quality: The previous constructs were expected to be positively correlated to aesthetic perceptions. We expected that perceptions of the web site's service quality are less related to perceptions of aesthetics. Although both the visual appearance and the service quality of an e-commerce site have shown to influence users' perceptions of those sites (Liu and Arnet, 2000; Mathwick et al., 2001), there is no evidence that these two qualities are correlated. Items that operationalized this construct were adapted from the Service Quality instrument (Watson et al., 1998) and were revised to fit the context of evaluating web sites.

For evidence of concurrent validity to emerge, the aesthetics constructs would have to relate to these other four constructs as postulated above. Evidence of discriminant validity will be established by the emergence of a simple structure corresponding to the constructs used in this study.

Sample: One hundred and forty-five engineering and business undergraduate students volunteered to participate in the study (61 female, 84 male, with an average age of 24.3). The participants received course credit for their participation.

Procedure The participants browsed the HaShulchan ("The Table")—an Israeli food and wine site (http://www.hashulchan.co.il)—and completed the questionnaire, based upon their impressions of that site. The study took place in a supervised computer laboratory. The online questionnaire was similar to the perceived aesthetics instruments used in the previous experiments with the addition of items from the four other scales. The computerized questionnaire was comprised of 25 aesthetic items, 7 usability items, 6 playfulness items, 5 pleasure items and 5 service quality items (see Appendix B).

Results: First, an exploratory factor analysis was conducted for only the aesthetic items in order to confirm the construct validity of the two-factor solution. Two factors were again extracted based on the three criteria (scree test, parallel analysis, and interpretability) and then rotated using the Oblimin method. The two-factor solution explained 55.7% of the total variance. The correlation between the two factors was 0.55, and the pattern of loading was very much in line with the solution obtained in study 2, again corresponding to the "classical" and "expressive" factors. Table 1 presents the rotated pattern matrix of the aesthetic items.

Table 1
Pattern matrix of the exploratory factor analysis for the aesthetics items in Study 3

	Factor	
	1 Expressive	2 Classical
Eigenvalues	*9.344*	*8.652*
Creative	**0.842**	0.020
Artistic	**0.777**	−0.134
Modern	**0.753**	−0.092
Sophisticated	**0.733**	0.055
Uses effects	**0.723**	0.124
Colorful	**0.665**	−0.065
Original	**0.646**	0.078
Energetic	**0.628**	0.022
Beautiful	**0.597**	−0.341
Challenging	**0.582**	0.002
Fascinating	**0.502**	−0.340
Intriguing	0.478	−0.238
Designed with skill	0.468	−0.450
Professional	0.415	−0.401
Includes pictures	0.306	−0.223
Good feeling	−0.054	**−0.921**
Aesthetic	−0.017	**−0.845**
Clear	−0.205	**−0.730**
Clean	−0.060	**−0.704**
Enjoyable	0.187	**−0.667**
Pleasant	0.243	**−0.653**
Organized	0.138	**−0.532**
Admiration	0.297	**−0.525**
Exciting	0.237	−0.486
Symmetrical	0.223	−0.451

Factor loading higher than 0.5 represented in bold face.

Subsequently, an exploratory factor analysis was conducted for the entire questionnaire, specifying 6 factors for extraction (for the 2 aesthetic factors and the other 4 concurrent validity measures). The six factors accounted for 62% of the variance. While the fundamental structure of the six factors corresponded to the six hypothesized constructs (two aesthetics scales, pleasure, usability, service quality and playfulness), the rotated pattern matrix indicated that some items did not exhibit simple structure. That is, they were loaded on more than one factor. This was not unexpected, since the measures were gathered from various sources without being tested together before, had semantically overlapping items and were hypothesized to be positively correlated. In particular, some aesthetics items were also loaded on the pleasure scale and on the usability scale. In addition, a few items of the other four scales exhibited relatively low loadings on their respective factors. Finally, participants in the study complained about the awkwardness of the playfulness items in the context of evaluating the web site.

To conclude, the results of Study 3 provided additional evidence that the aesthetic scale is bi-dimensional, comprised of a factor that projects classical notions of aesthetics and a factor that emphasizes expression and creativity. Overall there seems to be a clear factor structure that corresponds to the measured constructs. However, the results also indicate that the emerging scales are not yet sufficiently distinguished and unidimensional. Thus, Study 4 was conducted to establish the final content of the scales and to assess their construct validity.

3.8. Study 4—confirmatory factor analysis

In the final Study we used confirmatory factor analysis in a "model generation" mode (Jöreskog, 1993), to finalize the aesthetics scales and to assess the unidimensionality and the construct validity of these scales (Gerbing and Anderson, 1988). The software used (AMOS 3.6) allows the researcher to modify the measurement scales in order to achieve more accurate and parsimonious model. The respecification of the model that takes place under this mode, however, might capitalize on chance fluctuations in a way that compromises the generalizability of the model (MacCallum et al., 1992). To avoid this problem, we divided the sample into two. The modifications took place in the first stage of the analysis, using the first half of the split sample. In the second stage we cross-validated the results of the first confirmatory factor analysis, using the hold-out sample.

Sample: 384 users participated in this study (173 female, 211 male, ranging in age from 17 to 67 with an average of 27). The participants were ordinary web users who volunteered in response to solicitation on discussion forums of 5 Israeli web sites: http:// www.walla.co.il, http:// www.ynet.co.il, http:// www.nana.co.il, http:// www.exego.co.il and http:// www.tapuz.co.il.

Procedure: The users who participated in the study were asked to evaluate the site in which they found the recruitment advertisement. We announced a draw of a 300 Israeli Shekels (about $70 US) prize to be awarded to one of the users at the end of the experiment. They were then redirected to the study's site and responded to an online questionnaire identical to that of Study 3 except for the playfulness items, which were not included in this study due to the negative feedback from participants in Study 3.

3.8.1. Initial validation

This stage consisted of three phases. Firstly, we validated the two-factor aesthetic model that emerged in Studies 2 and 3. We then validated the other three scales that would later be used for the construct validation of the aesthetics factors. Finally, we tested the combined measurement model of all five factors.

We start with the aesthetics factors. Each of the questionnaire's aesthetics items was classified as belonging to one of the aesthetics factors (classical aesthetics and expressive aesthetics) based on their loadings in Studies 2 and 3. This baseline model did not exhibit adequate fit: χ^2 (229, $N = 192$) = 894.822, RMSEA = 0.123, TLI = 0.758, CFI = 0.781, IFI = 0.783. The model was then modified based on examination of the structure coefficients, the standardized residual covariance

matrix, and the modification indices. Because the aesthetics items were originally generated to measure a common underlying factor, several items did not exhibit a simple structure, that is, they were loaded on both factors. These items were eliminated from the model. In addition, items that did not exhibit high loadings (at least 0.50) on their respective factors were eliminated as well. Finally, modification indices suggested that a significant improvement can be achieved by correlating the error terms of two items in the ''classic aesthetics'' factor. Related error terms are not uncommon when items share the same method as is the case in many attitude scales (McIntosh, 2001). However, correlating error terms are usually discouraged in confirmatory factor analysis, unless they can be justified on strong conceptual ground (e.g. Byrne, 2001). In this case, the correlated errors belonged to the ''clean design'' and ''clear design'' items. Since these two items obviously denote very similar approach to classical aesthetics, we allowed their errors to correlate. The final two-factor model had 5 items on each factor (see Table 2, column 2). This modified model exhibited good fit. The correlation between the two aesthetic factors was 0.61. Consequently, we concluded that a two-factor structure adequately describes aesthetic perceptions of web sites.[1]

Next, we turned to initial validation of the three other scales (usability, pleasure and service quality). A measurement model was specified for these three factors and their corresponding items. After taking into account the residual errors and the modification indices we ended up with 4 usability items, 3 pleasure items and 3 service quality items. This model exhibited moderate fit (see Table 2, column 3).

Finally, after establishing the scales for each construct, we tested a measurement model of all of the five factors. The model yielded adequate fit. Yet, the modification indices indicated that the fit can be substantially improved if the ''clear design'' item (which belongs to the classical aesthetics factor) were also used as an indicator of the usability factor. The modification, however, resulted in relatively small structure coefficients of this item on each of these factors. Nevertheless, we figure that the fact that this item was loaded on both the classical aesthetics and the usability factors is of theoretical importance. (Removing this item altogether would somewhat worsen the model's fit statistics while not affecting the correlation between the usability and the classical aesthetics factors.) Thus, we decided to retain this item as an indicator of both classical aesthetics and usability. The item loadings and the fit indices for this model are presented in Table 2, column 4.

3.8.2. Cross validation

The two-factor model of aesthetic perceptions of web sites was now tested against the hold-out sample. The model exhibited good fit (see Table 2, column 5). The structure coefficients (presented in Table 2, column 5) are very similar to those of the initial validation sample. The correlation between the two aesthetics factors is almost identical to that of the initial validation sample (see Table 3), indicating that the two

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[1] To rule out the possibility that the aesthetic items form a single factor solution, we ran a confirmatory factor analysis on the 10 aesthetic items as indicators of a single factor. The fit indices indicated very poor fit for this model: χ^2 (34, $N = 192$) = 191.508, RMSEA = 0.156, TLI = 0.783, CFI = 0.836, IFI = 0.838.

Table 2
Study 4—structure coefficients and fit indices of the initial-validation stage (Columns 2, 3, 4) and of the cross-validation stage (Columns 5, 6)

Factor/item	Initial validation aesthetics only	Initial validation other scales	Initial validation all scales	Cross validation aesthetics only	Cross validation all scales
1	2	3	4	5	6
Factor 1: Classic aesthetics					
Aesthetic design	0.87		0.85	0.86	0.84
Pleasant design	0.79		0.82	0.87	0.90
Clear design[a]	0.64		0.37[a]	0.66	0.31[a]
Clean design	0.78		0.76	0.74	0.74
Symmetric design	0.58		0.57	0.55	0.56
Factor 2: Expressive aesthetics					
Creative design	0.76		0.77	0.77	0.78
Fascinating design	0.83		0.82	0.82	0.82
Use of special effects	0.59		0.60	0.62	0.63
Original design	0.84		0.84	0.71	0.71
Sophisticated design	0.77		0.76	0.81	0.80
Factor 3: Usability					
Convenient use		0.93	0.93		0.94
Easy orientation		0.90	0.90		0.95
Easy to use		0.93	0.92		0.92
Easy to navigate		0.88	0.88		0.83
Clear design[a]			0.41[a]		0.45[a]
Factor 4: Pleasurable interaction					
Feel joyful		0.75	0.76		0.76
Feel pleasure		0.88	0.87		0.91
Feel gratified		0.84	0.85		0.78
Factor 5: Service quality					
Can count on site		0.90	0.90		0.88
Site contains no mistakes		0.69	0.69		0.62
Site provides reliable information		0.89	0.89		0.88
Fit indices					
χ^2, df	49.28, 33	69.40, 32	273.22, 158	50.22, 33	259.12, 158
Sig.	0.034	0.000	0.000	0.028	0.000
RMSEA	0.051	0.078	0.062	0.052	0.058
TLI	0.977	0.965	0.949	0.975	0.955
CFI	0.983	0.975	0.957	0.982	0.962
IFI	0.983	0.975	0.958	0.982	0.963
SRMR	0.036	0.030	0.045	0.050	0.061

All structure coefficients are significant at the 0.05 level.
[a] This item was initially considered an aesthetics item.

Table 3
Intercorrelation matrix (reliabilities) of the study's measures

	Classical aesthetics	Expressive aesthetics	Usability	Pleasure	Service quality
Classical aesthetics	(0.85) (0.86)	0.69 0.63	0.68 0.78	0.68 0.61	0.60 0.61
Expressive aesthetics		(0.87) (0.86)	0.46 0.40	0.59 0.54	0.42 0.37
Usability			(0.95) (0.95)	0.51 0.44	0.48 0.51
Pleasure				(0.86) (0.86)	0.53 0.49
Service quality					(0.86) (0.83)

In each cell, values from the initial validation sample appear above values from the cross-validation sample.
All correlations are significant at the 0.01 level.

scales measure closely related yet separate dimensions of users' perceptions of web site aesthetics.

Finally, we turned to assess the concurrent validity of the aesthetics measures. The overall five-factor model that emerged from the initial validation stage was used again to assess the relations between the aesthetics factors and the other factors. The model's structure coefficients are presented in Table 2, column 6, and its fit indices suggest adequate fit.

Table 3 presents the reliabilities (Cronbach's Alpha) of the five factors and their intercorrelations from both the initial sub-sample and the cross-validation sub-sample. All scales demonstrate high reliability. The correlation between the classic aesthetics factor and the other factors are consistently high (between 0.60 and 0.78) in both sub-samples. The correlations among the other variables are positive but not as high as with the classic aesthetics scale. The expressive aesthetics scale is less strongly associated with the other variables ($r = 0.37$ to $r = 0.59$). Of special interest is the fact that the correlation between usability and classic aesthetics is considerably higher than the correlation between the usability and expressive aesthetics. In general (with the exception of the higher than expected correlation between the service quality scale and the other scales), these findings support the reliability and the concurrent validity of the aesthetics construct.

Finally, one can also test a scale's discriminant validity by demonstrating that it is not related to variables for which there is no apparent theoretical reason to expect such relation (Webster and Martocchio, 1992). In our case, there is no theoretical reason to expect that gender or age relate to perceptions of either the classical or the expressive aesthetics factors. Indeed, the correlations were insignificant at the 0.05 level in both the initial validation and the cross-validation samples. In the initial validation sample, the Pearson correlation between classical aesthetics and age was

−0.047 and with gender −0.069 (point biserial). The correlations between expressive aesthetics and age and gender were −0.008 and 0.019 respectively. For the cross-validation sample, classical aesthetics correlated −0.133 and 0.029 with age and gender respectively, and expressive aesthetics correlated −0.074 and 0.122 with age and with gender, respectively.

4. Discussion

In this research project we developed and validated a measurement instrument of perceived web sites aesthetics. This effort is another step in our quest to comprehend the aesthetic attitude of web users, which has been largely overlooked until recently. Furthermore, developing valid measures is a prerequisite for future study and design of the aesthetic aspect of web sites. The availability of such measures facilitates better understanding of human–computer interaction phenomena, such as the apparent paradoxical association between aesthetics and usability.

Due to the paucity of prior research in this area, we started in an exploratory manner. Three general stages were undertaken in order to develop the perceived aesthetics measures. In the first stage, based upon a broad literature review and experts' knowledge, the preliminary set of items reflecting perceptions of aesthetics was generated. Following that, exploratory and then confirmatory factor analyses were conducted to refine the emerging scales and to assess their reliability and validity.

One of this study's strengths lies in the fact that the perceptions of the web sites were studied in two different settings: university students in a lab and ordinary users in their natural (web) environment. In addition, the users evaluated both Hebrew (Israeli) and English (US) web sites, diminishing potential cultural or lingual colouring of the results. Moreover, the study used various types of web sites in order not to restrict the instrument to a specific web site genre.

4.1. Emerged dimensions and internal consistency

We began this investigation with no conjecture whatsoever regarding the type of aesthetic qualities that would emerge at the end of the process. The development process resulted in a two-dimensional structure of perceived web site aesthetics. The first dimension is represented by items that refer to the following design attributes of the web site: aesthetic, pleasant, clean, clear and symmetrical. It corresponds to the "visual clarity" dimension (Nasar, 1999) of the web site. This factor seems to represent qualities embraced by classical notions of what constitutes aesthetic design (Johnson, 1994; Kruft, 1994). In the words of Alberti, perhaps the most influential Renaissance architect, "it is the property and business of the design to appoint to the edifice and all its parts their proper places, determinate number, just proportion and beautiful order…" (cited in Johnson, 1994, p. 95). Accordingly, we termed this factor "classical aesthetics".

The second dimension is represented by the following design attributes: creative, using special effects, original, sophisticated and fascinating. This factor seems to

capture users' perceptions of the creativity and originality of the site's design. It corresponds to the visual richness dimension (Nasar, 1999) of the site, which includes ornamentation and expressions of the designers' character, creativity and originality. This facet of aesthetics reflect to some extent the revolutionary approach introduced by the Romantic period *vis a vis* classical concepts (Arnheim, 1964/66; Osborne, 1968). Consequently, we termed this factor "expressive aesthetics."

The two factors resemble findings from other fields. For example, two central factors that emerged in empirical studies of environmental aesthetics are the clarity/orderliness factor and the richness/diversity/ornateness factor (e.g. Oostendorp and Berlyne, 1978; Nasar, 1984, 1988b, 1999), which correspond to our first and second factors, respectively. Indeed, the two factors reflect two notable aesthetic qualities of landscape design—order and complexity—as distinguished by Arnheim (1966). "Order may be defined as the degree and kind of lawfulness governing the relations among the parts of an entity…Complexity is the multiplicity of the relationships among the parts of an entity." (p. 123). Similarly, Kaplan (1988) suggest that human preference for landscapes is affected by the degree to which the landscape "makes sense" (i.e. is clear and legible) and the degree to which it is stimulating on the other hand. The relations between these two qualities are not predefined, and good design should strive to balance their degrees given the design context. Thus, "complexity without order produces confusion; order without complexity produces boredom" (Arnheim, 1966, p. 124). Of Nasar's (1988b) dimensions of housing scenes—visual richness, clarity and openness—the former two dimensions clearly echo the observations of Arnheim and Kaplan as well as ours. The clarity dimension, which corresponds to Arnheim's order, to Kaplan's legibility and to our classical aesthetics, increases understanding and sense making and reduces ambiguity. The diversity dimension, which corresponds to Arnheim's complexity, to Kaplan's stimulating factor and to our expressive aesthetics increases arousal or involvement.

The two dimensions of perceived aesthetics demonstrate high internal consistency. The confirmatory factor analysis results indicate that they are highly correlated, yet distinctive factors. It is possible that the emergence of these two factors, and the similarity that they exhibit to landscape theories may reflect the more dynamic nature of web sites (e.g. Jennings, 2000) as opposed to the passive nature of works of art, which was mainly studied in past research on aesthetics (Pickford, 1972). Despite being demonstrably distinct, the positive high correlation between the two aesthetic factors reflects the underlying sense of visual beauty that both factors share. It may also indicate a middle ground chosen by designers of established web sites in an attempt to balance clarity and expressions, order and complexity. Future study on select web sites will be needed to clarify this issue.

4.2. The aesthetics factors and other constructs

In addition to establishing the existence of two distinct dimensions of web site aesthetics, this study has also examined the relations of these dimensions with other perceived qualities of the web site in order to confirm the discriminant and the concurrent validities of the aesthetics scales. The good fit of the final measurement

model (see Table 2, column 6) provides evidence for discriminant validity. With the exception of one item, which was retained for theoretical reasons to demonstrate the relations between classical aesthetics and usability, all other items reflect simple structure. Further, Kline (1998) suggests that to demonstrate discriminant validity the correlations between factors should not be greater than 0.85. The correlations between the factors in this study (see Table 3), while positive and quite high as expected, are not exceedingly high (between 0.37 to 0.78.), again, supporting the discriminant validity of the aesthetic factors.

Concurrent validity was demonstrated by the directionality and magnitude of correlations between the aesthetics scales and other measures. The literature is ripe with references to the relations between aesthetics and pleasure (e.g. Sheppard, 1987). Indeed, the results indicate that the correlations with pleasure were of similar magnitude for both aesthetic dimensions, with somewhat higher correlations for classical aesthetics.

Concurrent validity was also assessed by examining the relationship between the aesthetics factors and the service quality factor. These correlations were higher than expected. A possible explanation for these results may be the presence of common method bias (Campbell and Fiske, 1959). This concern can be alleviated to some extent by the fact that the differences in correlations among the factors were in the expected direction. That is, the correlations of the aesthetic factors with service quality were still lower than the correlations of each of the aesthetic factors with any of the other factors. It is also possible that some dimensions of the user experience colour perceptions of other dimensions. While it may be that users' satisfaction with the site's service quality influences their evaluation of other factors like the site's aesthetics, recent research suggests that aesthetics is the primal factor affecting other site perceptions (e.g. Tractinsky et al., 2000; van der Heijden, 2003).

Finally, support for the concurrent validity of the aesthetics measures is provided by the positive correlations with the perceived usability of the sites. The relationship between usability and aesthetic is of particular interest. Early findings that perceptions of aesthetics and usability are highly correlated (e.g. Kurosu and Kashimura, 1995; Tractinsky, 1997; Tractinsky et al., 2000) were surprising. The results of this research not only confirm those findings, but they also shed new light on the usability-aesthetics relations. As can be seen in Table 3, perceived usability was correlated substantially higher with the classic aesthetic dimension than with the expressive aesthetic dimension. In fact, some items (e.g. "clear design") reflect both classical aesthetics and perceived usability at the same time. Thus, it appears that the finer grain view of perceived aesthetics (that is, measuring two aesthetic dimensions rather than a general single construct) facilitates better understanding of this apparent paradoxical relationship. In discussing the aesthetic process, Cupchik (1992) distinguishes between several dimensions of artistic production. One such dimension is the contrast between the discipline of form and the sensuality of expression. The other dimension refers to the tension between following of rules and control on the one hand, and expression and vision on the other hand. Our work reveals that users judge web sites on both of these dimensions. They consider the aesthetic qualities of the disciplined, clear and controlled design that follows the classical rules. At the same time they also appreciate the expressive and innovative

attempts of designers as contributions to the aesthetics of web sites. However, one of the aesthetic factors—classical design—is strongly related to the perceived usability of the site while the other is less so. Thus, the classical aesthetic dimension may serve as a linkage between usability and aesthetics, being both an aesthetic concept and a usability principle (e.g. Karvonen, 2000). In a sense, this factor may represent the functionalist ideal as perceived by the users, where beauty is determined by the extent to which form follows function.

4.3. Limitations and future research

Clearly, this study is subject to some limitations. The results might have been influenced by certain confounding factors. Familiarity with the web site, for example, could have influenced the users' perception and evaluation. In other words, when participants responded to the questionnaire regarding the site's visual appearance, their answers may have been tainted by their past interactions with the site. This is particularly a concern regarding Study 4, in which respondents were recruited by advertisements in the evaluated sites. This concern has to be mitigated, however, by the fact that familiarity with sites in the previous studies (1 through 3) was lower, while the basic findings regarding the two aesthetics factors were similar. Yet, future studies may focus on comparing first impressions of web sites to aesthetic evaluations of familiar sites. Such a comparison would certainly increase our understanding of the dynamics of aesthetic perceptions of web sites and the relation of these perceptions to other perceived site qualities.

Another possible contaminating factor in this study relates to language and culture. In this research, some of the sites examined (in Experiments 1 and 2) were in English while the rest were in Hebrew (in Experiments 3 and 4). While the findings from these four studies show general stability and convergence, we have no way to completely rule out this potential bias. The difference between cultures might become significant when dealing with the issue of aesthetics, which might vary across cultures. For example, Karvonen (2000) points out the Finnish sense for simplicity and functionality; however, these notions of aesthetics may not be shared by other cultures.

It is important to note that, as in any case of measure development, the aesthetics scales emerged from a process that involved making judgements and interpretations of the data. It is conceivable that given different routes of item identification and scale adjustments, somewhat different factors could have emerged. However, we feel quite confident with the scale development process for two reasons. First, we have followed the most recent recommendations regarding scale development (e.g. MacCallum et al., 1992; Fabrigar et al., 1999; Russell, 2002; Conway and Huffcutt, 2003). In addition, the emerged scales conform to two established views of aesthetics, as is evident from the literature in fields of design, art, architecture and philosophy. Nevertheless, because the aesthetics literature is so multifaceted and because many ideas have surfaced regarding perceptions of aesthetics, it would be naïve to suggest that the only way to model users' aesthetic perceptions of web sites is through the lenses of the dimensions that we termed classical and expressive. Obviously, there may be other dimensions or other typologies of perceived web site aesthetics that did

not emerge in this study. These may be detected as further attempts are made to validate the current two-factor structure, or with a more directional (as opposed to exploratory) approach, driven by certain theoretical frameworks of aesthetics. One such approach, for example, is Hermeren (1988) distinction between five types of aesthetic qualities: Emotion qualities, behaviour qualities, gestalt qualities, taste qualities and reaction qualities. Studies can examine the design of interactive systems from each of these perspectives and their usefulness for understanding various human–computer interaction phenomena.

Future research may also test the adequacy of the aesthetics scales to other human–computer interaction domains. Despite the growing popularity of the web, other interactive forms exist that can benefit from understanding users' perceptions. We believe that the scales developed here capture the essence of the visual aesthetic experience in human–computer interaction regardless of the medium used to facilitate the interaction, although the two factor distinction may be more pronounced in certain application genres than in others.

The measures developed in this study are based on a sample of mostly naïve users. These perceptions may not coincide with those of expert designers, philosophers, or critics of aesthetic artefacts. In many cases, laymen evaluations of aesthetic objects differ from those of experts and practitioners (e.g. Getzels and Csikszentmihalyi, 1969; Hershberger, 1969; Winston, 1992; Hekkert and van Wieringen, 1996). It would be interesting to compare this study's findings with aesthetic evaluations from the other groups and to study how overall evaluations of the web sites are influenced by the potentially different aesthetic judgements.

This study was not designed to investigate how the two aesthetic dimensions affect preferences of web sites. Clearly, each of these dimensions lends itself to more or less "professional" design; each of these dimensions can be overdone to the extent of being incoherent or utterly lifeless; and each of these dimensions can pose challenges to designers' creativity. Consequently, there are many sub-factors associated with each of these dimensions that can eventually determine user preferences. We expect that individual and cultural differences will prove to be important contingencies here, as well as users' objectives, and perhaps design trends and web site genres.

Finally, scale development is a process that really never ends (Spector, 1992). Validation should occur in a cumulative, on-going process, involving multiple methods and samples. This study represents only an initial examination of the users' perceptions of web site aesthetics. Further research is needed in order to provide additional support to our findings and to evaluate web site aesthetics from different perspectives. Such research may use novel measurement methods, including biophysical measures (Jacobsen and Höfel, 2001; Scheirer et al., 2002) in order to assess users' response to aesthetic stimuli. In addition, the scales' stability over time should also be examined (Ghiselli et al., 1981).

5. Conclusion

This work examined users' perceptions of web site aesthetics. We found that these perceptions consist of two main dimensions, which we termed classical aesthetics and

expressive aesthetics. The classical aesthetics dimension pertains to aesthetic notions that presided from antiquity until the 18th century. These notions emphasize orderly and clear design. The expressive aesthetics dimension is reflected by the designers' creativity and originality and by the ability to break design conventions. While both dimensions of perceived aesthetic are drawn from a pool of aesthetic judgements, they are clearly distinguishable from each other. Each of the aesthetic dimensions is measured by a five-item scale. The reliabilities, factor structure and validity tests indicate that these items reflect the aesthetics scales adequately.

While interest in all aspects of the human–computer interaction experience is emerging, relatively little is known about users' preferences outside the realm of efficient task performance. This research contributes to our knowledge by establishing the existence of aesthetics as a distinguishable, measurable construct in the field of human–computer interaction. It also hints at a possible resolution to the apparent paradoxical relation of perceptions of aesthetics and usability by demonstrating that the classical aesthetics dimension is more closely related to perceived usability relative to the expressive aesthetics dimension. Finally, the proposed aesthetic measures can serve in future empirical research not only about the visual aesthetics of web sites but also about the entire user experience.

Appendix A. Items used in Study 1

1.	Admirable
2.	Dull
3.	Original
4.	Noisy
5.	Site has unique character
6.	Complex
7.	Intriguing
8.	Pleasing
9.	Colourful
10.	Sophisticated
11.	Vulgar
12.	Exciting
13.	Old fashioned
14.	Fun
15.	Clear
16.	Fascinating
17.	Lack imagination
18.	Standard
19.	Organized
20.	Creative
21.	Enjoyable
22.	Uses special effects
23.	Realistic appearance

24.	Harmonic
25.	Modern
26.	Beautiful
27.	Monotonous
28.	Artistic
29.	Skilfully designed
30.	Symmetrical
31.	Applies good taste
32.	Energetic
33.	Challenging
34.	Convenient
35.	Wretched
36.	Simple
37.	Pleasant
38.	Overloaded
39.	Clean
40.	Professional
41.	Aesthetic

Appendix B. Items used in Study 3

Aesthetics items ([a,b]) denote items that were retained for the final classical and expressive scales, respectively.

1.	Admirable
2.	Original[b]
3.	Clean[a]
4.	Pleasing
5.	Sophisticated[b]
6.	Breathtaking
7.	Clear[a]
8.	Fascinating[b]
9.	Organized
10.	Creative[b]
11.	Enjoyable
12.	Uses special effects[b]
13.	Beautiful
14.	Artistic
15.	Skilfully designed
16.	Colourful
17.	Energetic
18.	Modern
19.	Pleasant[a]
20.	Professional

21.	Includes pictures
22.	Symmetrical[a]
23.	Challenging
24.	Intriguing
25.	Aesthetic[a]

Items used for other constructs (*) denotes items that were retained for the final scales.

Usability
1. Convenient*
2. Easy orientation*
3. Satisfactory
4. Efficient
5. Easy to use*
6. Easy to navigate*
7. Confusing

Playfulness (I feel …)
1. Spontaneous
2. Imaginative
3. Creative
4. Happiness
5. Original
6. Innovative

Pleasure (I feel …)
1. Joyful*
2. Pleasure*
3. Gratified*
4. Satisfied
5. Relaxed

Service quality
1. The site is reliable*
2. The site provides reliable information*
3. The site makes no mistakes*
4. There are no unnecessary service delays
5. The site helps in solving users' problems

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